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

RESEARCH ARTICLES

M.A. MARGARIDO, G.R. DOS SANTOS, C.E. DE FREITAS VIAN, P.F. ASSIS SHIKIDA, B.F. CARDOSO BAUERMANN – CIDE and elasticity oscillation on the ethanol and gasoline market: Brazilian taxation policy under discussion 3

V. ZANIN, J.M. TONIN, V. HALMENSCHLAGER – Asymmetric price transmission in the commercialization of rice in Brazil 19

I. BERNETTI, V. ALAMPI SOTTINI, M. CIPOLLARO, S. MENGHINI – A survey on the performance of the Italian brewing companies 37

A. DI FONZO, C. LIBERATI – Consumers are unaware about European legislation on communication of the health benefits conveyed by claims. An empirical survey 51

C. MENNA, F. GANDOLFI, M. PASSARI, M. CANNELLINI, G. TRENTIN, T. DEL GIUDICE, C. CAVALLO, I. CIGLIANO – Farm advisory services and knowledge growth in Italy: comparison among three regional intervention models 61

FIRENZE UNIVERSITY PRESS

Vol. 75 I n. 1 | 2020

Italian Review of Agricultural Economics

Vol. 75, n. 1 – 2020

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

REA | ITALIAN REVIEW OF AGRICULTURAL ECONOMICS

Firenze University Press
www.fupress.com/rea

Citation: M.A. Margarido, G.R. dos Santos, C.E. de Freitas Vian, P.F. Assis Shikida, B.F. Cardoso Bauermann (2020) CIDE and elasticity oscillation on the ethanol and gasoline market: Brazilian taxation policy under discussion. *Italian Review of Agricultural Economics* 75(1): 3-17. doi: 10.13128/rea-11738

Received: June 29, 2019

Revised: December 24, 2019

Accepted: March 18, 2020

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.

CIDE and elasticity oscillation on the ethanol and gasoline market: Brazilian taxation policy under discussion

Mario Antonio Margarido[1], Gesmar Rosa dos Santos[2], Carlos Eduardo de Freitas Vian[3], Pery Francisco Assis Shikida[4], Bárbara Françoise Cardoso Bauermann[5]

[1] *Institute of Agricultural Economics - São Paulo, Brazil*
[2] *Institute for Applied Economic Research - Brasília, Brazil*
[3] *Luiz de Queiroz College of Agriculture, University of São Paulo - Piracicaba, Brazil*
[4] *Western Paraná State University (UNIOESTE) - Toledo, Brazil*
[5] *University Centre União Dinâmica das Cataratas (UDC) - Foz do Iguaçu, Brazil*

Abstract. The aim of this paper is to identify the path of the gasoline price elasticity, ethanol price elasticity, ethanol-gasoline cross-price elasticity and the gasoline-ethanol cross-price elasticity for the flex-fuel vehicle market, as well as to discuss the taxation policies impact of the Economic Domain Intervention Contribution (CIDE) on the ethanol and gasoline markets. Therefore, it was used the Structural Methodology model, as well as official data from 2003 to 2007. The results show great power of influence of the tax on the gasoline's price and on the costumer's choice between ethanol or gasoline. Thus, the CIDE is one of the most important reasons for ethanol consume, contributing to an effective reduction in the green house gases and atmospheric pollutants emissions.

Keywords: Brazilian taxation policy, price elasticity, ethanol, gasoline, consumer's choice.
JEL codes: Q42, Q48.

1. INTRODUCTION

The importance of the biofuel industry to the Brazilian economy, the urban environment and the country's strategic positioning in the world energy matrix is widely known (Brazil, 2006; Milanez *et al,*. 2012; Moraes, Bacchi, 2014; Santos, 2016). This importance dates back to the 1930s with the implementation of the Sugar and Alcohol Institute (IAA), gaining even greater relevance with the creation of the National Alcohol Program (PROÁLCOOL) in 1975, motivated by the petroleum crisis and the need to reduce its dependence. Since then, it has been important the Government participation in promoting competition, supporting technological innovation and improving policies for the biofuel industry (Shikida *et al.,* 2014).

Furthermore, there is the fact that biofuels are substitutes for petroleum derivatives, which have larger-scale production and more stable technological trajectory. Even though fossil fuels generate environmental pollution and damages to the health, which are not considered in their pricing, they have a lower cost than biofuels (Cardoso *et al.,* 2017; Santos, 2016; Neves, Conejero, 2010).

In this context, public policies have the purpose to actin the biofuels production viability, in such away that they would have conditions of competitiveness via price against fossil derivatives (Kutas *et al.,* 2007; Steenblik, 2007; Bentivoglio, Rasetti, 2015). It is not e worthy that PROÁLCOOL granted fiscal incentives for acquisition of exclusively ethanol driven cars to encourage the creation of the ethanol market. At that time, the decision for using one or other fuel was made at the car purchase time and not every refueling. At this stage, ethanol and gasoline were not substitutes (Moraes, Bacchi, 2014).

Although ethanol and gasoline are not perfect substitutes, consumers have been reacting to the hydrated ethanol price oscillations in relation to gasoline. Thus, consumers reaction to the fuel price oscillations with a specific tax, which is the Contribution of Intervention in the Economic Domain (CIDE-Fuels), is this paper's focus.

Before focusing specifically on this theme, it should be noted that historically government measures have been taken in four main thematic groups in attempt to favor biofuels, such as: i) establishment of a «market reserve» for the biofuel industry (for example, establishing a mandatory blend of 27% into gasoline); ii) the contribution of public resources to selected actions (such as research and an hydrous ethanol technology, credit subsidy, technology adoption programs); iii) supply regulation and diversification measures (storage support, ethanol supply obligation at pumps, support for the sugarcane-bagasse electricity generation); iv) exemptions and differentiation tax (Santos, 2016; Szmrecsányi, Sá, 2002).

In this context, this paper approaches the behavior of the ethanol and gasoline market in relation to only one thematic group – item iv. To this end, efforts are focused on CIDE-Fuels, or simply CIDE, because it is the main federal and the most oscillating fuel tax. Other aspects of the fuel production chain complexity – such as supply conditions, variations in other taxes, among others – are not focused in this paper.

It is easy to note that in the four groups of actions mentioned above, there are incentives for consumers to have the opportunity to choose between ethanol and gasoline for the price when arriving at the gas station. Given the other conditions and market dynamics, the hypothesis that justifies the actions in i, ii, iii and iv by the government is that they tend to balance ethanol-gasoline relative prices, mainly when there are petroleum and its derivatives price falls or macroeconomic policies changes. Such events, in this case, can make gasoline more competitive against hydrated ethanol, which demands public policies. Therefore, when approaching this issue from a stricter point of view to the economy, it is necessary to analyze the behavior of the ethanol price elasticity, gasoline price elasticity and the ethanol-gasoline cross-price elasticity. This is because the government actions tend to influence and, at the same time, to be influenced by decisions made involving the elasticities under analysis, even if not purposely.

Despite the well-known theses that are expected negative responses to tax rises, as well as the Government interference in the fuel industry, the justification for the government actions from the CIDE is to induce the consumption of a health-beneficial fuel – remembering that the CIDE is levied on gasoline and only occasionally on ethanol. Therefore, it is important to study the elasticities, so that the measures are improved in the context of the public spending optimization and the achievement of environmental and social aims (Costa, Burnquist, 2016).

Thus, the aim of this paper is to identify the path of the gasoline price elasticity, ethanol price elasticity, ethanol-gasoline cross-price elasticity, and the gasoline-ethanol cross-price elasticity for the flex-fuel vehicle market, using the Structural Model. In addition, it aims to verify the responses recorded by the market, expressed by the elasticities, on the government shock measures to induce price equilibrium. It is believed that, in this way, it can be offered one more way to assess the impacts of government policies on the fuel market, and to design more effective and efficient ethanol policies.

Considering that Brazil is one of the main ethanol producers and exporters worldwide, it is important to understand the ethanol price formation in Brazil, highlighting the Brazilian taxation policy. It can be an example for other countries since it represents an incentive for Brazilian people to consume a health-beneficial fuel. Other countries can adopt a similar system to help their economy.

2. BRIEF CONTEXT OF THE BRAZILIAN TAXATION POLICY ON FUELS

Since the Brazilian Revolution of 1930, government intervention has been strongly present in ethanol policies. In 1933 the Institute of Sugar and Alcohol

(IAA) was created, whose aim was to regulate the sugar and alcohol industry (Szmrecsányi, Sá, 2002). Another important fact for the boost of this industry was the institution of the National Alcohol Program (PROÁLCOOL) after the petroleum crises in the 1970s. It was from this Program that the ethanol production and use showed a significant increase, because the ethanol was consolidated as fuel, initially only an hydrous ethanol and, later, hydrated ethanol[1].

Brazil has been investing in the ethanol production since the 1970s, taking advantage of the natural competitiveness of sugarcane production in this country. Before that, the first incentive to boost ethanol production was through the Decree 19,717/1931, which determined the obligatory blend mandate of 5% of ethanol into imported gasoline; for vehicles of public agencies such obligation was 10% (Szmrecsányi, Sá, 2002).

In 1938 fossil fuel policies were set, with the creation of the National Petroleum Council (CNP), in which although it had federal scope, it gave the states and municipalities autonomy to create taxes on operations involving petroleum and its derivatives, such as production, distribution, marketing, consumption and import. However, in 1940, a new Law entrusted the Union to create such taxes, being levied on fuels the Import Tax (II), Sales and Consignments Tax (IVC) and Unique Tax on Fuels and Lubricants (IUCL) (Lima, 2016).

With the military dictatorship occurred in Brazil in 1964, there was a tax reform, which implied changes in the fuel prices formation. For example, the IVC was replaced by the Tax on Operations Related to the Goods Circulation and on Services of Interstate and Intercity Transport, and Communication Services (ICMS). As for the IUCL, Lima (2016, p.6) states that its rates «are now levied on tabulated amounts, fixed by the CNP. To these values, additional parcels have been added, denominated lines. The amount obtained with the sum of these lines constituted the billing price» (Lima, 2016). However, in 1980, the IUCL started to have a specific base for its computation, dissociating itself from the petroleum cost.

Furthermore, the Contribution to Social Integration Programmes (PIS), the Contribution to the Programme of Public Servants' Patrimony Formation (PASEP) and the Social Investment Fund (FINSOCIAL), which were created to be levy on business income, started to be accounted for in the fuels price in refineries (Lima, 2016).

In the 1970s, with the creation of PROÁLCOOL, the Brazilian government implemented fiscal policies to encourage the acquisition of ethanol-driven cars, since the technology did not allow the exchange of fuels. Ethanol-driven cars had lower tax, like ICMS, Taxes on Industrialized Products (IPI) and Motor Vehicle Property Tax (IPVA). In addition, the government committed to keep the ethanol price at 65% of the value paid for gasoline. With these incentives and the evolution of engine technology, sales of ethanol-driven cars grew exponentially until the late 1980s.

Currently, by Decree 9,101/2017, the main taxes which are levied on fuels are ICMS, PIS/PASEP and CIDE. CIDE was established in 2001 and has come to be considered the main instrument of government intervention to guarantee ethanol competitiveness, precisely because it was levied on gasoline.

It is worth noting that the tax burden varies according to the type of fuel and some also vary according to the Brazilian states. ICMS is an example; but, on average, its rate remains around 25% to 34% of the gasoline value; 12% to 25% of the diesel value; and from 12% to 30% of the ethanol value.

PIS/PASEP (unified in 1975) is a federal tax whose rate are R$ 0.7925/litre of gasoline, R$ 0.4615/litre of diesel and R$ 0.1309/litre of ethanol. CIDE, the focus of this study, is also a federal tax and its rate are R$ 0.10/litre of gasoline, R$ 0.05/litre of diesel and it is not levied on ethanol in the period here highlighted (2003-2007). Thus, taxes which are levied on gasoline correspond to 45% of its price, while taxes on ethanol represent 28% (National Federation of Fuels and Lubricants Trade – Fecombustíveis 2017).

Considering the taxation on fuels in São Paulo State at the beginning of 2017, it is estimated that the federal taxes value (CIDE, PIS and COFINS–Contribution for Social Security Financing) is R$ 0.652 for gasoline and R$ 0.242 for ethanol, remembering that CIDE aliquot is zero for ethanol; while the state tax (ICMS) is R$ 0.903 for gasoline and R$ 0.293 for ethanol. Thus, taxes total R$ 1.555 for gasoline and R$ 0.535 for ethanol (referring to October 2017). Considering the average selling price to consumers, the PIS/COFINS and CIDE values for gasoline correspond to approximately 73% of the value established by Decree 9,101/2017, due to the 27% of anhydrous ethanol present in the blend (Fecombustíveis 2017).

As for price formation, Lima (2016) argues that the final price paid by consumers is formed by the product value plus the taxes. In the case of gasoline, consumers also pay for the ethanol price added into gasoline. Luca and Barbosa (2016) corroborate adding that the taxes value considered in the final price paid by consumers is that in which is levied on the production, improvement, transportation, commercialization and resale of fuels. In

[1] It is emphasized that the hydrated type is the one used directly on the engines as fuel, while the anhydrous type is used in mixture with the gasoline.

this way, all or almost all of the tax burden is paid by consumers.

According to Costa and Guilhoto (2011), the final ethanol price paid by consumers is relatively more competitive vis-a-vis the gasoline price when considering CIDE rate and the differentiated ICMS rate. However, CIDE cannot be considered as the main factor in the increase of the ethanol competitiveness in relation to gasoline, since it has been used more as an inflationary control than a stimulus to the ethanol consumption. It was evident during the financial crisis of 2008, in which the CIDE rate decreased from R$ 0.28 to R$ 0.18 per liter.

In the early 2000s, with the introduction of the flex-fuel vehicle in Brazil, the ethanol use as a pure fuel without addition of gasoline was further expanded. For these vehicles, consumers could choose between ethanol or gasoline, or a mixture between both. Thus, assuming there is no price control and strong macroeconomic policy influences, when the petroleum and its derivatives prices are high, ethanol consumption is favored and, therefore, its production increases (Santos, 2016).

Thus, top revent the petroleum price instability from significantly affecting the sugar and alcohol sector, the government decided to obligate ethanol mixture into gasoline, guaranteeing part of the ethanol production and consumption. By Law 13,033/2014, such mixture is 27% of ethanol anhydrous into gasoline. Since 2016, the government also opted to defend the market autonomy regarding the practice of fuel prices in general, based on the PETROBRÁS autonomy as the main gasoline producer and distributor and an important stakeholder in the ethanol distribution.

3. METHODOLOGY

Most of the studies that address the issue of the fuel market elasticities in Brazil use traditional time series models focused on cointegration, which have the advantage of producing elasticities of both short-and long-term. However, the elasticities values are average values for a given period. In this way, this study uses the Structural Model, since it has the advantage of obtaining the point-to-point elasticities for the analyzed period. This information will be useful in identifying the intensity of consumers responses and behavior in relation to the government measures which impact some goods prices.

3.1. Theoretical model

According to Hughes *et al.* (2006), several studies on the gasoline price elasticity are based on microeconomic theory, being the quantity demanded of product as an inverse function of gasoline price and a direct function of income. More specifically, as stated by Sterner and Dahl (1992), the gasoline demand model is based on the hypothesis that the utility function of the consumer depends on gasoline demand (*GD*) plus aggregate demand for other goods (*OD*). Consumers know both the gasoline price (*GP*) and the other goods prices (*OP*) – hypothesis of full rationality, being the other goods prices represented by the consumer price index. Based on the assumption that consumers are rational, they choose *GP* and *OP* in such a way as to maximize their respective utility function, which is given by their respective budget constraint, represented as $(GP^*GD)+(OP^*OD)\leq Y$, where Y is the consumer's income.

Therefore, the equation to be maximized is the combination of the consumer utility function and its budget constraint, $U(GD,OD)+\lambda[Y-(GP^*GD)-(OP^*OD)]$, where λ is Lagrange multiplier. Based on the hypothesis of the traditional neoclassical microeconomic model, it is estimated that the quantity demanded of gasoline is a function of the gasoline price, the substitute good price and of the income. However, in the case of the non-existence of a substitute for gasoline, the determination of the gasoline price elasticity presents a more restricted econometric model, since the amount of gasoline consumed depends only on its own price and on the consumer's income. This model is written as:

$$lnGD_t=\beta_0+\beta_1\, lnGP_t+\beta_2\, lnY_t+\varepsilon_t \quad (1)$$

where GD_t corresponds to the quantity demanded of gasoline; β_0 is the constant; β_1 represents the price elasticity; GP_t is the gasoline price; β_2 is the income elasticity; and Y_t is the consumer's income. Finally, ε_t corresponds to the residues which, by hypothesis, are random. Considering that the variables are in the logarithmic format, the estimated coefficients correspond to the respective elasticities.

Alves and Bueno (2003) estimated the gasoline demand for Brazil using Engle-Granger's cointegration method (Engle, Granger, 1991) based on equation (1), which represents gasoline demand models. One item that distinguishes this model from the models applied in the international market is the introduction of the ethanol price as a substitute for gasoline. The econometric model for the gasoline demand has this composition:

$$lnGD_t=\beta_0+\beta_1\, lnGP_t+\beta_2\, lnY_t+\beta_3\, lnEP_t+\varepsilon_t \quad (2)$$

where β_3 is the cross-price elasticity and EP_t is the ethanol price, while the other variables and parameters remain the same as in equation (1).

However, when Alves and Bueno's study was developed, the flex-fuel car technology was not used on a commercial scale yet, since this technology started being commercialized only from 2003. On the other hand, from 2003 onwards, the use of flex-fuel vehicles showed an upward trend, reaching almost 80% of the new vehicles that went into circulation in São Paulo State in 2012.

In this context, this paper analyses both the gasoline and the ethanol market, emphasizing that the introduction of the flex-fuel car was a watershed, allowing the consumer greater freedom in terms of which fuel to use. Thus, a second model was estimated aiming to determine the ethanol demand:

$$lnED_t=\beta_0+\beta_1\ lnGP_t+\beta_2\ lnY_t+\beta_3\ lnEP_t+\varepsilon_t \quad (3)$$

where ED_t represents the quantity demanded of ethanol; and the other elements have already been defined previously.

From models (2) and (3),the respective long-run elasticities can be estimated as:

$$\frac{\partial lnGD_t}{\partial lnGP_t}=\beta_1;\ \frac{\partial lnGD_t}{\partial lnY_t}=\beta_2;\ \frac{\partial lnGD_t}{\partial lnEP_t}=\beta_3 \quad (4)$$

where the first term corresponds to the gasoline price elasticity; the second represents the gasoline income elasticity, and the third represents the cross-price elasticity between ethanol price and the quantity demanded of gasoline. Similar reasoning applies to the calculations of the long-run elasticities of the ethanol demand model.

3.2. Data

This paper analyses price elasticities and cross-price elasticities in the gasoline and ethanol markets, using data from São Paulo State because it is statistically representative of Brazil. The series used were: gasoline average price (*Gasoline price*); amount of gasoline commercialized (*Gasoline sale*); hydrated ethanol average price (*Ethanol price*); and amount of hydrated ethanol commercialized (*Ethanol sale*). All these variables were obtained for retail in São Paulo State in the Price Survey System of the National Agency of Petroleum, Natural Gas and Biofuels (ANP, 2018). Brazilian Gross Domestic Product (GDP-BR) was used as proxy for income, whose source was the Institute of Applied Economic Research database (IPEADATA, 2017).

All variables were used in logarithm form, so their estimated coefficients represent their respective elasticities. To identify variables in logarithmic form, the letter *L* was added at the beginning of their acronym. The period analyzed is from January 2003 to May 2017.

In order to verify the impacts due to government measures, data about fuel tax were used (Tab. 1). Selected data refers to the months when there was some oscillation on taxes.

3.3. Structural Model

Traditional econometric methods, such as regression or time series models, for example, Transfer Function Models, Engle-Granger Cointegration and Vector Error Correction Model (VECM), among others, allow one to estimate the mean elasticity in both the short-and long-run period. However, such methods do not consider the unobservable components, which will be presented in detail in this subsection.

Tab. 1. Tax rates on gasoline and ethanol: Jan./2003 to May/2017 (R$ nominal).

Period	CIDE Gasoline	CIDE Ethanol	PIS Gasoline	COFINS Gasoline	PIS Gasoline	COFINS Ethanol
Jan./2003 – Dec./2003	0.38	0.007	0.058	0.2344	0.0508	0.2344
Jan./2004 – Dec./2004	0.41	0.007	0.058	0.2344	0.0508	0.2344
Jan./2005 – Dec./2008	0.21	0.000	0.058	0.2344	0.0508	0.2344
Jan./2009 – Dec./2009	0.14	0.000	0.058	0.2344	0.0508	0.2344
Jan./2010 – Jan./2011	0.17	0.000	0.058	0.2344	0.0508	0.2344
Feb./2011 – Apr./2011	0.11	0.000	0.058	0.2344	0.0508	0.2344
May/2011 – Dec./2011	0.17	0.000	0.058	0.2344	0.0508	0.2344
Jan./2012 – Oct./2012	0.14	0.000	0.058	0.2344	0.0508	0.2344
Nov./2012 – Jun./2013	0.07	0.000	0.058	0.2344	0.0508	0.2344
Jul./2013 – Apr./2015	0.00	0.000	0.058	0.2344	0.0508	0.2344
May/2015 – May/2017	0.10	0.000	0.058	0.2344	0.0508	0.2344

Source: Federal Senate (2018).

This paper uses Structural Model to estimate the price elasticity, income elasticity and the cross-price elasticity in the gasoline and ethanol markets. However, the main advantage of Structural Model is to determine not only the average elasticity, but also the respective point-to-point elasticities over time. In this paper, the focus is on variable elasticities calculations rather than average elasticities, specifically on the gasoline price elasticity, ethanol-gasoline cross-price elasticity, ethanol price elasticity, and the gasoline-ethanol cross-price elasticity.

Structural Model allows time series decomposition into its four unobservable components: Trend, Seasonality, Cycle and Irregular component. Tendency component is decomposed into two parts, series level and its respective slope, allowing to determine whether series level is constant or not, and whether its slope is constant or not over time. It also allows us to determine if there is Seasonality, and once it is confirmed, whether it is stochastic or deterministic; the same occurs with the Cycle component. In relation to the Irregular component, Structural Model allows its modelling through the Autoregressive-moving-average Model (ARMA), for both regular and seasonal parameters.

Mathematically, Irregular component is represented as:

$$\phi(B)\Phi(B^s)\ \varepsilon_t=\theta(B)\Theta(B^s)\ a_t \tag{5}$$

where B corresponds to the lag operator, which is defined as $B\varepsilon_t=\varepsilon_{t-1}$. Thus, the greater exponent, the greater its time lag.ARMA model is represented by a set of polynomials. The term $\phi(B)$ is the regular autoregressive polynomial; $\Phi(B^s)$ is the seasonal autoregression polynomial; $\theta(B)$ is the regular moving average polynomial; $\Theta(B^s)$ is the seasonal moving average component; and s is the extent of seasonality.

Mathematically, complete Structural Model can be written as:

$$Ln(Y_t) = \mu_t + \gamma_t + \psi_t + \sum_{k=0}^{k}\left(\varepsilon_i ln(X_{t-k})\right) + \beta_t w_t + \phi_t + \sum_{t=2}^{t}\varphi_i Y_{t-1} + \epsilon_t \tag{6}$$

Trend (μ_t) can be subdivided into two components, level and slope, whose formulae are:

$$\mu_{t+1}=\mu_t+\nu_t+\xi_t \text{ (level)} \tag{7}$$
$$\nu_{t+1}=\nu_t+\zeta_t \text{ (slope)} \tag{8}$$

Variation in level and slope is managed by the variances of the terms ξ_t and ζ_t in the respective equations. If the variance ξ_t=0, the slope will be constant and equal to ν_0. On the other hand, if the variance ζ_t=0, it implies that μ_t will be a deterministic trend given by $\mu_0+\nu_0 t$.

Seasonal component can be represented by two ways: dummy variables or trigonometric terms. In the case of seasonality representation by dummy variables, with the extension of seasonality represented by s, we have the following stochastic equation:

$$\sum_{i=0}^{s-1}\gamma_{t-i} = \omega_t\ ,\ \omega_t \sim i.i.d.N(0,\sigma_\omega^2) \tag{9}$$

Seasonality (γ_t), in the case of monthly data, implies that s=12. In this paper seasonality with trigonometric basis was used:

$$\gamma_t = \sum_{j=1}^{[s/2]}\gamma_{j,t} \tag{10}$$

where $j = 1, 2, \ldots, [s / 2]$ and each $\gamma_{j,t}$ is generated by the following formulae:

$$\gamma_{j,t+1}=\gamma_{j,t}\cos\lambda_j+\gamma_{j,t}^{*}\text{sen}\lambda_j+\omega_{j,t} \tag{11}$$

$$\gamma^{*}_{j,t+1}=-\gamma_{j,t}\cos\lambda_j+\gamma_{j,t}^{*}\text{sen}\lambda_j+\omega_{j,t}^{*} \tag{12}$$

where $\lambda_j=\frac{2\pi j}{s}$ is the frequency in radians, and the terms ω_t and ω_t^{*} are mutually independent.

ψ_t represents the cyclic component. Stochastic equation that manages the Cycle component of period p and the damping factor ρ is:

$$\begin{bmatrix}\psi_t \\ \psi *_t\end{bmatrix} = \rho\begin{bmatrix}\cos\lambda & \sin\lambda \\ -\sin\lambda & \cos\lambda\end{bmatrix}\begin{bmatrix}\psi_{t-1} \\ \psi *_{t-1}\end{bmatrix} + \begin{bmatrix}\upsilon_t \\ \upsilon *_t\end{bmatrix} \tag{13}$$

where υ_t and υ^{*}_t represent independent Gaussian errors with zero mean and variance σ^2_υ; and $\lambda=\frac{2\pi}{p}$ is the cycle angular frequency. Any period (p) greater than 2 is permissible, while damping factor (ρ) may assume any value in the interval (0, 1], i.e. including one, but excluding zero. Values of ρ smaller than one produce stationary cycle, while ρ = 1 produces non-stationary cycle.

ϕ_t is the autoregressive term; $\beta_t\ w_t$ allows to use dummy variables to treat structural breaks due to the presence of outliers; and $\varphi_i\ Y_{t-1}$ represents the lagged dependent variable.

After the Structural Model estimation, it is necessary to analyze residues in order to verify the effectiveness of the filtering process.

Among the statistics used to verify if the estimated model is suitable or not, we have the Mean Squared Error (or Error Variance), whose formula is:

$$MSE = \frac{\sum_{t=0}^{T}(y_t-\widehat{y_t})^2}{T-k} = \frac{SSR}{T-k,} \tag{14}$$

where *SSR* corresponds to the sum of squared residuals and is given by the following formula: $SSR=\sum_{t=0}^{T}(y_t-\hat{y}_t)^2$; being y_t the value observed in period t; $\hat{y}_t$ the predicted value within the sample at time t; T is the number of sample observations; and k is the number of estimated parameters. The closer to zero the *MSE*, the more predicted values approach the observed values, and the better the model fit. A second indicator used was the Root Mean Square Error (RMSE), whose formula is:

$$RMSE=\sqrt{SSR}=\sqrt{\frac{SSR}{T-k}} \tag{15}$$

As in previous statistics, the closer to zero the *RMSE*, the better the model fit. Another important statistic is the Mean Absolute Percentage Error (MAPE), which determines the accuracy of the model. The closer to zero the *MAPE*, the better the model fit. Its formula is as follows:

$$MAPE=\frac{100}{T}\sum_{t=0}^{T}\left|\frac{(y_t-\widehat{y_t})}{y_t}\right| \tag{16}$$

Other indicators used to evaluate the model estimated in this paper were: Coefficient of Determination (R^2), adjusted R^2, Random Walk R^2 and Amemiya's adjusted R^2.In general, R^2 is the most commonly used measure of adjustment and consists of a squared correlation coefficient ranging between 0 and 1. The closer to the unit, the better the model fit.

Mathematically, R^2 is represented as:

$$R^2=1-\frac{SSR}{TSS} \tag{17}$$

where TSS is the total sum of squares.

According to Brooks (2002), it should be noted that R^2has some problems. Given that R^2 is defined in terms of variation around the mean of *y*. If the model is reparametrized and the dependent variable is modified, the value of R^2 will also change. Therefore, R^2 values should not be compared between models with different dependent variables. R^2 value also never decreases if more regressors are added to the model. Thus, it is impossible to use R^2 as a determinant whether one variable should be present in the model or not.

To solve problems related toR^2, we often consider the loss of degrees of freedom associated with including more variables in the model. It is known as adjusted R^2:

$$\overline{R^2}=1-\left[\left(\frac{T-1}{T-k}\right)(1-R^2)\right] \tag{18}$$

If an extra regressor is added to the model, k increases and, unless R^2 more than compensates for this increase, the value of the adjusted R^2 will decrease. Consequently, the adjusted R^2 can be used to make decision whether a given variable should or should not be included in the model.

A variant of adjustedR^2 is Amemiya's adjusted R^2. According to Yaffee and McGee (2000, p. 219), «adjusted R^2 and Amemiya's adjusted R^2 use different adjustments to compensate for the number of parameters which are being estimated». The formula for Amemiya's adjusted R^2 is:

$$Amemiya's\ adjusted\ \overline{R^2}=1-\left[\left(\frac{T+k}{T-k}\right)(1-R^2)\right] \tag{19}$$

For both the adjusted R^2 and the Amemiya's adjusted R^2, the best model fit occurs when their respective values approach the unit.

Finally, the last indicator used was the Random Walk R^2, which compares R^2 of the estimated model with R^2 of a random variable. Its formula is as follows:

$$Random\ Walk\ R^2=\ 1-\left(\frac{T-1}{T}\right)\ \frac{SSR}{SSRRV} \tag{20}$$

where: $SSRRV=\sum_{t-2}^{T}(y_t-y_{t-1}-\mu)^2$ and $\mu=\frac{1}{T-1}\sum_{t=2}^{T}(y_t-y_{t-1})$, in which *SSRRV* is the sum of squared residuals of the random variable; and μ is a constant or mean value of the series.

It is important to highlight that in the Structural Model, the first step consists in verifying that each of the unobservable components of the time series, Trend (level and slope), Seasonality, Cycle and Irregular component, presents stochastic or deterministic behavior.

In this paper, instead of removing all the non-statistically significant parameters at once, we opted for the individual removal of each parameter. After this removal, the model was estimated again, and so on, until the model with all the statistically significant parameters.

4. RESULTS AND DISCUSSION

In this section, we present empirical data and the results obtained with the application of the Structural Model. Demand models and elasticities of ethanol and gasoline are considered according to the consumer's options on fueling their flex-fuel car.

4.1. Gasoline demand model

Results for this model are presented in Table 2 and should be interpreted from the point of view of both means and variances.

Tab. 2. Structural model's estimates results for the gasoline market, São Paulo State: Jan./2003 to May/2017.

Component	Parameter	Estimate	Standard Error of the Estimate	*t*-value	*p*-value
LGDPBR	Coefficient	0.91384	0.16363	5.58	< 0.0001
LS99[1]	Coefficient	0.23318	0.04786	4.87	< 0.0001
AO01[2]	Coefficient	0.14541	0.03718	3.91	< 0.0001
AO100[3]	Coefficient	0.13405	0.03885	3.45	0.0006
LS05[4]	Coefficient	0.11693	0.03731	3.13	0.0017
AO03[5]	Coefficient	-0.06994	0.02549	-2.74	0.0061
Lgasolineprice	Error Variance	0.00131	0.0002921	4.49	< 0.0001
Lethanolprice	Error Variance	0.00151	0.0008440	1.79	0.0739

Source: Research results.
[1]Dummy, Level Shift in March 2011; [2]Dummy, Additive Outlier in January 2003, [3]Dummy, Additive Outlier in April 2011, [4]Dummy, Level Shift in April 2003 and [5]Dummy, Additive Outlier in March 2003.

In general, all the estimated parameters are statistically relevant at the significance level of 10%. In relation to the means, it can be observed that 1% variation in income, represented by Brazil's GDP, induces an average change of 0.9138% in the quantity sold of gasoline in São Paulo State, forming an inelastic relation. In addition, to estimate the model, it was necessary to insert five intervention variables, being three of the Additive Outlier (AO) and two of the Level Shift (LS) type, according to Table 2. On the variance point of view, both gasoline price and ethanol price are statistically significant, considering the significance level of 10%. This implies that both variables have stochastic behavior over time.

Different indicators produced, which show the results robustness, are adequate, since MSE, RMSE and MAPE are close to zero (Tab. 3). This fact indicates that differences between the observed and estimated values are very close and, therefore, the model is well-adjusted.

Indicators based on the R^2 criterion are also adequate, since the adjusted R^2 and the Amemiya's adjusted R^2 are close to 60%. It indicates that 60% of the dependent variable's behavior are explained by independent variables and the time series components (Tab. 2).

Figure 1 presents the residuals correlograms of the gasoline demand model. As can be seen, residues are free of autocorrelation, that is, they correspond to white noise.

At the beginning of the series, January 2003, CIDE's rate was equal to R$ 0.38/liter on gasoline, while CIDE's rate on ethanol was R$ 0.07/liter. Both rates remained constant until December 2003. In this period, it is observed that the gasoline price elasticity and the ethanol-gasoline cross-price elasticity tend to become more elastic (Fig. 2). However, its sign is negative, but it should be positive, according to the economic theory.

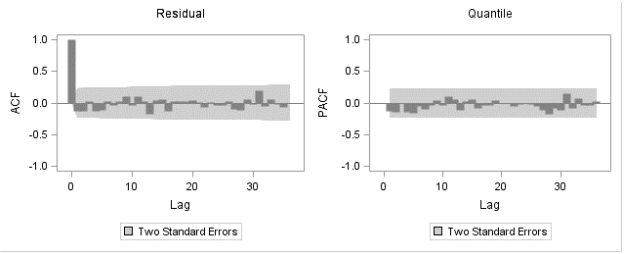
From January to December 2004, CIDE's rate on the gasoline price increased to R$ 0.41/liter, while this rate on ethanol remained at R$ 0.07/liter. In this period, the gasoline price elasticity had two distinct phases. Until the middle of 2004, the gasoline price elasticity continued to increase, in module, and reversed its trajec-

Tab. 3. Statistical indicators for the estimated structural model for the gasoline market, São Paulo State: Jan./2003 to May/2017.

Statistical Indicators	Statistical Adjustment Based on Residuals
Mean Squared Error	0.00281
Root Mean Square Error	0.05298
Mean Absolute Percentage Error	0.20257
R^2	0.60529
Adjusted R^2	0.59973
Random Walk R^2	0.63322
Amemiya's Adjusted R^2	0.58306

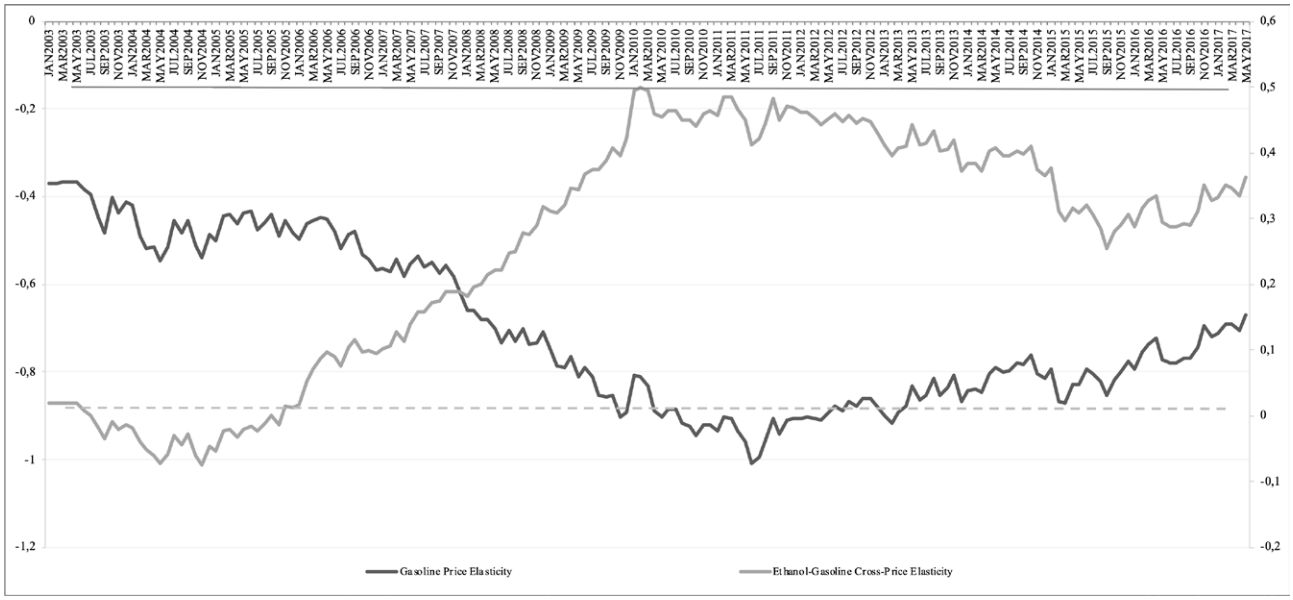
Source: Research results.

Fig. 1. Autocorrelation and partial autocorrelation of residuals of the structural model of gasoline demand, São Paulo State: Jan./2003 to May/2017.



Source: Research Results.

Fig. 2. Gasoline price elasticity and ethanol-gasoline cross-price elasticity evolution, São Paulo State: Jan./2003 to May/2017.



tory, becoming less elastic, whereas the ethanol-gasoline cross-price elasticity continued with a negative sign.

From January 2005 to December 2008, there was a reduction in CIDE's rate on gasoline to R$ 0.21/liter, while CIDE's rate on ethanol was zero. In this period there are two interesting moments. According to Figure 2, from January to July 2005, the gasoline price elasticity fluctuated, but it did not change its level. From August 2005 to December 2008, the gasoline price elasticity became more elastic, that is, the reduction in CIDE's rate on the gasoline price has made the gasoline demand more sensitive because it increased the competitiveness of gasoline in relation to ethanol.

As for the ethanol-gasoline cross-price elasticity, in the same period, it is verified that up to November 2005 this elasticity continued with the negative sign, but from December 2005 there was an upward trend. These behaviors confirm that, despite CIDE's rate on ethanol is zero, the reduction in this rate on gasoline had a greater impact on both gasoline and ethanol demand than on the reduction in CIDE's rate on ethanol.

Results seem to be related to another relevant factor, such as the uncertainties in the fuel market, the expansion of flex-fuel vehicles from 2004, and the great expansion of the ethanol supply from the 2004/2005 crop year.

The great entry of flex-fuel vehicles into the Brazilian market is a possible explanation for the behavior of the ethanol-gasoline cross-price elasticity, which has contributed to make demand more elastic, as it has provided the consumer with a substitute product. With the flex-fuel vehicles, the consumer decision between gasoline and ethanol is made in each fueling and not more at the time of vehicle purchase.

It can be inferred that the evolution of flex-fuel vehicles sales and the reduction in the market for gasoline-driven cars, coupled with the reduction in CIDE's rate on gasoline price, influenced trend in the gasoline price elasticity and in the ethanol-gasoline cross-price elasticity. This up ward trend in both elasticities continued between January and December 2009, evidenced by the two elasticities which had divergent trajectories, both becoming less inelastic (Fig. 1).

It is important to remember that, in that period, CIDE's rate on gasoline decreased from R$ 0.21/liter to R$ 0.14/liter, while this rate on ethanol remained at zero. Thus, it can be inferred that the reduction in CIDE's rate on gasoline and the consolidation of flex-fuel vehicles in the Brazilian market significantly altered the elasticities of the fuel market.

From January 2010 to January 2011, CIDE's rate on gasoline was raised to R$ 0.17/liter, whereas it remained at zero on ethanol. In this period, while the gasoline price elasticity continued to increase in modulus, the ethanol-gasoline cross-price elasticity reached its highest value throughout the analyzed period (January 2003 to May 2017), approaching 0.5, then presented a small retraction and returned to increase at the end of the period, as shown in Figure 2. On the other hand, in the same period, whilst the fleet of gasoline-driven vehicles continued to decline, the fleet of flex-fuel vehicles con-

tinued to grow, but at decreasing rates, possibly due to the economic crisis occurred in 2008.

From February to April 2011, CIDE's rate on gasoline was reduced to R$ 0.11/liter, and CIDE's rate ethanol remained at zero. Apparently, this gave rise to the trajectories of the two elasticities in March. The trajectory of the gasoline price elasticity, initially descending, rose and, in the end, returned to its downward trajectory. Regarding to the ethanol-gasoline cross-price elasticity, there was a movement in the opposite direction. Despite the period, it was possible to observe that changes in fuel prices affected consumers behavior, even in the short-term.

From May 2011, CIDE's rate on gasoline was readjusted to R$ 0.17/liter, keeping CIDE's rate on ethanol at zero until December 2011. In this period, for both elasticities, two similar movements are identified, but in the opposite direction. The gasoline price elasticity reached its lowest value during all the analyzed period, resulting in unit elasticity in June 2011, then reversed the trajectory. Cross-price elasticity trajectory presented opposite movement. It is necessary to emphasize two aspects: first, both elasticities, which previously tended to diverge in their respective trajectories, began to converge and showed co-movement behaviors. Second, the increase in the CIDE's rate on gasoline price initially impacts both elasticities by changing the respective trajectories. On the vehicle market side, it is observed that the flex-fuel vehicles fleet continued to increase, however, at lower rates, especially because of the reduction in the ethanol supply (Santos, 2016). These facts can explain the changes in the respective elasticities.

Despite the reduction in CIDE's rate on gasoline to R$ 0.07/liter from November 2012 to June 2013, and remaining CIDE's rate on ethanol at zero in the same period, there is another rally in the trajectories of both elasticities. In this period both elasticities tend to become more inelastic (Fig. 2), starting a new period of stabilization highlighting the gasoline competitive advantage, although in 2013 the flex-fuel vehicles had reached the apex of sales. This set of indicators shows that the flex-fuel vehicle success is not related to the ethanol competitiveness itself.

Until April 2015 CIDE's rate on gasoline was zero, as well as that one on ethanol. In this period, both elasticities had more inelastic trajectories, as seen in Figure2. Even with both rates equal zero, elasticities tended to become more inelastic, i.e. apparently the price effect was exceeded by the income effect. This period is characterized by uncertainties in policies, falling income, rising unemployment, and the reduction in vehicle sales in general. In other words, both elasticities became less sensitive, that is, changes in gasoline prices induced less variation in the quantity demanded of gasoline, and the same effect in relation to the increase in ethanol. This means that even with CIDE's rate being zero, the price effect was not offset by the income effect, that is, the magnitude of the fall in consumer income more than offset the effect related to the reduction in the gasoline price.

In May 2015 CIDE's rate on gasoline was adjusted to R$ 0.10/liter. The impact of this increase is evident in the behavior of the elasticities in Figure 2, since, from June 2015, the gasoline elasticity price presented ascending trajectory, becoming more inelastic. The ethanol-gasoline cross-price elasticity had reversed its downward trend, assuming an upward trend, that is, it became less inelastic. Possibly, the economic uncertainty in this period may have induced consumers to be more sensitive to changes in the ethanol price than in the gasoline price, even with the increase in CIDE's rate on gasoline. However, it is important to highlight that ethanol supply growth was lower than the growth in consumption of the Otto cycle fuels. Therefore, ethanol naturally reduced its market share since exports also declined.

4.2 Ethanol demand model

Based on the estimated coefficients for the ethanol market, it is verified that, on the means side, all coefficients are statistically significant for the significance level of 1% (Tab. 4).

In economic terms, there is a variation of 1% in income, which induces to a variation of 1.72% in the amount of ethanol demanded, forming an elastic relationship between these two variables. Compared to the gasoline market, the income effect in the ethanol market is much more elastic (0.98 for gasoline versus 1.72 for ethanol). It was also necessary to insert eight dummy variables to estimate the model, being three Additive Outlier (AO) and five Level Shift (LS) variables.

According to Table 5, the indicators show that results are robust, since MSE, RMSE and MAPE are close to zero, indicating that the differences between the observed and estimated values are very close, that is, they emphasize that the model is well-adjusted.

Indicators based on the R^2 criterion are also adequate, since the adjusted R^2 and the Amemiya's adjusted R^2 are close to 80%. It indicates that 80% of the dependent variable's behavior are explained by independent variables and the time series components (Tab. 5).

Figure 3 presents the residuals correlograms of the gasoline demand model. As can be seen, residues are free of autocorrelation, that is, they correspond to white noise.

Tab. 4. Structural model's estimates results for the ethanol market, São Paulo State: Jan./2003 to May/2017.

Component	Parameter	Estimate	Standard Error of the Estimate	*t*-value	*p*-value
Irregular	Error Variance	0.00059115	0.0002163	2.73	0.0063
LGDPBR	Coefficient	1.72552	0.24632	7.01	<0.0001
AO01[1]	Coefficient	0.32829	0.05374	6.11	<0.0001
LS37[2]	Coefficient	0.36825	0.05758	6.40	<0.0001
LS12[3]	Coefficient	0.34281	0.04140	8.28	<0.0001
AO09[4]	Coefficient	-0.14010	0.03757	-3.73	0.0002
LS20[5]	Coefficient	-0.20986	0.04903	-4.28	<0.0001
LS99[6]	Coefficient	-0.33941	0.06872	-4.94	<0.0001
LS49[7]	Coefficient	0.19258	0.05442	3.54	0.0004
AO100[8]	Coefficient	-0.33938	0.05987	-5.67	<0.0001
Lgasolineprice	Error Variance	0.00427	0.0016307	2.62	0.0089
Lethanolprice	Error Variance	0.00116	0.0005553	2.10	0.0361

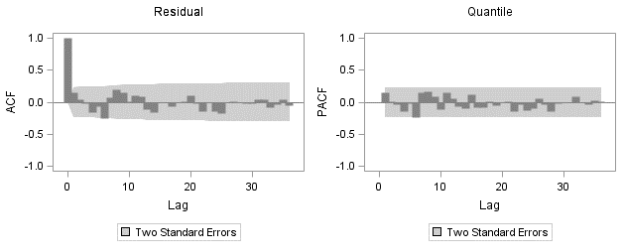
Source: Research results.
[1]Dummy, Additive Outlier in January 2003; [2]Dummy, Level Shift in January 2006, [3]Dummy, Level Shift in December 2003, [4]Dummy, Additive Outlier in September 2003, [5]Dummy, Level Shift in August 2004, [6]Dummy, Level Shift in March 2011, [7]Dummy, Level Shift in January 2007, and [8]Dummy, Additive Outlier in April 2011.

Tab. 5. Statistical indicators for the estimated structural model for the ethanol market, São Paulo State: Jan./2003 to May/2017.

Statistical Indicators	Statistical Adjustment Based on Residuals
Mean Squared Error	0.00541
Root Mean Square Error	0.07354
Mean Absolute Percentage Error	0.27457
R^2	0.83691
Adjusted R^2	0.83225
Random Walk R^2	0.57592
Amemiya's Adjusted R^2	0.82294

Source: Research results.

Fig. 3. Autocorrelation and partial autocorrelation of residuals of the structural model of ethanol demand, São Paulo State: Jan./2003 to May/2017.



Source: Research results.

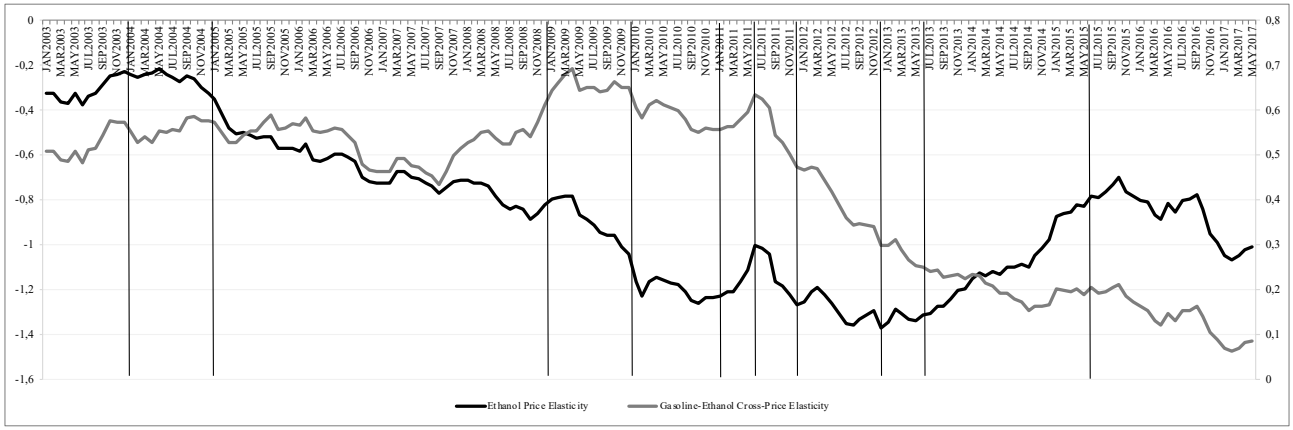
Between January and December 2003, CIDE's rates on gasoline and ethanol were R$ 0.38/liter and R$ 0.07/liter, respectively. In this period, while the ethanol price elasticity became more inelastic with an upward trajectory, the gasoline-ethanol cross-price elasticity became more elastic presenting an upward trajectory (Fig. 4).The increase in the flex-fuel market possibly justifies the respective elasticities behavior.

From January to December 2004, CIDE's rate on gasoline price increased from R$ 0.38/liter to R$ 0.41/liter, while this rate on ethanol remained at R$ 0.07/liter. In this period, the ethanol price elasticity increased in magnitude at the end of the period, becoming less inelastic. Contrary movement occurred in relation to the gasoline-ethanol cross-price elasticity, as it tended to become more inelastic at the end of the period (Fig. 4).

The fact that the ethanol price elasticity tends to become more elastic may be related to the rapid expansion of flex-fuel vehicles sales in the analyzed period. Therefore, the increase in CIDE's rate on gasoline and keeping on CIDE's rate on ethanol, coupled with the presence of a substitute product for the gasoline-driven vehicle, conditioned both elasticities to diverge at the end of the period, since the ethanol price elasticity became more inelastic, while the opposite occurred with the gasoline-ethanol cross-price elasticity.

Between January 2005 and December 2008, CIDE's rate on gasoline reduced to R$ 0.21/liter, and it remained at zero on ethanol. From January 2005 to June 2007, both elasticities followed the same direction, that is, while the ethanol price elasticity became more elastic, the gasoline-ethanol cross-price elasticity became more

Fig. 4. Ethanol price elasticity and gasoline-ethanol cross-price elasticity evolution, São Paulo State: Jan./2003 to May/2017.



inelastic. After July 2007 until December 2008, the ethanol price elasticity continued its trajectory and became even more elastic. Nonetheless, the gasoline-ethanol cross-price elasticity trajectory reversed its position and became more elastic, with the trajectories of both elasticities becoming divergent.

It should be noted that in this period occurred several facts that may have contributed to both elasticities trajectories, among which the following stand out: i) flex-fuel vehicle sales grew at increasing rates; ii) sales of gasoline-driven vehicles declined significantly; iii) the government, aimed at containing inflation, insured that fossil fuels prices did not be transferred totally to the domestic consumer in the period prior to the international financial crisis in 2008 (Santos, 2016).

From January to December 2009 there was a further reduction in CIDE's rate on gasoline to R$ 0.14/liter, remaining CIDE's rate on ethanol at zero. In this period, the ethanol elasticity-price continued to fall, that is, this elasticity become increasing in magnitude, even becoming equals to one in December 2009, while the gasoline-ethanol cross-price elasticity also became more elastic, reaching its value equals to 0.7 (Fig. 4). Possibly, this fact is showing the increase in the substitution effect between both fuels, and the productive chain complexity, which responds immediately to the measures that result in competitive factors imbalance. On the other hand, it needs one or two crops, or even a complete cycle sugarcane cultivation to respond to the measures of balance in supply (six or seven years) (Santos, 2016).

In January 2010, CIDE's rate on gasoline rose to R$ 0.17/liter, and again the CIDE's rate on ethanol remained at zero. These rates were into force until January 2011. While the ethanol price elasticity continued becoming more elastic, exceeding the value of -1.2, the gasoline-ethanol cross-price elasticity trended to become more inelastic, that is, less sensitive to price changes.

As already mentioned, between February and April 2011, CIDE's rate on gasoline was reduced to R$ 0.11/liter, while it remained at zero on ethanol. It is observed that the reduction in CIDE's rate on gasoline changed the trajectories of both elasticities because the ethanol supply was limited, since it is the final period of the off-season, in which historically the ethanol price becomes higher than the gasoline price. While the ethanol price elasticity became more inelastic, the gasoline-ethanol cross-price elasticity became more elastic (Fig. 4). Therefore, the reduction in CIDE' rate on gasoline made this fuel even more competitive in relation to ethanol.

From May 2011, CIDE's rate on gasoline was R$ 0.17/liter and it remained at zero on ethanol until December 2011. The ethanol price elasticity became more elastic, exceeding the value of -1.2, while the gasoline-ethanol cross-price elasticity became much more inelastic (Fig. 4). Based on these behaviors, it is observed that ethanol has become more competitive in relation to gasoline, and the Brazilian economy crisis was reflected on the light vehicle market, which presented decreasing rates. Therefore, it can be inferred that the reduction in consumer income was relevant to change the respective price effects in the ethanol market.

Between January and October 2012, CIDE's rate on gasoline was reduced to R$ 0.14/liter and it remained at zero on ethanol. The trajectories of both elasticities continued in downward direction. The ethanol price elasticity reached the value of -1.3 and, the gasoline-ethanol cross-price elasticity fell much more sharply, tending to 0.3 (Fig. 4).

In November 2012, CIDE's rate on gasoline was reduced to R$ 0.07/liter and it remained at zero on ethanol, remaining until June 2013. Initially, the trajectory

of the ethanol price elasticity continued to fall reaching elasticity with a value close to -1.3, the highest elasticity in modulus throughout the analyzed period. Later, it reversed the trajectory and became less elastic. The gasoline-ethanol cross-price elasticity continued its downward trajectory, increasing its inelasticity (Fig. 4).

In July 2013, CIDE's rate on both gasoline and ethanol was zero. It was in force until April 2015, when the curves of both elasticities converged. From January 2014 to April 2015, both curves presented divergent behavior, distancing from each other. The intensity by which the ethanol price elasticity has become more inelastic is higher than the move towards the greater inelasticity of the gasoline-ethanol cross-price elasticity curve, since the former showed a steeper slope than the second (Fig. 4). The possible explanation for this behavior may be due to the political-economic crisis in the analyzed period, since the fall in industrial production, coupled with increase in unemployment, negatively impacted consumers' income, resulting in a sharp drop in vehicle sales. Negative impact of the income effect may have outweighed the price effect, that is, even gasoline having become cheaper, which is a positive price effect, the quantity sold for both gasoline and ethanol became more inelastic.

In May 2015, CIDE's rate on gasoline increased again and remained at R$ 0.10/liter, keeping CIDE's rate on ethanol at zero until May 2017, the last month analyzed in this research. At the beginning of this last period the ethanol price elasticity presented an ascending trajectory, becoming more inelastic. From January 2016, this trajectory was reversed and reached the value of -1.068 in January 2017, a situation in which the ethanol price elasticity was again elastic. Meanwhile, the trajectory of the gasoline-ethanol cross-price elasticity continued in its downward trajectory, becoming increasingly inelastic.

5. CONCLUSION

The aim of this paper was to identify the path of the gasoline price elasticity, ethanol price elasticity, ethanol-gasoline cross-price elasticity and the gasoline-ethanol cross-price elasticity for the flex-fuel vehicle market, as well as to discuss the taxation policies impact of CIDE on the ethanol and gasoline markets from 2003 to 2017. It was during this period that hydrated ethanol and gasoline became substitute products, since flex-fuel cars allowed the fuel supply decision to be made at each fueling. Consumers were used to comparing fuel prices to decide which one is better at each fueling. Thus, the analysis of price elasticities of each fuel and of cross-price elasticities were important both for the evaluation of taxation measures and for the analysis of policies to support light fuels production and pricing (Otto Cycle) in Brazil.

Regarding this last aspect, this research showed the intensity in which CIDE displaced equilibrium prices and favored the ethanol market. Data also showed how consumers reacted to price changes in the analyzed period, and how flex-fuel vehicles were important for the consumer who had different reactions from the period when cars used only one type of fuel. Thus, CIDE played an important role in price discrimination between hydrated ethanol and gasoline, inducing gasoline substitution for ethanol at a time when CIDE's rate increased on gasoline and remained at zero on ethanol.

Another conclusion is that CIDE could have played an important role in the induction of ethanol sales if its rates had remained stable in the period. As this did not occur, the period was marked by different phases and behaviors of the cross-price elasticities that alternated periods of price elasticity with those of price inelasticity.

In this regard, the policy was positive in favor of the biofuel supply that benefits health in urban centers; despite the oscillation of the gasoline rate. It had negative effects on the production chain, for example: i) generating uncertainties for investments in a long production chain (six years); ii) reducing operating margins of producers when CIDE is low and raising margins when it is high, being both not dynamic effect measures in the economy.

It is important to highlight the need to define priorities and plan more consistently other measures to improve the fuel market in Brazil, including taxation. Such planning is important to create a medium- and long-term scenario that allows stakeholders to study their investments, boosting the ethanol supply and other products linked to the production chain. Thus, large variations in installed capacity and product supply in the market can be avoided, as well as creating an environment more conducive to investments in productivity.

From the environmental point of view and people's health, a tax such as CIDE should boost differentiated consumption of ethanol, whose effects are noticeable in large cities due to ethanol's capacity to reduce greenhouse gas emissions (GHG) and pollutants. In this regard, data presented in this paper allow future research using, for example, GHG emission reduction calculation in function of the amount of CIDE or its different rates.

It should be noted that this paper has not exhausted the theme of the use of public policies for boosting

renew able fuels consumption. There is a lot of research on this subject, including understanding consumer decisions, besides price, to understanding the real efficiency of flex-fuel vehicles when using ethanol and gasoline in different combinations of anhydrous and hydrated ethanol.

REFERENCES

Alves D.C.O., Bueno R.L.S. (2003). Short-run, long-run and cross elasticities of gasoline demand in Brazil. *Energy Economics*, (25): 191-199. https://doi.org/10.1016/S0140-9883(02)00108-1

Bentivoglio D., Rasetti M. (2015). Biofuels sustainability: review of implication for land use and food price. *Rivista di Economia Agraria (REA),* 70(1): 7-31. Firenze University Press. Available at: https://oajournals.fupress.net/index.php/rea/issue/view/418 (accessed 30 November 2019).

Brazil Ministério da Agricultura, Pecuária e Abastecimento (MAPA) (2006). *Plano Nacional de Agroenergia*. Brasília: MAPA. Available at: http://www.agricultura.gov.br/assuntos/sustentabilidade/agroenergia/arquivos/pna-2ed-portugues.pdf (accessed 24th October 2019).

Brooks C. (2002). *Introductory Econometrics for Finance*. United Kingdom: Cambridge University Press.

Cardoso B.F., Shikida P.F.A., Finco A. (2017). Development of Brazilian biodiesel sector from the perspective of stakeholders. *Energies*, 10(3): 1-14. https://doi.org/10.3390/en10030399

Costa C.C., Guilhoto J.J.M. (2011). O papel da tributação diferenciada dos combustíveis no desenvolvimento econômico de São Paulo. *Economia Aplicada*, 15(3): 369-390. http://dx.doi.org/10.1590/S1413-80502011000300002

Costa C.C., Burnquist H. (2016). Impactos do controle do preço da gasolina sobre o etanol biocombustível no Brasil. *Estudos Econômicos*, 46(4): 1003-1028. Available at: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0101-41612016000401003 (accessed 20 May 2019).

Engle R.F., Granger C.W.J. (1991). *Long-run economic relationship: readings in cointegration*. New York: Oxford University Press.

Federal Senate (2018). *Cide*. Available at: https://www12.senado.leg.br/noticias/entenda-o-assunto/cide (accessed 4 July 2019).

Hughes J.E., Knittel C.R., Sperling D. (2006). Evidence of a Shift in the Short-Run Price Elasticity of Gasoline Demand. NBER Working Paper Series. *Working Paper* 12530. Available at: http://www.nber.org/papers/w12530 (accessed 1st September 2019

Institute of Applied Economic Research database IPEADATA (2017). Available at: http://www.ipeadata.gov.br/Default.aspx (accessed 16 July 2019).

Kutas G., Lindberg C., Steenblik R. (2007). *Biofuels: at what cost? Government support for ethanol and biodiesel in selected OECD countries*. Available at: http://www.iisd.org/library/biofuels-what-cost-government-support-ethanol-and-biodiesel-selected-oecd-countries (accessed 14 November 2019).

Lima P.C.R. (2016). Preço dos combustíveis no Brasil. Consultoria Legislativa, Brasília-DF.

Luca G.D., Barbosa R.S. (2016). Análise da tributação sobre o etanol e o seu impacto no desenvolvimento sustentável brasileiro. *Revista Tributária e de Finanças Públicas*, 130: 1-15. Available at: http://www.mpsp.mp.br/portal/page/portal/documentacao_e_divulgacao/doc_biblioteca/bibli_servicos_produtos/bibli_boletim/bibli_bol_2006/RTFPub_n.130.11.PDF (accessed 24 October 2019).

Milanez A.Y., Nyko D., Garcia J.L.F., Reis B.L.S.F.S. (2012). O déficit de produção do etanol no Brasil entre 2012 e 2015: determinantes, consequências e sugestões de políticas. *BNDES Setorial*, (35): 277-302. Available at: https://www.bndes.gov.br/SiteBNDES/export/sites/default/bndes_pt/Galerias/Arquivos/conhecimento/bnset/set3508.pdf (accessed 12 July 2019).

Moraes M., Bacchi M. (2014). Etanol, do início às fases atuais de produção. *Revista de Política Agrícola*, XXII (4): 5-22. Available at: https://seer.sede.embrapa.br/index.php/RPA/article/view/950 (accessed 13 August 2019).

National Agency of Petroleum, Natural Gas and Biofuels – ANP (2018). *Price Survey System*. Available at: http://www.anp.gov.br/preco/ (accessed 16 July 2019).

National Federation of Fuels and Lubricants Trade – Fecombustíveis (2017). *Revendedor: tributação*. Available at: http://www.fecombustiveis.org.br/revendedor/tributacao/ (accessed 18 June 2019).

Neves M.F., Conejero M.A. (2010). *Estratégias para a cana no Brasil: um negócio classe mundial*. São Paulo: Atlas.

Santos G.R. (org.) (2016). *Quarenta anos de etanol em larga escala no Brasil: desafios, crises e perspectivas*. Brasília: IPEA. Available at: http://www.ipea.gov.br/portal/index.php?option=com_content&view=article&id=27354 (accessed 30 July 2019).

Shikida P.F.A., Finco A., Cardoso B.F., Galante V.A., Rahmeier D., Bentivoglio D., Rasetti M. (2014) A Comparison Between Ethanol and Biodiesel Production:

The Brazilian and European Experiences. In: Domingos Padula A., Silveira dos Santos M., Benedetti Santos O., Borenstein D. (eds) *Liquid biofuels: emergence, development and prospects*. Lecture Notes in Energy, vol 27. Springer, London

Steenblik R. (2007). Subsidies: the distorted economics of biofuels. *Discussion paper* n. 3. International Transport Forum/OCDE. Available at: https://www.itf-oecd.org/sites/default/files/docs/discussionpaper3.pdf (accessed 30 September 2019).

Sterner T., Dahl C. (1992). Modelling Transport Fuel Demand. In: Sterner, T. (eds). *International Energy Economics*. Great Britain: Chapman & Hall: 65-80.

Szmrecsányi T., Sá A.C. (2002). Instituto do Açúcar e do Álcool (IAA). Available at: http://www.fgv.br/cpdoc/acervo/dicionarios/verbete-tematico/instituto-do-acucar-e-do-alcool-iaa (accessed 17 May 2019).

Yaffee R., McGee M. (2000).*Introduction to time series analysis and forecasting with applications of SAS and SPSS*. San Diego: Academic Press.

REA | ITALIAN REVIEW OF AGRICULTURAL ECONOMICS

Firenze University Press
www.fupress.com/rea

Citation: V. Zanin, J.M. Tonin, V. Halmenschlager (2020) Asymmetric price transmission in the commercialization of rice in Brazil. *Italian Review of Agricultural Economics* 75(1): 19-35. doi: 10.13128/rea-11739

Received: July 11, 2019

Revised: October 31, 2019

Accepted: March 18, 2020

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.

Asymmetric price transmission in the commercialization of rice in Brazil

Vanclei Zanin[1], Julyerme Matheus Tonin[2], Vinícius Halmenschlager[3]

[1] *Department of Economics and Statistics of the Rio Grande do Sul State (DEE-RS)*
[2] *Maringa State University (UEM) - Paraná, Brazil*
[3] *Institute of Economics, Business Administration and Accounting Sciences, Federal University of Rio Grande - Brazil*

Abstract. This paper aims to investigate the presence of price transfer asymmetry (APT) in the rice production chain in Rio Grande do Sul incorporating in the analysis the effects of public policy interventions, specifically the agricultural minimum prices. The results indicate the occurrence of positive APT among all relations analyzed (contemporaneous, lagged or cumulative) in the rice production chain. In general, the industry-producer relationship presented the best adjustment and the existence of positive asymmetry indicates that this market link takes advantage of the direct relationship with the producer to pass through price increases more quickly reductions to its consumers. Finally, it was identified that in periods of market prices below the minimum price, the asymmetry was not rejected, indicating its permanence in times of greater government intervention.

Keywords: price transmission, minimum prices, rice market.
JEL codes: L11, L66, L81.

1. INTRODUCTION

Researchers of the agricultural sector have struggled to understand the phenomenon of asymmetric price transmission (APT) in the vertical structure of production chains. The traditional economic theory does not predict or explain APT occurrence (Meyer, Von Cramon Taubadel, 2004). When relating price transmission symmetry to perfect competition, the theory does not explain whether asymmetry is due to imperfect competition, market failures, or both (Lloyd, 2017). Moreover, the prevalence of an asymmetric response in price transmission can be interpreted as a gap in the economic theory (Peltzman, 2000). Thus, the diagnosis of the factors that induce APT and political implications of this phenomenon remain unclear. In addition, the deepening of issues related to the APT occurrence may provide a better understanding of the connection between the vertical links of a supply chain or market.

This study investigates occurrence of APT between the links of the rice supply chain in Rio Grande do Sul, Brazil, using monthly data from Janu-

ary 2003 to December 2018. In the literature on the rice market, the results of Aguiar and Figueiredo (2011) study indicate the occurrence of APT, given that increases in wholesale prices were transmitted more quickly than price decreases by the retail sector. That said, if there is APT in this market, two specific objectives are follow: i) to evaluate whether asymmetry in price transmission occurs contemporaneously or if there are lags in the process, ii) to evaluate whether the policy of minimum prices and its relationship with price practiced in the Rio Grande do Sul market had an impact on price transmission in the rice supply chain.

The original contribution of this study is the adaptation of the baseline method of diagnosing the occurrence of APT in a supply chain to incorporate the effects of government intervention into the analysis, such as the minimum price policy. The pioneering work of Kinnucan and Forker (1987) indicated government interventions as a source of asymmetry in support of producer prices. However, the methodological framework used by the authors did not incorporate this variable into the analysis.

Depending on how political intervention is carried out, it can either reduce the problem or cause distortions within the market. In the analysis of APT, political intervention means the policy of minimum prices, implemented at a federal level, but with important regional implications for the rice market. In this context, the geographic scope of the analysis was chosen due to the productive, agricultural and industrial concentration of the rice sector in Rio Grande do Sul. Both extreme climatic events such as prolonged floods or droughts, as well as decoupling between the prices practiced in this region and the minimum prices causing important economic impacts on this productive sector.

In short, in the presence of APT, price decreases for producers are not passed on to consumers in the same way as price increases are. For Meyer and Von Cramon Taubadel (2004), the occurrence of APT that results from market power, there is not only a transfer of welfare between agents, but also a welfare net loss, favoring political intervention. Although the relationship between market power and APT is widely analyzed by literature, the study of political interventions that cause shifts in characteristics of price changes (size and timing) is still considered a lag of knowledge.

This article comprises this introduction and a literature review on APT. The data analyses on the national and regional markets for rice justify the choice of the relevant market for the study. In the following section, the research methodological aspects are presented, followed by a description of the data used. Afterwards, the analysis and discussion of the results are carried out to present the main considerations, implications and limitations of the study.

2. THE MODEL OF ASYMMETRIC PRICE TRANSMISSION (APT)

The asymmetric price transmission (APT) model in food and agricultural markets has been developed based on the premise that in the absence of market imperfections, there is a symmetrical price adjustment at market level and changes in cost inputs, at the antecedent market level (Kinnucan, Forker, 1987). Thus, asymmetry occurs if certain groups or links in a supply chain have advantages (increased profits or mark-up) by transmitting price increases with more intensity (and/or magnitude) than decreases (Meyer, Von Cramon Taubadel, 2004) or when price decreases are more readily passed on to subsequent supply chain segments (Ward, 1982).

The construction of the concept of asymmetric transmission of prices, which is currently diversified in terms of scope of analyses and methodologies used, dates back to the 1970s with the theoretical contributions of Gardner (1975) and methodological input of Tweeten and Quance (1969). The Gardner (1975) approach focused on equilibrium or interdependent relations (regarding demand derived) and formation of mark-up between the vertical links of a perfectly competitive productive chain. When analyzing price elasticity of demand and price volatility between farm and retail price levels, the author showed that exogenous shocks could propagate asymmetrically between the links of a production chain.

Methodologically, in order to analyze demand elasticity, Tweeten and Quance (1969) created a partition technique of each price series into its increasing and decreasing components. With the methodological improvements of Wolfram (1971) and Houck (1977), this technique is used to evaluate the presence and magnitude of price transfer asymmetry (APT) between different links in a productive chain, especially in the agricultural sector. Moreover, methodological advances presented by Engle and Granger (1987), which established duality between cointegration and error correction, provided a new momentum to studies on APT (Lloyd, 2017).

In turn, Von Cramon Taubadel (1998) proposed a modification in the Wolfram-Houck specification to include the error term into the analysis. Recent developments expand the methodological scope to five main

groups of analysis: Autoregressive Distributed Lag Model (ARDL), Partial Adjustment Model (PAM), Error Correction Model (ECM), Regime Switching Models (RSM) and their multivariate extensions (Frey, Manera, 2007).

In terms of factors that induce APT, the association between market power and APT becomes recurrent in the literature. In more concentrated markets, asymmetry may be associated to differences in information assimilation level in each link of the production chain (Ward, 1982), the exercise of market power in storage stages, transport, the processing of agricultural products (Kinnucan, Forker, 1987), vertical integration (Bernard, Willett, 1996) and price research costs in imperfect competitive markets (Miller, Hayenga, 2001). In addition, other APT sources commonly identified in the literature include product perishability (Ward, 1982), government interventions, such as price support and marketing quotas (Kinnucan, Forker, 1987), menu costs (Bailey, Brorsen, 1989), degree of organization of rural producers (Aguiar, Santana, 2002), positive trend inflation (Ball, Mankiw, 1994), and the management of inventories (Meyer, Von Cramon Taubadel, 2004; Vavra, Goodwin, 2005), among others.

Thus, given the multiplicity of aspects related to asymmetric price transmission, literature on the subject begins to adopt different classification perspectives: magnitude and velocity, positive or negative and vertical or spatial (Meyer, Von Cramon Taubadel, 2004). In terms of time, there are short-term analyses, most suitable to identify if asymmetry is positive or negative, as well as the long-term approach, more suitable for evaluating the adjustment speed (Frey, Manera, 2007).

Regarding empirical studies, seminal studies that identified APT occurrence were performed in the United States. Among the main markets analyzed in that country are the vegetable market (Ward, 1982), dairy market (Awokuse, Wang, 2009; Capps, Sherwell, 2007; Hahn, Stewart, Blayney, Davis, 2016; Kinnucan, Forker, 1987), beef market (Goodwin, Holt, 1999) and chicken meat (Bernard, Willett, 1996).

In the international scenario, APT occurrence was also identified for the vegetable market in the Netherlands (Verreth, Emvalomatis, Bunte, Kemp, Oude Lansink, 2015), for the dairy market in Brazil (Azevedo, Politi, 2008) and Panama (Acosta, Valdés, 2014), and the swine market in Australia (Griffith, Piggott, 1994), Germany (Von Cramon Taubadel, Loy, 1999) and China (Dong, Brown, Waldron, Zhang, 2018). APT was also identified in the grain and flour market in Zaire (Minten, Kyle, 2000) and South Africa (Cutts, Kirsten, 2006), the pistachio market in Iran (Moghaddasi, 2009), and the markets of table grapes (Alves, Tonin, Carrer, 2013), beans (Cunha, Wander, 2014) and ethanol (Santos, Aguiar, Figueiredo, 2015) in Brazil.

Among empirical studies few of them analyze APT for the rice market. Internationally, it was the case for the rice market in Togo, from 1991 to 2013, with the application of the TAR model, Irazou (2015) showed that international price shocks to domestic prices tend to confirm the existence of market power between intermediary links; therefore, preventing a better price transmission. In turn, Alam *et al.* (2016) studied the rice market in Bangladesh from 2002 to 2007 and reported that intermediaries (retailers) respond more quickly to price changes that reduce their margins than when the margins are expanded.

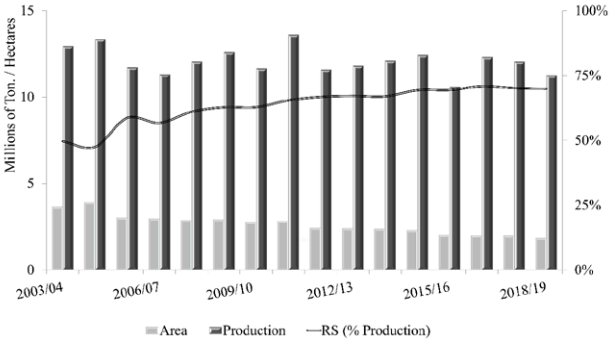
In the Brazilian rice market, we highlight the studies of Aguiar and Santana (2002) and Aguiar and Figueiredo (2011) who evaluated different food products and included rice in their analysis for the period between January 1989 and November 2008. Aguiar and Santana (2002) did not find APT between producers and retailers from 1987 to 1998, whereas Aguiar and Figueiredo (2011) report APT between wholesalers and retailers only in the short term, which indicated that increases in the wholesale price were transmitted by the retail sector more intensely than decreases, and in the wholesaler-producer relationship, APT was found in both the short and long terms. However, it appears that price decreases are transmitted more intensely than price increases in the wholesale market.

3. THE RICE MARKET IN BRAZIL AND RIO GRANDE DO SUL

In Brazil, between 2003/2004 and 2017/2018 crops, rice production amounted to 12 million tons, with a reduction of the cultivated area of 3.65 to 2 million hectares. Meanwhile, in Rio Grande do Sul, in an area of about 1 million hectares, the production of irrigated rice – thin, long and polished grains –increased from 6.4 to 8.5 million tons in the analyzed period. Because of the expansion of productivity over the last 15 harvests, the state of Rio Grande do Sul increased from 50% to 70% in national production (Fig. 1). The concentration of primary production has also led to concentration of industrialization, with Rio Grande do Sul accounting for 52% of the sales value of rice benefited by the Brazilian industry in 2016 (IBGE, 2019).

Between the 2003/2004 and 2017/2018 crops, important changes occurred in the national rice market, namely i) increased exports, from 92 to 1,400 thousand tons; ii) public invent or practically non existent

Fig. 1. Area planted and rice production in Brazil and participation (%) of Rio Grande do Sul in the national production, from 1997 to 2019.



Source: National Supply Company (CONAB, 2019a).

in 2003/2004, excess of 1.5 million tons in 2010/2011 and 2011/2012 crops, and then reaching a reduction of less than 100 thousand tons, recently. The private stock volume also reduced, but to a lesser extent, therefore, showed overall inventory reduction with increased participation of private stock of the total stocks in the country in recent years (Tab. A.1., Appendix).

The reduction in public inventories and the relative increase of private inventories results from the change in government activities in the market. Since the 1990s, with economic opening and monetary stabilization, there have been important changes in the different agricultural policy instruments (rural credit in the modality of funding, investment and commercialization, agricultural insurance, etc.), restructuring the Minimum Price Guarantee Policy (PGPM). This policy, although not mandatory, that is, not automatic, operates in several markets, such as rice, and its impacts are variable over time.

The PGPM has been redesigned to ensure reduced government intervention and costs, increasing storage and financing from the private sector (Rezende, 2000). In this context, government intervention during oversupply, made by purchase of production at the minimum guaranteed price for maintenance of regulatory inventory, such as the Acquisition of the Federal Government (AGF), is replaced by other commercialization instruments. In this new model, in the commercialization support instruments known as Prizes for Agricultural Product Flow (PEP) and the Equalizing Premium Paid to the Producer (PEPRO), subsidy is now given by the difference between the minimum and market prices. On the other hand, in instruments denominated Agricultural Products Selling Option Contract (COVPA) and Private Option Risk Premium (PROP), government actions resemble the policy of price insurance (Schwantes, Bacha, 2017).

In general, the government may a) directly purchase the production and stock it with the AGF, b) launch or encourage the private sector to create purchase options (COVPA, PROP) or c) offer subsidies to move the product to deficit regional markets (PEP, PEPRO). In any case, it is direct the importance of minimum price as an indicator of potential state intervention in the market. In other words, the level of minimum price (in comparison with the market price) increases government's chance to intervene in the market through the different support instruments mentioned.

Thus, in the last two decades, the PGPM has been reducing its magnitude and importance in the general context of the agricultural policy. However, rice is still among the crops most affected by this policy. Between 2003 and 2018, rice was the third largest agricultural product that received commercial aid from the Brazilian federal government, accounting for 2.5 billion of Reais or approximately 13% of the total spent, only after the wheat and corn crops (MAPA, 2019).

In the last two decades, government intervention has been concentrated mainly in the second half of the 2000s, with a peak in the 2011 crop, (Fig. A.1., Appendix) in which almost 3 million tons, of 13.6 million tons, were affected by some marketing instrument. In average terms, in the period 2001 to 2018, 4.3% of the rice crop benefited from some commercialization support of the federal government. Geographically, the state of Rio Grande do Sul accounted for 87% of the total amount of rice affected by marketing support instruments (MAPA, 2019). Still, in this environment of sectoral changes, reduction of public inventory, diversification of the instruments of commercialization support of agricultural products and increased participation of foreign trade are important to understand how price transmission between different links of the market place occurs.

4. EMPIRICAL STRATEGY

The theoretical approach to asymmetry price transmission (APT) adopted in this study is derived from the Engle and Granger (1987) approach, that is, it analyzes the vertical transmission of prices in a context of cointegration. In this sense, the relationship between prices is modeled by an error-correcting mechanism, following the adaptations of Von Cramon Taubadel and Loy (1999), Canêdo Pinheiro (2012), Jacomini and Burnquist (2018) and described by Frey and Manera (2007), according to equation (1):

$$\Delta p_{rt} = \alpha_0 + \sum_{k=1}^{K} \gamma_j \Delta p_{rt-j} + \sum_{J=0}^{J+} \beta_j^{+} \Delta p_{f\,t-j}^{+} + \sum_{J=0}^{J-} \beta_j^{-} \Delta p_{f\,t-j}^{-} + \theta^{+} ECT_{t-1}^{+} + \theta^{-} ECT_{t-1}^{-} + \varepsilon_t \quad (1)$$

Where: Δp_r and Δp_f are variations of the retail price and the producer level, respectively; subscript t denotes the time and superscripts (+) and (-) indicates whether the variation is positive or negative; $ECT_t = p_{rt} - \gamma_0 - \gamma_1 p_{ft}$ is the error correction term obtained from the long-term relationship between prices. The lag operators are k and j for retail and producer price, respectively. Naturally, this relationship can be applied to the retail industry-case and/or producer-industry or any other relationship within the production chain.

Equation (1) allows testing some forms of asymmetry presented by Frey and Manera (2007), such as i) contemporary impact asymmetry (AIC) if $\beta_0^{+} \neq \beta_0^{-}$; ii) asymmetry due to the distributed lags effect (AED), if $\beta_j^{+} \neq \beta_j^{-}$ for all j; iii) cumulative impact asymmetry (AIA) if $\Sigma_{j=J}^{J+} \neq \Sigma_{j=J}^{J-}$, where $J \in [0, min\ (J^{+}, J^{-})]$; iv) asymmetry in the equilibrium adjustment trajectory (ATAE) if $\theta^{+} \neq \theta^{-}$, that is, testing whether the speed of convergence depends on the retail price is above ($ECT_{t-1} \geq 0$) or below ($ECT_{t-1} \leq 0$) the long-term equilibrium.

While the cases presented in i) and ii) (AIC and AED) refer to short-term asymmetry, comparing the positive or negative impact in a given period, the test of ECT terms refers to long-term asymmetry. In the latter case, if there is a cointegration between two market levels, only the equilibrium adjustment speed (ATAE) can be asymmetric (Meyer, Von Cramon Taubadel, 2004).

During investigation, statistical tests are used, such as the unit root tests Dickey and Fuller (1979) and Philips and Perron (1988) and cointegration test Johansen (1988). Using of the Granger causality test (1969), the empirical analysis starts from the assumption that pricing ranges from the primary sector to the other vertical links of the rice production chain. In each case, the Wald test is applied to verify the APT between the links of the Brazilian rice production chain. The Stata 14 was used to calculate all this tests.

As a contribution, we intend to evaluate if the policy of minimum prices practiced by the Brazilian government affects price transmission in the rice production chain in Rio Grande do Sul. To this end, Equation (1) is modified to cover two situations: i) price paid to the producer above the minimum price; ii) price paid to the producer below the minimum price.

$$\Delta p_{rt} = \beta_0 + \sum_{k=1}^{K} \gamma_j \Delta p_{rt-j} + \theta ECT_{t-1} + \left(\sum_{i=0}^{M1} \beta_{1i} \Delta p_{ft-i}^{+} + \sum_{i=0}^{M2} \beta_{2i} \Delta p_{ft-i}^{-} \right) + \left(\sum_{j=0}^{M1} \gamma_{1j} \Delta p_{ft-j}^{+} + \sum_{j=0}^{M2} \gamma_{2j} \Delta p_{ft-j}^{-} \right) + \vartheta_t \quad (2)$$

Where: i and j represent the time subperiods where $pp > pm$ or $pp \leq pm$, respectively; with pp being the producer-level price and pm the minimum price established in the PPGM of the federal government. In this context, it is intended to identify if the results on the existence of APT are kept in the segmented series $pp > pm$ and $pp \leq pm$, which define the subperiods where the price paid to the producer was above or below the minimum price, respectively.

In order to segment the sample, as described above, we use the information on the historical series of the producer prices in Rio Grande do Sul and the Minimum Price Guarantee Policy (PGPM) of the Federal Government for rice produced in Rio Grande do Sul (Fig. A.1. and Tab. A.3., Appendix). We create a segment when the market forces are the main driver (producer-level price greater than minimum price) and a second term, when the minimum price are greater than the market priced received by producers (the last part of equation 2, when the government intervention are more probable).

The Figure A.1. (Appendix) shows the comparison between the series from January 2003 to December 2018, in nominal terms. We have 49 of the 191 months analyzed with market price lower than the minimum price, which implies the possibility of implementation of the intervention policy and represents the third part of equation 2. We can also see that the policy of support is strongly concentrated during harvesting (first half of the year) from 2006 to 2009, as well as practically throughout the year of 2011.

Here, it is essential reinforce that the PGPM is executed by the National Supply Company (CONAB) who sets the minimum price annually, at least sixty days before the beginning of the planting of the crop, taking into account the cost of production (in general, it uses the average variable cost of production as a guide) and parameters as export and import price, internal and external supply, and others. The Table A.3. (Appendix) shows the minimum rice price in Rio Grande do Sul during the period analyzed.

Obviously, the effectiveness of minimum price policy depends on government-set price values, resource

availability, and the volume of product operationalized compared to total production (Stefanelo, 2005)[1]. In other words, the existence of a minimum price in not guarantee that government will intervene (and in which magnitude) in the rice market.

Besides, it is not clear the way this intervention will affect the price transmission. On the one hand, as Kinnucan and Forker (1987) point, the existence a price support, often in the form of minimum prices, can lead to APT if retailers or wholesalers believe that the government intervention will reduce de uncertainty associated with interpreting a cost changes. In this context, a reduction in farm prices could be view as temporary because it will trigger government intervention, while an increase in farm prices is more likely to be permanent. Therefore, in this situation, it is expect that price support will probably result in positive APT. On the other hand, if the support price instrument pay the subside to the middlemen (that pass through it to farmers), as some PGPM instruments in Brazilian case, maybe they have an incentive to transmit more rapidly farm price decrease, in order to reinforce the probability of government intervention and increase his stocks with a lower average price. Consequently, the existence of minimum price could create APT, but it is not clear if it is a negative or positive price transmission.

5. DATA

As this study aimed to verify the occurrence of APT between the links in the rice production chain, price data was collected from February 2003 to December 2018 at three levels. The producer and industry prices in Rio Grande do Sul and the retail price in Porto Alegre (capital of the State) were obtained from the National Supply Company (CONAB, 2019b), the Rio Grande do Sul Rice Institute (IRGA, 2019) and the Center for Studies and Economic Research (IEPE, 2019), respectively. The producer price series consists of average selling prices of rice in shell per 50 kg bag, the price for the industry in 30 kg bags and retail are available in R$/Kg. The data were deflated using the General Price Index (IGP-M), calculated by Getúlio Vargas Foundation (FGV, 2019), with base of 100 for December 2018.

The data presented justify these choices. Firstly, Rio Grande do Sul is the main agricultural producer and industrial beneficiary of rice. Secondly, according to Miranda *et al.* (2009), in general, rice commercialization in Rio Grande do Sul from the rural producer is given by the deposit of cereal in some processing plant (cooperative or direct sale to an intermediary). In this system, the producer delivers their product to be stored at the plant without prior price adjustment, and transaction is made only when the parties (producers and industry) agree. Thus, although there is no formal contractual relationship, this practice functions as such, since the producer hardly takes the product from one plant to negotiate in another. In turn, the industry, usually by representatives, market their product already benefited with retail sector. In fact, in the rice market is usual the industry replace wholesale by marketing the product directly with retail, for this reason we use the industry price (the price that industry sells rice to their costumers) in our analysis.

Thus, the analyses of different market levels allowed to select the price to producers in the state of Rio Grande do Sul (largest primary producer), the price at the industry in the state (major rice producer) and retail in the main market of this region, metropolitan region of Porto Alegre, because it prevents modification of tax rates between states from affecting the relationship between the chain links, common in the Brazilian context.

Figure 2 shows the evolution of these prices in the period. The visual inspection of the data indicates that prices in the three levels considered are moving in the same direction with the retailer distancing slightly, showing an increase of the retail margin to the detriment of the others, as pointed out by Zanin (2013).

Finally, to evaluate jointly the different market levels, prices were converted into R$ / Kg at each market level[2]. Prices are in real terms, excluding the inflation as a source for asymmetry.

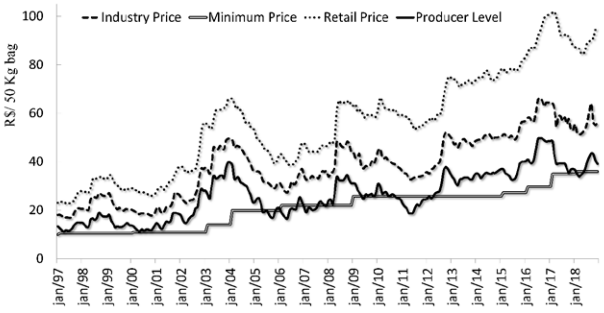
6. RESULTS AND DISCUSSION

In the context of cointegration, the first step is to analyze if the series are stationary. Table 1 shows that all the series of prices at level have unit root and in first difference are stationary (test ADF and PP). In addition, the

[1] The flow for approval of this minimum price is defined as follows: CONAB prepares the minimum price proposal and submits it to the Ministry of Agriculture and Livestock and Supply (MAPA); 2) MAPA analyzes and coordinates a meeting with the Ministry of Economy; 3) After technical approval, MAPA prepares and forwards votes to the National Monetary Council (CMN); 4) The CMN approves; 5) The MAPA launches Ordinance containing the minimum prices approved; 5) CONAB prepares and discloses the operating rules of this minimum price and 7) CONAB performs PGPM operations. This process follows the rules indicated by Decree-Law 79 of 12/19/1966 and Law 8171 of 01/17/1991.

[2] The price to the producer is not in an equivalent quantity, that is, no transformations were made in their unit to account for the equivalence between the product in shell (*in natura*) and the product benefited.

Fig. 2. Price of rice to the producer, in industry and retail of Rio Grande do Sul and minimum price of the Minimum Price Guarantee Policy (PGPM) for Rio Grande do Sul, monthly data, from January 2003 to December 2018.



Source: CONAB (2019b), CONAB (201;9d), IRGA (2019) and IEPE (2019).

series are leptokurtic and the hypothesis of normality of the residues is rejected (Jarque Bera test).

The long-term relationships between the price series in the different links of the rice production chain in Rio Grande do Sul (Tab. 2) are analyzed. The results of Johansen cointegration test indicate the existence of only a long-term cointegration relationship between different market levels analyzed, considering the different test specifications at a significance level of 5%.

Based on the results of the unit root (ADF and PP) and cointegration tests (Johansen), the Granger causality test was performed for the variable series. For the Johansen cointegration test specifications, we chose the case with the inclusion of a trend in the cointegration vectors, and because it is an agricultural product, factors such as increased productivity can influence the analysis. Following the recommendation of Miller and Russek (1990), in situations where there are cointegration relationships between the series analyzed, the residuals of the long-term equation are used as a mechanism of error correction in the short-term equation of the causality test (Tab. 3).

In general, the results of the Granger causality test demonstrate that each link in the rice productive chain has a causal effect on downstream links. Causality is observed in all cases, producer-retail, producer-industry and industry-retail, in a directional sense. These results corroborate the hypothesis that a supply shock tends to propagate to the subsequent links in the production chain. In the Brazilian literature on rice, Aguiar and Santana (2002) indicate producer-retail causality, while Aguiar and Figueiredo (2011) report wholesale-retail causality, reinforcing the hypothesis that shocks begin, predominantly, upstream and propagate downstream in the production chain.

The APT model for the rice market was performed considering the series in first difference, with bivari-

Tab. 1. Statistical properties of rice prices, level series and series returns.

Series	pp	pi	pr	D.pp	D.pi	D.pr
Panel A: Basic Descriptive Statistics						
Mean	0.951	2.306	3.368	-0.003	-0.006	-0.007
Std. Dev	0.248	0.492	0.564	0.062	0.11	0.101
Minimum	0.570	1.658	2.673	-0.276	-0.309	-0.284
Maximum	1.903	3.941	5.229	0.249	0.594	0.626
Skewness	1.885	1.746	1.713	0.565	1.468	1.742
Kurtosis	6.671	5.795	5.653	7.111	10.43	11.499
JB	81.41***	71.01***	69.15***	34.09***	79.65***	93.26***
Panel B: Unconditional Correlation Coefficients						
pp	1			1		
pi	0.974	1		0.736	1	
pr	0.938	0.937	1	0.397	0.554	1
Panel C: Unit Root Tests						
ADF	-2.483	-1.932	-2.325	-11.38***	-11.35***	-8.74***
PP	-2.16	-1.93	-2.19	-10.38***	-11.35***	-8.74***

Notes: 1. JB refer to Jarque–Bera test for normality; ADF and PP are the empirical statistics of the Augmented Dickey and Fuller (1979) and the Philips and Perron (1988) unit root tests were performed including the trend and constant terms, with lags based on the AIC and SBIC criteria (pp: 2 lags, pi and pv: 1 lag).
2. *, ** e *** denote 10, 5 and 1 percent significance levels, respectively.
Source: Prepared by the authors.

Tab. 2. Johansen cointegration test on the different relations between market levels for rice in Rio Grande do Sul from January 2003 to December 2018.

Rank	Model2 (restricted constant)		Model 3(unrestricted constant)		Model 4(restricted trend)	
	Trace Stat. (λ)	Max Eigen Value (λmax)	Trace Stat. (λ)	Max Eigen Value (λmax)	Trace Stat. (λ)	Max Eigen Value (λmax)
Farm Price and Retail price						
r = 0	26.376	22.427	25.921	22.407	31.284	27.635
r ≤ 1	3.948[a]	3.948[a]	3.514[a]	3.514[a]	3.649[a]	3.649
Industry Price and Retail price						
r = 0	16.000[a]	12.0349[a]	15.673	12.031	36.139	31.808
r ≤ 1	3.965	3.965	3.641[a]	3.641	4.330[a]	4.33
Farm Price and Industry price						
r = 0	25.718	22.049	25.382	22.031	47.536	41.622
r ≤ 1	3.668[a]	3.668[a]	3.352[a]	3.352[a]	5.913[a]	5.913[a]

Notes: 1.Models 2, 3 and 4 refer respectively to the Johansen test specifications: Case 2 - restricted constant, Case 3 - unrestricted constant and Case 4 - restricted trend, in Stata context.
a. Level of significance of 5% and critical values for trace statistics (λ): Case 2 – 19.96; Case 3 – 15.41 and Case 4 – 25.32; and critical values for Maximum Eigenvalue are: Case 2 – 15.67; Case 3 – 14.07 and Case 4 – 18.96.
Source: Prepared by the authors.

Tab. 3. Results for Granger Causality Test between the levels of the Brazilian rice market, February 2003 to December 2018.

Market Levels	The nullhypothesis	F Stat.	Prob.	Lags	Causality
Retail *X* Producer	D.pp does not Granger-cause D.pr	13.780	0.000	5	Producer → Retail
	D.pr does not Granger-cause D.pp	1.390	0.230	5	
Retail *X* industry	D.pi does not Granger-cause D.pr	7.290	0.000	3	Industry → Retail
	D.pr does not Granger-cause D.pi	0.390	0.760	3	
Industry *X* Producer	D.pp does not Granger-cause D.pi	22.020	0.000	2	Producer → Industry
	D.pi does not Granger-cause D.pp	0.480	0.617	2	

Note: 1. * For the Granger Causality tests, the following equations were used:
$\Delta y_t = \alpha_0 + \sum_{i=1} \beta_{yi} \Delta y_{t-i} + \sum_{i=1} \beta_{xi} \Delta x_{t-i} + \alpha_1 \mu_{t-1} + \epsilon_t$ (direction $x \rightarrow y$) and
$\Delta x_t = \alpha_0 + \sum_{i=1}^{p} \beta_{xi} \Delta x_{t-i} + \sum_{i=1}^{q} \beta_{yi} \Delta y_{t-i} + \alpha_2 \mu_{t-1} + \epsilon_t$ (direction $y \rightarrow x$).
Source: Prepared by the authors.

ate analyses between the different market levels, in two distinct specifications: i) model with specification of the Error Correction Term (ECT); ii) model with segmentation of the error term. Thus, these two models (ECT and segmented ECT) were estimated for three relationships between the rice market levels, namely Retail-Producer; Industry-Producer and Retail-Industry, following the logic that shocks start upstream (in the primary sector, producer or industry) and propagate to the subsequent link (industry and / or retail).

In terms of methodological specification, there are indications of correct specification of the models with error correction term (ECT), since ECT coefficients are statistically significant (Tab. 4). In addition, the model with segmented ECT presented higher level statistical significance in all ATP tests.

The asymmetry tests demonstrate the occurrence of contemporary asymmetry (AIC) in the Retail-Industry relationship, the presence of asymmetry of lagged effect (AED) in the Retail-Producer case, and both contemporary and lagged asymmetries in the Industry-Producer relationship. The comprehensive cumulative impact asymmetry test (AIA) corroborates the diagnosis of the occurrence of APT between the links in the rice produc-

Tab. 4. Asymmetric Price Transmission models for the Brazilian rice market, monthly data from January 2003 to December 2018.

	Retail (dependent) x Producer (independent)		Industry (dependent) x Producer (independent)		Retail (dependent) x Industry (independent)	
Variables	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
$D.P_{ft}^{+}$	0.546***	0.544***	1.440***	1.450***	0.558***	0.584***
$D.P_{ft}$	0.233*	0.230*	0.755***	0.754***	0.266***	0.267***
$LD.P_{ft}^{+}$	0.936***	0.932***	0.913***	0.912***	0.272***	0.275***
$LD.P_{ft}^{-}$	0.310**	0.316**	0.175	0.155	0.226**	0.175*
$L2D.P_{ft}^{+}$	-0.379**	-0,382**				
ECT_{t-1}	-0.142***		-0.250***		-0.090***	
ECT^{+}_{t-1}		-0.135***		-0.302***		-0.187***
ECT^{-}_{t-1}		-0.147***		-0.195**		-0.028
L.D.PR	-0.284***	-0.284***			0.220***	0.236***
L.D.PI			-0.199***	-0.201***		
L2D.PI			-0.072**	-0.071*		
Cons.	-0.014***	-0.015***	-0.007***	-0.028***	-0.014*	-0.005
F-test	51.27	44.62	61.01	53.33	44.29	38.90
R^2	0.666	0.667	0.704	0.705	0.594	0.601
BG Test	0.554	0.577	1.577	1.731	0.125	0.02
(AIC)	2.08	2.08	10.26**	10.50**	5.46**	6.41**
(AED) (one lag)	8.96***	7.95***	12.16***	12.58**	0.13	0.62
(AIA)	3.72**	3.35***	30.86***	31.37***	4.24**	6.10**
(ATAE)		0.02		0.58		3.26*

Notes: In the nomenclature of the series used, D refers to the variables in first difference; L and L2 refers to lagged series, 1 lag and 2 lags, respectively; P_{ft} refers to the price paid to the producer in the Producer-Retail and Producer-Industry analyses, and the relationship between Industry-Retail P_{ft}=P_{it} price in the industry; + (positive) represents price increases; and - (negative) refers to price decreases, at each market level analyzed.

2. We use the Breusch-Godfrey (BG) LM test for autocorrelation, H0 is: no autocorrelation.

3. In the selection of the number of lags, such as the Akaike (AIC), Schwarz-Bayes Criterion (SBIC) and Hannan-Quinn (HQ) information criteria, different lags were chosen, the parsimony criterion was chosen, maintaining the lower number of lags recommended (with significant coefficients).

4. The tests between the regression parameters are equivalent to (AIC) Wald^{D}:$\beta_1 \Delta P_{ft}^{+} = \beta_2 \Delta P_{ft}^{-}$; (AED) Wald^{LD}:$\beta_1 \Delta P_{ft}^{+}(-1) = \beta_2 \Delta P_{ft}^{-}(-1)$; (AIA) $\text{Wald}^{ALL} = \sum_{i=0}^{J+} \beta_{1i} \Delta P_{ft-i}^{+} = \sum_{i=0}^{J-} \beta_{2i} \Delta P_{ft-i}^{-}$ e (ATAE) Wald^{ECT}:$\theta^{+} ECT_{t-1}^{+} = \theta^{-} ECT_{t-1}^{-}$.

Source: Prepared by the authors.

tion chain, where price increases are transmitted more intensely, to the detriment of price drops.

Asymmetry in the speed of adjustment to the long-term equilibrium (ATAE) was significant and statistically valid only for the Retail-Industry case, and again, the positive impacts present the highest transmission speed. Even in this case, the term ECT was not significant (in the negative segment), but presented the expected signal, and since in the non-segmented case (Model 1), the term ECT is significant, it is understood that this non-significance is sampling result rather than the absence of cointegration between the variables.

For the links investigated, the industry-producer relationship presented the best fit (R^2> 0.71), most of its coefficients are statistically significant and showed positive asymmetry in all cases (contemporary, lagged, and cumulated).

As for the sources of APT, Meyer and Von Cramon Taubadel (2004) and Vavra and Goodwin (2005) list factors that may be relevant in the analysis of the rice production chain in Brazil. One of the factors is government intervention through minimum price policies for agricultural products. Kinnucan and Forker (1987) raised this and highlighted that government policies can lead to asymmetric price adjustments if agents, such as retailers / wholesalers or even industry, believe that price movements in one direction are more susceptible to interventions than in another direction.

In this sense, to capture the effect of the minimum price policy on the dynamics of price transmission between links in the rice chain, this study proposes a segmentation of the traditional model into two series of price increases and decreases, representing the sub periods when the price paid to the producer is above or below the

Tab. 5. Asymmetry Price Transmission Model of rice market in Brazil, segmented in moments that market prices are belowor above minimum prices, January 2003 to December 2018.

	Retail (dependent) x Producer (independent)		Industry (dependent) x Producer (independent)		Retail (dependent) x Industry (independent)	
Variables	Model 1	Model 3	Model 1	Model 3	Model 1	Model 3
$D.P_{ft}^{+}$ (all)	0.546***		1.440***		0.558***	
$D.P_{ft}^{-}$ (all)	0.233*		0.755***		0.266***	
$D.P_{ft}^{+}$ (in)		-0.203		1.244***		-0.391*
$D.P_{ft}^{-}$ (in)		0.593**		0.601***		0.688***
$D.P_{ft}^{+}$ (out)		0.909***		1.716***		0.630***
$D.P_{ft}^{-}$ (out)		0.380**		0.884***		0.267***
$LD.P_{ft}^{+}$	0.936***		0.913***		0.272***	
$LD.P_{ft}^{-}$	0.310**		0.175		0.226**	
$L2D.P_{ft}^{+}$	-0.379***					
ECT	-0.142***	-0.230***	-0.250***	-0.308***	-0.090***	-0.194***
L.D.PR	0.284***	0.285***			0.220***	
L.D.PI			-0.199***			
L2D.PI			-0.072**			
Constant	-0.014***	-0.009	-0.007***	-0.020***	-0.014*	-0.0110
F-test	51.27	42.20	61.01	52.63	44.29	32.64
R^2	0.666	0.582	0.704	0.67	0.594	0.47
BG Test	0.554	0.113	1.577	5.37	0.125	10.93
AIC	2.08		10.26**		5.46**	
AIC^{IN}		3.17*		4.62**		11.41***
AIC^{OUT}		5.64***		12.68***		3.41**
AIA^{ALL}	3.72**	0.23	30.86**	10.65***	4.24***	2.81*

Notes: In the nomenclature of the series used, D refers to the variables in first difference; L and L2 refers to lagged series, 1 lag and 2 lags, respectively; P_{ft} refers to the price paid to the producer in the Producer-Retail and Producer-Industry analyses, and in the analysis of the Industry-Retail $P_{ft}=P_{it}$ price in the industry; + (positive) represents price increases; - (negative) refers to the price drops, at each market level analyzed; and IN refers to the periods when *pp≤pm* and OUT when *pp>pm*.

2. The tests between the regression parameters are equivalent to (AIC) $Wald^{D}$:$\beta_1 \Delta P_{ft}^{+} = \beta_2 \Delta P_{ft}^{-}$, performed for the periods in which *pp≤pm* (AIC^{IN}) and when *pp>pm* (AIC^{OUT}) and(AIA) $Wald^{ALL} = \sum_{i=0}^{J+} \beta_{1i} \Delta P_{ft-i}^{+} = \sum_{i=0}^{J-} \beta_{2i} \Delta P_{ft-i}^{-}$.

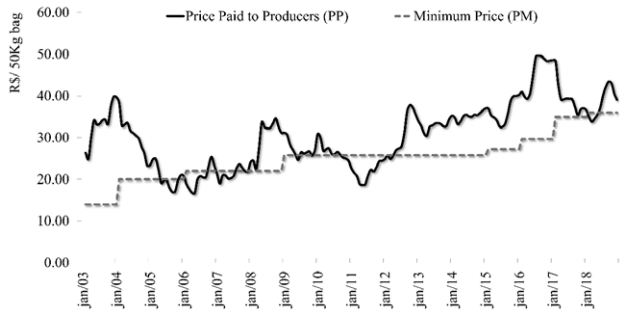
3. We use the Breuch-Godfrey (BG)LM test for autocorrelation, H0 is:no autocorrelation; When this test is significative we estimate the model without the lagged dependent variable and with the Newey-West standard error correction. Models with lagged dependent variable and more lags do not change the results.

Source: Prepared by the authors.

current minimum price. Table 5 shows the comparison between the results of the baseline model, without segmentation of the sample period (Model 1) in relation to the segmented APT model based on the relation between the market and the minimum prices (Model 3). Based on the statistical significance of the estimated parameters for all the relationships (producer-retail, industry-producer and industry-retail) the APT is observed in both periods, when the market price is higher than the minimum price (segment called "out") and when the market price is lower than the minimum price (segment called "in").

When the market price for rice is below the minimum price (period "in" in Tab. 5) the asymmetry are negative in cases involving retail sector. The coefficient for price increase is not significant for retail-producer and retail-industry relationship, whereas the price decrease coefficient are. In these cases, it seems that pass-through of price decrease occurs more rapidly, a behavior that is not present in the period drive by market forces (segment "out"). It could reflect a strategy of a more intense transfer of falls to the next link to increase sales and reduce inventories that tend to grow at these times. Finally, the results of the segmented sample confirm asymmetry (when market price less than minimum price) but in a different way (negative APT) and should be analyzed with caution given the size of the sample obtained and the not statistical significance of increase prices coefficients.

Fig. 3. Producer Prices and Minimum Price for 50-kg bag of rice in Rio Grande do Sul, from January 2003 to December 2018.



Source: Prepared by the authors, based on CONAB (2019b, 2019d).

On the other hand, the industry-producer relationship, in period "in", shows positive APT. In this case, both price coefficient (increase and decrease) are significant and shows that the industrial sector, which is directly related to the producer, tends to pass the price increases faster to its consumers than the falls, when intervention policy is more likely to occur. When market forces prevail, the period out, this positive APT remains. Therefore, for the industry-producer relationship the potential government intervention does not change the APT behavior and is detected as a source of it.

In short, it seems that intervention policy may be one of the explanations for APT in Brazilian rice market, but not the only one, as it remains and even strengthens in periods without government intervention. In this sense, other explanations could help to understand the APT. One of them is the management of rice inventory, as described by Meyer and Von Cramon Taubadel (2004) and Vavra and Goodwin (2005). Rice is a commodity; thus, storage has implications on price transmission. Therefore, intermediaries (as retail in our case) could benefit from reduced prices at producer level to replenish or increase their inventories (Reagan, Weitzman, 1982). Moreover, Balke *et al.* (1998) showed the accounting method used to manage the inventories can also generate APT, methods as first in first out (FIFO), might lead to adjustments of asymmetric price shocks. In addition, restriction of non-negativity to the stock, according to Blinder (1982), could also lead to APT.

In this context, as we saw in the Table A.1 the inventories had an important variation along the all sample with private sector replacing the public sector as the holder of rice stored in Brazil, maybe this modification could bring light to understand the APT. But, this is a difficult hypothesis to test for the rice market, due to the lack of known series of stocks of private agents (retailers / wholesalers/industry) available in a disaggregated way.

Furthermore, methodological adjustments are required to test inventory and APT relationship, in addition to the collection of data not available in the present study. These adjustments are not in the scope of this work; nevertheless, they are important points for further research. This study aims to contribute to a better understanding of price asymmetry. In addition to measuring it, this study sought to identify a possible cause of APT, namely the role of the policy of minimum prices, which were confirmed. For further research, maybe different methodological frameworks available in the literature could be implemented to confirm our results.

7. FINAL REMARKS

The objective of this work was to investigate asymmetric price transmission (APT), through the error correction model (ECM) between the links of the rice production chain in producer and industry markets of the state of Rio Grande do Sul, Brazil, and the retail market in the metropolitan region of the state capital, Porto Alegre, from February 2003 to December 2018. The period of analysis is fruitful in terms of changes in the rice market in Brazil. Changes are namely related to the regional concentration of primary production and the industrial processing of the cereal, the use of public policies, such as minimum prices, changes in inventory levels and greater insertion into the international market, among others, which allow testing the APT.

At the different levels analyzed (Retail-Producer, Industry-Producer and Retail-Industry), the APT tests indicated the presence of positive asymmetry, both contemporaneous or lagged and cumulatively, in prices transmission in the rice production chain. The result confirms the empirical results available in the literature. The evaluation of the different extracts of analysis shows that the industry-producer relationship presented the best fit, expected signs and positive asymmetry in the different measured forms (AIC, AED and AIA). This market link has a direct relationship with producers and the results indicate they could benefit from this proximity by passing on price increases more quickly than price reductions for their customers.

As a methodological contribution, this study aimed to adapt the model to evaluate the results in sub periods of time, specifically to differentiate the periods in which the market price was above or below the minimum price. The results show that when the market price was below the minimum price, the transmission of the price falls were greater than increases when the retail sector is considered, making negative asymmetry in retail-pro-

ducer and retail-industry relationship. In the industry-producer case, we found positive asymmetry in the same sample segmentation. These results may indicate that the government intervention is a potential source of asymmetry in Brazilian rice market, but not the only one, as the APT remain in the period where the market price was above the minimum price.

Regarding the limitations of this study, although the results indicate the occurrence of APT, the price series adopted in the analysis, monthly basis, have limitations in the accurate monitoring of price dynamics between the links in the production chain. Finally, for future research on the process of price transmission in the rice sector in Brazil, we could assess which inventory levels have more influence on the APT process. Furthermore, studies could be conducted to evaluate the effects of changes on price transmission, namely changes in the contractual framework or in the negotiation policies between the links of the productive chain.

REFERENCES

Acosta A., Valdés A. (2014). Vertical price transmission of milk prices: are small dairy producers efficiently integrated into markets? *Agribusiness*, 30(1): 56-63. Doi: 10.1002/agr.21357

Aguiar D.R., Figueiredo A.M. (2011). Poder de mercado no varejo alimentar: uma análise usando os preços do estado de São Paulo. *Revista de Economia e Sociologia Rural*, 49(4): 967-990. Doi: 10.1590/S0103-20032011000400007

Aguiar D.R., Santana J.A. (2002). Asymmetry in farm to retail price transmission: evidence from Brazil. *Agribusiness*, 18(1): 37-48. Doi: 10.1002/agr.10001

Alam M.J., McKenzie A.M., Begum I.A., Buysse J., Wailes E.J., Huylenbroeck G. (2016). Asymmetry price transmission in the deregulated rice markets in Bangladesh: asymmetric error correction model. *Agribusiness*, 32(4): 498-511. Doi: 10.1002/agr.21461

Alves A.F., Tonin J.M., Carrer M.J. (2013). Assimetria de transmissão de preço na comercialização da uva fina de mesa no Paraná: 1997 a 2011. *Revista de Economia e Sociologia Rural*, 51(3): 479-498. Doi: 10.1590/S0103-20032013000300004

Awokuse T.O., Wang X. (2009). Threshold effects and asymmetric price adjustments in US dairy markets. *Canadian Journal of Agricultural Economics/Revue canadienned'agroeconomie*, 57(2): 269-286. Doi: 0.1111/j.1744-7976.2009.01151.x

Azevedo P.F.D., Politi R.B. (2008). Concorrência e estratégias de precificação no sistema agroindustrial do leite. *Revista de Economia e Sociologia Rural*, 46(3): 767-802. Doi: 10.1590/S0103-20032008000300008

Bailey D., Brorsen B.W. (1989). Price asymmetry in spatial fed cattle markets. *Western Journal of Agricultural Economics*: 246-252. Available at: <http://www.jstor.org/stable/40988103> (accessed 1st March 2019).

Ball L., Mankiw N.G. (1994). Asymmetric Price Adjustment and Economic Fluctuations. *The Economic Journal,* 104: 247-261. <https://doi.org/10.2307/2234746>.

Balke N.S., Brown, S.P.A., Yüce L.M.K. (1998). Crude Oil and Gasoline Prices: An asymmetric Relationship?, Federal Reserve Bank of Dallas, *Economic Review*, First Quarter: 2-11.

Bernard J.C., Willett L.S. (1996). Asymmetric price relationships in the US broiler industry. *Journal of Agricultural and Applied Economics*, 28(2): 279-289. Doi: 10.1017/S1074070800007306

Blinder A. (1982). Inventories and Sticky Prices: More on the Microfoundations of Macroeconomics. *The American Economic Review,* 72(3): 334-348.

Canêdo Pinheiro M. (2012). Assimetrias na transmissão dos preços dos combustíveis: o caso do óleo diesel no Brasil. *Revista Brasileira de Economia*. RJ, Brasil, 66(4): 557-578. <http://dx.doi.org/10.1590/S0034-71402012000400005>.

Capps O., Sherwell P. (2007). Alternative approaches in detecting asymmetry in farm-retail price transmission of fluid milk. *Agribusiness*, 23(3): 313-331. Doi: 10.1002/agr.20126

Centro de Estudos e Pesquisas Econômicas – IEPE – UFRGS (2019). Available at: <http://www.ufrgs.br/iepe/> (accessed 20 January 2019).

Companhia Nacional de Abastecimento – CONAB – Séries Históricas (2019a). Available at: <https://www.conab.gov.br/info-agro/safras/serie-historica-das-safras> (accessed 28 January 2019).

Companhia Nacional de Abastecimento – CONAB – Preços Agropecuários (2019b). Available at: <https://www.conab.gov.br/info-agro/precos?view=default> (accessed 28 January 2019).

Companhia Nacional de Abastecimento – CONAB – Quadro Oferta e Demanda (2019c). Available at: <https://portaldeinformacoes.conab.gov.br/index.php/oferta/oferta-dashboard> (accessed 28 January 2019).

Companhia Nacional de Abastecimento – CONAB – Preço Mínimo (2019d). Available at: <https://www.conab.gov.br/precos-minimos> (accessed 28 January 2019).

Cunha C.A., Wander A.E. (2014). Asymmetry in farm-to-retail dry bean price transmission in São Paulo, Brazil. *Journal on Chain and Network Science*, 14(1): 31-41. Doi: 10.3920/JCNS2014.0233

Cutts M., Kirsten J. (2006). Asymmetric Price Transmission and Market Concentration: an investigation into four south african agro-food industries. *South African Journal of Economics*, 74(2): 323-333. Doi: 10.1111/j.1813-6982.2006.00064.x

Dickey D.A., Fuller W.A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74(366a): 427-431. Doi: 10.1080/01621459.1979.10482531

Dong X., Brown C., Waldron S., Zhang J. (2018). Asymmetric price transmission in the Chinese pork and pig market. *British Food Journal*, 120(1): 120-132. Doi: 10.1108/BFJ-02-2017-0056

Engle R., Granger C. (1987). Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica,* 55(2): 251-276. Doi:10.2307/1913236

Frey G., Manera M. (2007). Econometric models of asymmetric price transmission. *Journal of Economic surveys*, 21(2): 349-415. Doi:10.1111/j.1467-6419.2007.00507.x

Gardner B.L. (1975). The farm-retail price spread in a competitive food industry. *American Journal of Agricultural Economics*, 57(3): 399-409. Doi:10.2307/1238402

Getulio Vargas Foundation – FGV (2019). Available at: <http://www14.fgv.br/fgvdados20/default.aspx> (accessed 28 October 2019).

Goodwin B.K., Holt M.T. (1999). Price transmission and asymmetric adjustment in the US beef sector. *American Journal of Agricultural Economics*, 81(3): 630-637. Doi: 10.2307/1244026

Granger C.W.J. (1969) Investigating Causal Relations by Econometric Models and Cross-spectral Methods. *Econometrica*, 37(3): 424-38. Doi:10.2307/1912791.

Griffith G.R., Piggott N.E. (1994). Asymmetry in beef, lamb and pork farm-retail price transmission in Australia. *Agricultural Economics*, 10(3): 307-316. Doi: 10.1016/0169-5150(94)90031-0

Hahn W., Stewart H., Blayney D.P., Davis C.G. (2016). Modeling price transmission between farm and retail prices: a soft switches approach. *Agricultural Economics*, 47(2): 193-203. Doi: 10.1111/agec.12222

Houck J.P. (1977). An approach to specifying and estimating nonreversible functions. *American JournalofAgriculturalEconomics*, 59(3): 570-572. Doi: 10.2307/1239663

Instituto Brasileiro de Geografia e Estatística – IBGE – Pia produto 2016 (2019). Available at: <https://www.ibge.gov.br/estatisticas-novoportal/economicas/industria/9044-pesquisa-industrial-anual-produto.html?=&t=downloads> (accessed 1st February 2019).

Instituto Rio-Grandense do Arroz – IRGA – Mercado (2019). Available at: <https://irga.rs.gov.br/inicial> (accessed 20 January 2019).

Irazou T.T. (2015). International Price Shocks Transmission: The Case of Rice in Togo. *Journal of Agricultural Science and Technology*, 7(3): 441-450. Doi: 10.17265/2161-6264/2015.07.001

Jacomini R.L., Burnquist L.H. (2018). Asymmetric price transmission in the Brazilian refined sugar market. *Italian Review of Agricultural Economics*, 73(1): 5-25. Doi:10.131228/REA-23576

Johansen S. (1988). Statistical analysis of cointegration vectors. *Journal of economic dynamics and control*, 12(2-3): 231-254. Doi: 10.1016/0165-1889(88)90041-3

Kinnucan H.W., Forker O.D. (1987). Asymmetry in farm-retail price transmission for major dairy products. *American journal of agricultural economics*, 69(2): 285-292. Doi: 10.2307/1242278

Lloyd T. (2017). Forty Years of Price Transmission Research in the Food Industry: Insights, Challenges and Prospects. *Journal of Agricultural Economics*, 68(1): 3-21. Doi: 10.1111/1477-9552.12205

Meyer J., Von Cramon Taubadel S. (2004). Asymmetric price transmission: a survey. *Journal of Agricultural Economics*, 55(3): 581-611. Doi: 10.1111/j.1477-9552.2004.tb00116.x

Miller D.J., Hayenga M.L. (2001). Price cycles and asymmetric price transmission in the US pork market. *American Journal of Agricultural Economics*, 83(3): 551-562. Doi: 10.1111/0002-9092.00177

Miller S.M., Russek F.S. (1990). Co-Integration and Error-Correction Models: The Temporal Causality between Government Taxes and Spending. *Southern Economic Journal*, 57(1). Doi: 10.2307/1060491

Ministério da Agricultura, Pecuária e Abastecimento – MAPA – (2019). Política Agrícola - Comercialização e Abastecimento. Availabla at: < https://www.gov.br/agricultura/pt-br/assuntos/politica-agricola/todas-publicacoes-de-politica-agricola/apoio-a-comercializacao/ano-civil-apoio-a-comercializacao-2003-2020-janeiro-20-pdf> (accessed 29 January 2019).

Minten B., Kyle S. (2000). Retail margins, price transmission and price asymmetry in urban food markets: The case of Kinshasa (Zaire). *Journal of African Economies*, 9(1): 1-23. Doi: 10.1093/jae/9.1.1

Miranda S.H.G, Silva G.S., Serigatto Braghetta Motta M.A., Oliveira Moraes Esposito H. (2009). A Cadeia Agroindustrial Orizícola do Rio Grande do Sul. *Análise Econômica*, 27(52). Doi: https://doi.org/10.22456/2176-5456.5113

Moghaddasi R. (2009). Price transmission in agricultural markets: an Iranian experience. *American-Eurasian Journal of Agricultural and Environmental Science*, 6(1): 70-75. Available at: http://www.idosi.org/aejaes/jaes6(1)/

Peltzman S. (2000). Prices rise faster than they fall. *Journal of Political Economy*, 108(3): 466-502. Doi: 10.1086/262126

Phillips P.C.B., Perron P. (1988). "Testing for a Unit Root in Time Series Regression". *Biometrika*. 75(2): 335–346. Doi:10.1093/biomet/75.2.335.

Reagan P.B., Weitzman M.L. (1982). Asymmetries in price and quantity adjustments by the competitive firm. *Journalof Economic Theory*, 27(2): 410-420. Doi: 10.1016/0022-0531(82)90037-0

Rezende G.C. de. (2000). Política de preços mínimos na década de 90: dos velhos aos novos instrumentos. *Texto para Discussão,* 740: 19. IPEA. Available at: <http://www.ipea.gov.br/portal/images/stories/PDFs/TDs/td_0740.pdf>. Accessed date: (acessed 06 February 2019).

Santos J.Z.D., Aguiar D.R., Figueiredo A.M. (2015). Assimetria na Transmissão de Preços e Poder de Mercado: o caso do mercado varejista de etanol no estado de São Paulo. *Revista de Economia e Sociologia Rural*, 53(2): 195-210. Doi: 10.1590/1234-56781806-9479005302001

Schwantes F., Bacha C.J.C. (2017). Custos Sociais e Orçamentários das Políticas de Garantia de Preços no Brasil - estudo dos casos de arroz e milho. *Revista de Economia e Sociologia Rural*, 55(2): 367-388. Piracicaba – SP. <http://dx.doi.org/10.1590/1234-56781806-94790550209>.

Stefanelo E.L. (2005). A Política de Garantia de Preços Mínimos no Brasil: Classificação e operacionalização dos seus instrumentos no período 1990-2004.176p. Tese de Doutorado (Engenharia da Produção) Universidade Federal de Santa Catarina-UFSC, Florianópolis, 2005.

Tweeten L., Quance C. (1969). Positivistic Measures of Aggregate Supply Elasticities: Some New Approaches. *American Journal of Agricultural Economics,* 51(2): 342-352. Doi: 10.2307/1237584

Vavra P., Goodwin B.K. (2005), Analysis of Price Transmission Along the Food Chain, OECD Food, Agriculture and Fisheries *Working Papers*, 3. OECD Publishing. Doi:10.1787/752335872456

Verreth D.M., Emvalomatis G., Bunte F., Kemp R., Oude Lansink A.G. (2015). Price Transmission, International Trade, and Asymmetric Relationships in the Dutch Agri-Food Chain. *Agribusiness*, 31(4): 521-542. Doi: 10.1002/agr.21420

Von Cramon Taubadel S.V. (1998). Estimating asymmetric price transmission with the error correction representation: An application to the German pork market. *European review of agricultural economics*, 25(1): 1-18. Doi: 10.1093/erae/25.1.1

Von Cramon Taubadel S., Loy J.P. (1999). The identification of asymmetric price transmission processes with integrated time series. *Jahrbucher fur Nationalokonomie und Statistik*, 218(1-2): 85-106. Doi: 10.1515/jbnst-1999-1-206

Ward R. (1982). Asymmetry in Retail, Wholesale, and Shipping Point Pricing for Fresh Vegetables. *American Journal of Agricultural Economics,* 64(2): 205-212. Doi: 10.2307/1241124

Wolffram R. (1971). Positivistic Measures of Aggregate Supply Elasticities: Some New Approaches: Some Critical Notes. *American Journal of Agricultural Economics,* 53(2): 356-359. Doi: 10.2307/1237462

Zanin V. (2013). Panorama Geral da Orizicultura brasileira. *Revista Indicadores Econômicos FEE*, 41(2): 51-66. Porto Alegre. Available at: <https://revistas.fee.tche.br/index.php/indicadores/article/view/2978/3186> (accessed 10 February 2019).

Tab. A.1. Rice supply and demand for Brazil, 1997 to 2018 (in thousand tons).

Harvest	1996/1997	1997/1998	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007
Initial Inventory	1,857.0	1,762.0	1,565.6	2,110.2	2,113.3	1,921.4	1,965.8	1,917.9	2,397.7	2,470.7	2,259.5
Production	9,524.5	8,462.9	11,582.2	11,423.1	10,386.0	10,626.1	10,367.1	12,960.4	13,355.0	11,721.7	11,315.9
Import	1,232.0	2,009.0	1,338.0	936.5	951.6	737.3	1,601.6	1,097.3	728.2	827.8	1,069.6
Total Supply	12,613.5	12,233.9	14,485.8	14,469.8	13,450.9	13,284.8	13,934.5	15,975.6	16,480.9	15,020.2	14,645.0
Domestic Consumption	10,846.9	10,658.4	12,305.4	12,335.4	11,505.1	11,271.4	11,993.1	13,485.7	13,630.5	12,308.4	12,305.5
Export	4.6	9.9	37.7	21.1	24.4	47.6	23.5	92.2	379.7	452.3	313.1
Total Demand	10,851.5	10,668.3	12,343.1	12,356.5	11,529.5	11,319.0	12,016.6	13,577.9	14,010.2	12,760.7	12,618.6
Final Inventory (Feb 28)	1,762.0	1,565.6	2,142.7	2,113.3	1,921.4	1,965.8	1,917.9	2,397.7	2,470.7	2,259.5	2,026.4
Final Public Inventory	449.1	99.5	867.1	1,933.4	1,320.5	79.7	1.8	4.6	956.7	1,060.4	1,413.1
AGF	449.1	99.5	867.1	1,046.2	767.8	71.8	1.3	2.4	504.9	607.5	505.2
Options Contracts	0.0	0.0	0.0	887.2	552.7	7.9	0.5	1.8	424.5	421.9	880.7
Agricultura Familiar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	27.3	31.0	27.2
Private Inventory	1,312.9	1,466.1	1.275.6	179.9	600.9	1,886.1	1,916.1	2,393.1	1,514.0	1,199.1	613.3
Private Inventory (% Total)	74.1	93.64	59.53	8.51	31.27	95.95	99.91	99.81	61.28	53.07	30.27
Harvest	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018
Initial Inventory	2,026.4	2,033.7	2,531.5	2,457.3	2,569.5	2,125.3	1,082.1	868.2	962.9	430.8	711.6
Production	12,074.0	12,602.5	11,660.9	13.613.1	11,599.5	11,819.7	12,121.6	12,448.6	10,603.0	12,327.8	12,064.2
Import	589.9	908.0	1,044.8	825.4	1,068.0	965.5	807.2	503.3	1,187.4	1,042.0	1,000
Total Supply	14,690.3	15,544.2	15,237.2	16,895.8	15,237.0	14,910.5	14,010.9	13,820.1	12,753.3	13,800.6	13,775.8
Domestic Consumption	11,866.7	12,118.3	12,152.5	12,236.7	11,656.5	12,617.7	11,954.3	11,495.1	11,428.8	12,024.3	11,700
Export	789.9	894.4	627.4	2,089.6	1,455.2	1,210.7	1,188.4	1,362.1	893.7	1,064.7	1,400
Total Demand	12,656.6	13,012.7	12,779.9	14,326.3	13,111.7	13,828.4	13,142.7	12,857.2	12,322.5	13,089.0	13,100.0
Final Inventory (Feb 28)	2,033.7	2,531.5	2,457.3	2,569.5	2,125.3	1,082.1	868.2	962.9	430.8	711.6	675.8
Final Public Inventory	515.3	992.6	976.6	1,823.8	1,506.93	586.01	146.69	97.9	22.77	22.3	
AGF	63.8	67.6	67.9	461.4							20.45
Options Contracts	438.8	914.1	899.6	1,253.5							
Agricultura Familiar	12.7	10.9	9.1	11.5							
Private Inventory	1,518.4	1.538,9	1.480,7	745.7	618.4	496.1	721.5	865.0	408.0	689.25	655.35
Private Inventory (% Total)	30.00	30.00	30.00	29.02	29.10	45.85	83.10	89.83	94.71	96.86	96.97

Source: CONAB (2019a; 2019c).

Tab. A.2. Support from the Federal Government for the commercialization of rice (thousand tons) - harvest year (March / February) from 2001 to 2018.

Item /Crop	2001/2002	2004/2005	2005/2006	2006/2007	2008/2009	2009/2010	2010/2011	2017/2018
PEP								
Offered			480	485		307.5	2238	543
Sold			459.8	157.5		143.3	1,538.2	390.2
AGF Direct	60	571.4	307.7	62	0.3		396.3	20.4
PROP								
Offered		700.1	548					
Sold		327.6	238.9					
PREPO								
Offered							307	369
Sold							64.3	109.4
OPTIONS								
Offered	1,374.3	350		910.2	878		1,113.1	
Sold	611.5	350		857.7	668.6		982.8	
Accomplished	4.4	350			156.8		403.3	
Total	671,5	1,249	1,006.4	1,077.2	668.9	143.3	2,981.6	520
Production	11,076.1	13,405.2	11,721	11,315.9	12,603	11,660.9	13,613.1	12,064.2
Participation (%)	*6.1%*	*9.3%*	*8.6%*	*9.5%*	*5.3%*	*1.2%*	*21.9%*	*4.3%*

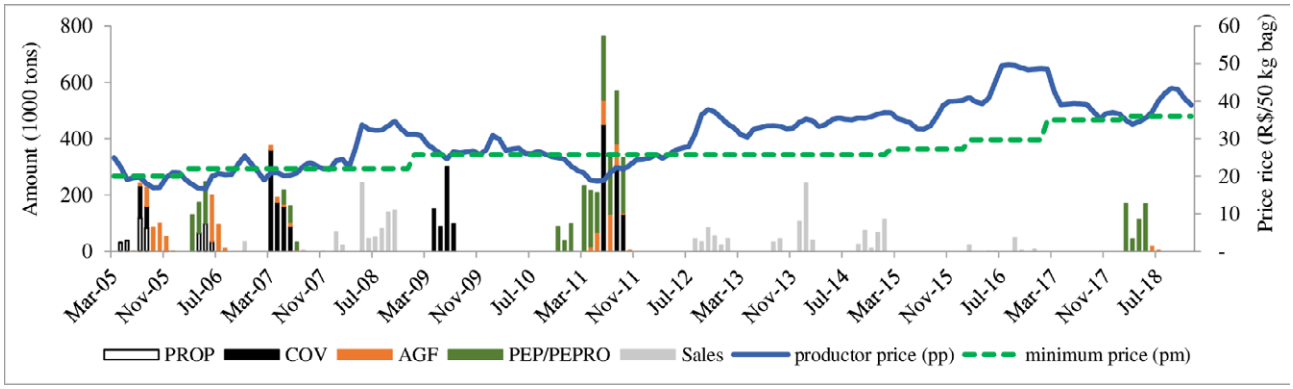
Note: 1. Only the years in which there was support from the federal government for the commercialization of rice are presented.
Source: Ministry of Agriculture Livestock and Supply (MAPA, 2019b).

Tab. A.3. Minimum price for rice in Rio Grande do Sul, by type, duration and value from 2003 to 2020.

Product	Type/Class	UF	Region	Start (month/ year)	End (month/ year)	Unity	R$/ bag
PADDY RICE	Type 1-58/10	RS	South	02/2003		50 kg bag	14.00
PADDY RICE	Type 1-58/10	RS	South	02/2004		50 kg bag	20.00
PADDY RICE	Type 1-58/10	RS	South	02/2005		50 kg bag	20.00
PADDY RICE	Type 1-58/10	RS	South	02/2006		50 kg bag	22.00
PADDY RICE	Type 1-58/10	RS	South	02/2007		50 kg bag	22.00
PADDY RICE	Type 1-58/10	RS	South	01/2008		50 kg bag	22.00
PADDY RICE	Type 1-58/10	RS	South	01/2009		50 kg bag	25.80
PADDY RICE	Type 1-58/10	RS	South	01/2010		50 kg bag	25.80
PADDY RICE	Type 1-58/10	RS	South	02/2012	01/2013	50 kg bag	25.80
PADDY RICE	Type 1-58/10	RS	South	02/2013	01/2014	50 kg bag	25.80
PADDY RICE	Type 1-58/10	RS	South	02/2014	01/2015	50 kg bag	25.80
PADDY RICE	Type 1-58/10	RS	South	02/2015	01/2016	50 kg bag	27.25
PADDY RICE	Type 1-58/10	RS	South	02/2016	01/2017	50 kg bag	29.67
PADDY RICE	Type 1-58/10	RS	South	02/2017	01/2018	50 kg bag	34.97
PADDY RICE	Type 1-58/10	RS	South	02/2018	01/2019	50 kg bag	36.01
PADDY RICE	Type 1-58/10	RS	South	02/2019	01/2020	50 kg bag	36.44

Source: National Supply Company (CONAB, 2019d).

Fig. A.1. Market price and minimum price for rice in Rio Grande do Sul and quantity of rice marketed by Minimum Price Guarantee Policy (PGPM) in Rio Grande do Sul, monthly data, from March 2005 to December 2018.



Source: National Supply Company (CONAB, 2019b, 2019d).

REA | ITALIAN REVIEW OF AGRICULTURAL ECONOMICS

Firenze University Press
www.fupress.com/rea

Citation: I. Bernetti, V. Alampi Sottini, M. Cipollaro, S. Menghini (2020) A survey on the performance of the Italian brewing companies. *Italian Review of Agricultural Economics* 75(1): 37-50. doi: 10.13128/rea-11741

Received: October 8, 2019

Revised: January 21, 2020

Accepted: March 18, 2020

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.

A survey on the performance of the Italian brewing companies

Iacopo Bernetti, Veronica Alampi Sottini, Maria Cipollaro, Silvio Menghini

Department of Agriculture, Food, Environment and Forestry – DAGRI - University of Florence, Italy

Abstract. The paper analyzes the performance of a sample of Italian microbreweries. For small and very small companies, performance analyses represent an important tool for the investigation of both the efficiency and the survival chances of the companies in the medium and long term. The methodology used consists of calculating different profitability and productivity indexes followed by a DEA model for the evaluation of the companies' efficiency. The results show that the companies operate at significantly low productivity levels and in conditions of technical inefficiency, due to both the inability of the managers to manage the inputs and the fact that companies operate at sub-optimal levels of scale. Lastly, profitability turns to be positive for two out of three indexes examined.

Keywords: Italian brewing industry, economic performance, profitability indexes, productivity indexes, DEA model.
JEL codes: L25, L66, D24.

1. INTRODUCTION

In the last ten years, the Italian beer sector hasshowed a rapid growth (Aquilani *et al.,* 2015; Donadini *et al.*, 2016; Donadini, Porretta, 2017; Fastigi *et al.*, 2018; Garavaglia, 2018).

In 2015 the sector involved 649 companies, including multinationals, industrial and craft breweries, counting a total of 7,893employees (Chamber of Commerce, 2018). Between 2015 and the end of 2017, the number of production units increased by 55% (1,008 firms), while the number of employees increased by 16% (9,128 people) in the same period.

The significant growth that has affected the sector in terms of both production units and workforce is almost entirely related to the proliferation of craft microbreweries, which produce unfiltered and non-pasteurized craft products with heterogeneous beer styles characterized by exclusive recipes. According to statistics from both the Italian Chambers of Commerce and professional associations, in 2017, 91% of the firms counted less than10 employees each. In detail, 52% of the total number offirms countedonly one employee, while companies with 50 or more employees were 1.4% of the total (Unionbirrai ObiArt, 2018).

The rapid growth of microbreweries in Italy is not an isolated phenomenon on the European and international panorama (Colen, Swinnen, 2010; Garavaglia, 2018). It is a consequence of the microbreweries movement, born in the US in the 1970s (Carrol, Swaminathan, 2000; Swaminathan, 1998; Tremblay *et al*., 2005), which spread rather quickly over other continents, including Europe, in the following two decades (Fanelli, 2018; Fastigi *et al*., 2018; Fastigi, Cavanaugh, 2017; Fastigi *et al*., 2019; Garavaglia, 2018; Howard, 2010).

The phenomenon is the result of competitive forces acting on the sector at a global level (Argent, 2018). As in other countries, the growth of small craft breweries in Italy has also responded to the needs of a demand increasingly focused on both quantity and quality. In particular, the development of large multinational industrial groups supported growth in terms of quantity, while the demand for higher quality products accentuated the development of residual market niches, able to meet the tastes of an ever-increasing number of educated consumers (Donadini *et al*., 2016; Garavaglia, 2009; Garavaglia, 2018).

The aim of this paper is to carry out an analysis of the performance of Italian craft breweries according to the scientific literature that deals with the performance of small and medium enterprises in the manufacturing sector, with a focus on the food and beverage industry (Blackburn *et al*., 2013; Charoenrat, Harvie, 2014; Dimara *et al*., 2008; Pilar *et al*., 2018). A methodological approach that took into account the different aspects that contribute to defining company performance was implemented (Sellers Rubio, 2010) for the analysis of the craftbeer sector in Italy. A multidimensional concept of «performance» was adopted, which evaluated the performance of a sample of companies operating in the craft sector in terms of profitability, productivity and efficiency.

The analysis of the performance of the companies operating in the Italian craft beer segment is extremely important, asthe concept of performance is closely linked to that of survival. To achieve high performance levels is the fundamental prerequisite for the growth and survival of the small Italian brewing companies. Smaller companies are less likely to survive than large ones, especially if their birth and growth are linked to the development of new technologies or new products (Brock, Evans, 1989), as in the case of «craft beer». Moreover, the economic situation of the beer market calls for the development of analyses focusing onthe craft beer company's performance, as in the next few yearsthe reduction of both company costs and final product priceswill become fundamental objectives forbreweries.

1.1. Literature review

The scientific literature analyzing the performance of MSMEs is rather heterogeneous, extensive and varied, though most of it assesses the performance of MSMEs in terms of profitability (Aragón Sánchez, Sánchez Marín, 2005; Fernández *et al*., 2018; Foreman Peck *et al*., 2006; Hall *et al*., 2009; Padula *et al*., 2015, Pollack, Adler, 2016). The generation of income is an essential condition for them to remain on the market, although it is not the only objective MSMEs pursue. Poor profitability provesto be both a lack of profit for the owner/manager and a reduced availability of financial resources to invest in the company (Prowl *et al*., 2017). MSMEs generally operate with limited resources (Prowl *et al*., 2017), and their main objective is to achieve maximum productivity through the optimized use of the inputs (Hall *et al*., 2009; Kurniawati, Yuliando, 2015; Mahmood, 2004; Van Beveren, 2012). This optimized use depends on technical efficiency, which is a fundamental parameter for measuring company performance, as well as one of the main causes of MSMEs' lower productivity (Alvarez, Crespi, 2003; Taymaz, 2002; Setiawan *et al*., 2019).

The beer sector has aroused renewed interest from the scientific literature on a global level. In recent years, a growing number of studiesfocused on both the structure of the sector in different countries and on the entry of new small and very small companies in markets generally dominated by large multinationals (Beck *et al*., 2018; Cabras *et al*., 2018; Garavaglia, Castro, 2018; Hani, Cheriet, 2014; Howard, 2010; McLaughlin *et al*., 2014; Toro Gonzalez, 2017; Weersink *et al*., 2017).

Previous studies analysed the sector using the theory of strategic groups (Day *et al*., 1995; Tremblay, 1985). The phenomenon of the proliferation of micro breweries was considered as it refers to the industry life cycle model and the resource partitioning model (Carroll, Swaminathan, 2000; Horvarth *et al*., 2001; Swaminathan, 1998). Analyses of micro breweries' performance were developed mainly dynamically through survival analysis (Bentzen, Smith, 2018; Wessonand De Figueiredo, 2001). As far as Italy is concerned, Garavaglia (2009; 2018) developed surveys at a macro level, analysing the structure, performance and competitiveness of the brewing industry by calculating concentration and market powerindexes. Fanelli and Felice (2014) (ref. paragraph 1) examined the sector in the period 2008-2012 and, implementing a multivariate analysis and a cluster analysis, identified the economic indexes that can explain the differences among the different companies operating in the beer sector. The studies by Cannatelli *et al.* (2017) and Espositi *et al.* (2017) analysed the per-

formance of the companies operating in the craft beer segment. Cannatelli *et al.* (2017) carried out an analysis aimed at verifying the relationship between company performance, product quality and the brand management strategies adopted. On the other hand, Espositi *et al.* (2017) analysed the phenomenon of the proliferation of microbreweries in Italy from a dynamic point of view, considering the effect that spatial factors play on company performance.

In this paper, the performance of craft beer companies is investigated through the implementation of both specific productivity and profitability indexes and the DEA model (Cooper, 2006; Zhou *et al.*, 2018). The implementation of the DEA model allows to both analyze the company's performance in terms of technical efficiency and scale efficiency and determine if the causes of the company's inefficiency are due to managerial inabilities in organizing and governing the inputs or to the fact that they do not operate at the optimal production scale. The awareness of company inefficiency has important implications especially for micro, small and medium enterprises (MSME), as it provides the owner/manager with the information that allows him/her to best manage the company's often scarce resources, to avoid waste and reduce production costs, elements that contribute to improve the profitability of the company itself. To the best of our knowledge, such studies have not yet been carried out, at least not at a national level.

2. METHOD AND SAMPLING

2.1. Theoretical framework

This research was developed using the methodology proposed by Sellers Rubio (2010, pp. 76-77) and Sellers Rubio and Alampi Sottini (2016, p. 35) for the wine sector in Spain and Italy. In the papers cited above, the performance of production companies is investigated using different approaches, which involve calculating specific productivity and profitability indexes and a non-parametric frontier approach to evaluate the efficiency of production companies. In accordance with Sellers Rubio and Alampi Sottini (2016, p. 36), the evaluation of profitability and productivity was carried out using balance sheet indexes. Although part of the scientific literature has criticized the adoption of these indexes (De Andrés *et al.*, 2009), they are still widely used as representative indicators of company performance (De Andrés *et al.*, 2009; Chaudhuri *et al.*, 2016; Chenall, Smith, 2007).

Productivity was calculated in terms of relative productivity, using per-capita turnover (Sellers Rubio, 2010; p. 77), as an indicator of labour productivity. This indicator has been considered relevant for the analysis of small and very small companies because it allows to examine the relationship between labour factor and productivity. Even though a smaller number of employees may seem to lead to an increase in productivity, elements such as technological innovation (Baumann, Kritikos, 2016; Hall *et al.*, 2009) and staff skills (Alvarez, Crespi, 2002; Cassell *et al.*, 2002) can still influence the final result, both in a positive and negative manner.

The efficiency analysis was developed by formalizing an input-oriented DEA model 3+1 (3 inputs and 1 output), calculated considering both constant (CRS) and variable (VRS) returns to scale. We decided to adopt an input-based approach because we believed as more realistic to consider that micro breweries, operating with limited resources and carrying out their activities in niche markets might better improve their efficiency, starting from the reduction of costs and waste and with a better organization of production factors, rather than trying to maximize output. The calculations were elaborated within R (R Core Team, 2017), using both the «non paraeff» package (Dong yhun, Dukrok, 2013) and the «Benchmarking» package (Bogetoft, Otto, 2015).

The variables were selected referring to the contributions provided by Sellers Rubio and Alampi Sottini (2016).

The number of employees was selected as the representative input of the labor factor (Rubio, 2010; Rubio, 2016). The skills and professionalism of human resources are factors that strongly influence the quality of the final product, and consequently the company's performance in terms of profitability and income (Rose, Kumar, 2006). The number of employees is also considered one of the most critical parameters in terms of cost management, productivity and technical inefficiency in the case of small and very small companies (Alvarez, Crespi, 2002).

The debt/equity ratio characterises the financial structure of companies and provides information on the sustainability of the financial debt, by comparing it to the capital of the company (both the capital generated by the company and the shareholders' equity). This indicator was considered relevant to the model, given the importance that making investments has for small and very small companies and the difficulty that these companies generally face in obtaining loans from banks or other credit institutions (Alvarez, Crespi, 2002; Reid, 2003).

The Total debt variable (both short-term and long-term debt) has been introduced in the model as an input capable of monitoring the capital factor; this variable provides information about external financing and the related costs and is a key factor for the company's

competitiveness in the market (Reid, 2003). In the case of small companies, the «Total debt» variable provides useful information on the management of monetary advances (Reid, 2003). As for the output variable, Revenues from sales and services were selected: in monetary terms, it represents all the products sold on the market by the company. The variable was selected as an increase in sales and profit improvement is perceived to be one of the most important objectives for MSMEs.

The DEA model is based on the envelopment of data to identify an efficient frontier that is used to evaluate the performance of the production units under study (Cooper *et al.*, 2006).

The most efficient DMUs (Decision Making Units) determine the efficient frontier, against which the efficiency of the other DMUs is measured (Hoff, 2007).

Conceptually, the most efficient DMUs are those that can reduce their inputs while keeping the outputs at their current levels (DEA input-oriented model), or that can produce a higher amount of outputs while keeping the inputs at their current levels (DEA output-oriented model).

Given a set of DMUs, whose production process is described by a vector of input variables (I) and a vector of output variables (J) common to all units but distributed in different quantities among the different production units, the production efficiency of each of them is calculated as the maximum ratio between the weighted amounts of output and input (Serafini, 2009; p. 417):

$$\text{Max} \quad \sum_{j\in J} w_j Y_j^K \Big/ \sum_{i\in I} v_i X_i^k \tag{1}$$

With
X_i^k: quantity of inputs used in the production process by company k;
Y_j^K: quantity of output produced by company k;
$w_j>0$ and $v_i>0$ weights attributed to inputs and outputs.

The problem can easily be turned into a linear programming problem (and in its dual problem) by imposing the constraint $\sum_{i\in I} v_i X_i^0 = 1$ (Serafini, 2009; p. 418):

$$\begin{aligned} &\max \sum_{j\in J} w_j Y_j^0 \\ &\sum_{j\in J} w_j Y_j^k \le \sum_{i\in I} v_i X_i^k \quad k\in [n] \\ &\sum_{i\in I} v_i X_i^0 = 1 \\ &v_i, w_j \ge 0 \qquad\qquad j\in J,\ i\in I \end{aligned} \tag{2}$$

$$\begin{aligned} &\text{Min } \theta \\ &\sum_{k=1}^{n} \lambda^k X_j^k \ge Y_j^0 \quad j\in J \\ &\sum_{k=1}^{n} \lambda^k X_i^k \le \theta X_i^0 \quad i\in I \\ &\lambda^k \ge 0 \quad k\in [n] \end{aligned} \tag{3}$$

Where in (3) $X_j^k Y_j^k$ are, respectively, the vectorof inputs and the vector of output sand λ^k is a non-negative vector of variables.

The problem of linear programming in (1) refers to an input-oriented DEA model with constant returns to scale. It is possible to introduce the variable returns to scale hypothesis by adding a supplementary constraint(Serafini, 2009):

$$\Sigma_k \lambda^k = 1 \text{ for variablereturns to scale} \tag{4}$$

The methodology assigns each DMU an efficiency score between 0 and 1 (Cooper *et al.*, 2006). Efficient border companies show an efficiency score equal to 1, while totally inefficient units show an efficiency score equal to 0. However, efficient solutions can be detected even with some parameters of input or output equal to zero. DMUs for which this option occurs are defined as weakly efficient. The weakly efficient DMUs have excess input and output deficits called slacks. To detect weakly efficient DMUs, an infinitesimal constant ε>0, defined «non-Archimedean» is introduced.

Considering constant returns to scale, the dual problem in the case of an input-oriented modelis the following(Wen, 2015; p. 50):

$$\begin{aligned} &\text{Min}\theta - \varepsilon\left(\sum_{1=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right) \\ &\sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = \theta x_{i0} \\ &\sum_{j=1}^{n} y_{rj}\lambda_j - s_r^+ = y_{r0} \\ &\lambda_k \ge 0 \\ &s_i^- \ge 0 \\ &s_r^+ \ge 0 \end{aligned} \tag{5}$$

Where s_i^- are input slacks, s_r^+ are output slacks and θ is the efficiency score obtained for each DMU analysed.

The dual problem considering constant returns to scale can be formulated simply by adding the following constraint to (5):

$$\sum_{k=1}^{n} \lambda_k = 1 \tag{6}$$

A DMU is efficient only if θ^* is equal to 1, and the optimum value and all slacks are equal to zero (Serafini, 2009).

The CRS scoreprovides the so-called «global technical efficiency» (Cooper *et al.*, 2006), because it does not consider the scale effect (Banker *et al.*, 1984; Cooper *et al.*, 2006). The VRS score provides the so-called «pure technical efficiency» (Banker *et al.*, 1984; Cooper *et al.*, 2006). The ratio between «global technical efficiency» and «pure technical efficiency» is called «scale efficiency» (Banker *et al.*, 1984). The calculation of these scores allows identifying the source of inefficiency for each investigated DMU (Cooper *et al.*, 2006). Thus, efficiency can be broken into (Cooper *et al.*, 2006; p. 141):

[Technical Eff. (TE)] = [Pure Technical Eff (PTE)] x [Scale Eff. (SE)] (7)

Where the PTE score reveals inefficient operations or management and the SE scorereveals that the DMU does not operate at optimal scale (Cooper *et al.*, 2006).

Scale inefficiencies may be due to the fact that the DMU works at increasing or decreasing returns to scale. To obtainthis information, it is necessary to verify whether:

$\sum_{k=1}^{n} \lambda_k < 1 \rightarrow$ the DMU is working at increasing returns to scale (8)

$\sum_{k=1}^{n} \lambda_k > 1 \rightarrow$ the DMU is working at decreasing returns to scale. (9)

Then, Spearman's correlation indexes were calculated between the selected performance indicators to analyze the level of correlation between the variables and to highlight a possible relationship between them.

As a final step, the matrix containing the data relating to the various performance indexes was divided into three classes, according to the years of activity of the different production realities (less than 5 years, between 5 and 10 years, more than 10 years). The classes were divided as to create homogeneous groups in terms of number of observations per group. Finally, a Kruskal-Wallis test was carried out to point out whether there were significant differences between the medians relative to the different performance indexes in the three groups identified.

2.2. The sample

The economic information on the breweries was extracted from the «AIDA-Italian company information and business intelligence» database, the computerized database of Italian companies of Bureau van Dijk, updated to 2016. The database refers to the economic accounts and structural characteristics of Italian capital companies. The companies were selected according to the ATECO 2007 classification for economic activities (ISTAT, 2009). The selected firms belong to the class 11.05 «Beer production», which includes craft and industrial breweries, with their production facilities. Once the enterprises that did not have any information on the selected variables were discarded, the sample turned out to count a total of 163 production units, including multinationals and large, medium, small and very small companies operating in both the craft and industrial beer segments. Several definitions for «craft breweries» can be found in the scientific literature. In order to identify and extract only the craft breweries from the database, in this paper we have taken as reference the recent Italian Law 154/2016, thanks to which a unique definition of craft brewery has been provided at the national level. Breweries are defined as craft breweries (Chapter V, Article 35) according to the following factors: 1) the production size, defined within the limit of 200,000 hl per year, and the type of product obtained; 2) the economic and legal independence of the brewery from any other brewery; 3) the product characteristics: craft beers must not have undergone the process of filtration and pasteurization.

Since Law 154/2016 could theoretically include even large breweries (as the average annual production could reach up to 200,000 hl), we also verified that the craft breweries were consistent with Recommendation 2003/361 EC provided by the Ministry of Economic Development (OJ, 2003), which provides the definition for small and micro-enterprises. The criteria suggested by the Recommendation are consistent with those identified in the scientific literature for the definition of «Small Brewery» and «Micro brewery» (Cabras, Bamforth, 2015). Official statistics and sector studies describe the sector as composed mainly of small and very small businesses, with an average annual production of between 750 and 800 hl (Assobirra, 2016; ISTAT, 2001, Unionbirrai ObiArt, 2018).

In the present paper, the independence of the companies under study was verified by carrying out detailed verification on specialized sites (microbirrifici.org; cronachedibirra.it), checking companies' potential character as craft companies in terms of adopted techniques and production volumes and whether they had forfeited their «independence» through the sale of their business to large industrial groups. Once we verified this, which led to the exclusion of only one company, the data were processed in order to guarantee the correct application of the methodologies adopted (Cook *et al.*, 2014; Dyson *et al.*, 2001).

Tab. 1. Descriptive statistics on the variables used for the analysis.

Variable	Micro	Small	
Firm Size (num. of employees)	53	11	
	Mean	Median	Standard dev.
Firm Age	9	8	5
Per capita turnover (€)	136,266	134,738	136,711
ROI (%)	*3.90*	*3.81*	*3.97*
ROE (%)	*-3.22*	*-3.36*	*-2.78*
ROA (%)	*2.34*	*2.29*	*2.42*
Total Revenues (€)	635,765	613,124	623,026
Employees (num.)	5	5	5
Total Debt (€)	540,512	534,348	541,748
Debt/ Equity ratio	3.67	3.71	3.75

Source: our elaboration based on data from AIDA - Bureau van Dijk.

The final sample consisted of 64 companies, for which all the information on the extracted variables was available. The size of the sample was considered adequate for the purpose of the research, and in agreement with the indications given in the literature for the correct application of the DEA models (Cook *et al.*, 2014; Dyson *et al.*, 2001).

The characteristics of the sample and the descriptive statistics of the selected variables are shown in Table 1.

3. RESULTS

3.1. Profitability, productivity and efficiency analysis

The descriptive statistics of the selected indexes were calculated (Tab. 2) to analyse the performance of the breweries examined in terms of profitability and productivity. The mean values measured are positive for all the indexes analysed, with the exception of ROE.The median value, however, assumes positive and above average values for all three indexes examined: this means that half of the production units show positive performance regarding profitability. As for productivity, average revenues per employee amounted to 136,266.09 euros, for a median value of 124,600.00 euros per employee.

The descriptive statistics of CRS scores, VRS score and scale efficiency are listed in Table 3. In average terms, the global technical efficiency shows values equal to 0.53 in the sample examined, with a median value equal to 0.48. This result shows that, on average, companies can become efficient by reducing their inputs by 47%.

Tab. 2. Descriptive statistics for profitability and productivity indices.

	Per capita Turnover	ROI	ROE	ROA
Minimum value	1,440.00	-21.34	-135.90	-16.94
1th Quartile	65,615.00	-0.15	-1.54	-0.08
Median	124,600.00	4.60	3.58	3.05
Mean	136,266.09	3.90	-3.22	2.34
3th Quartile	160,827.50	9.85	10.38	5.93
Maximum value	505,790.00	27.59	56.17	18.48
Standard deviation	99,081.43	8.74	36.26	6.31

Source: our elaboration based on data from AIDA - Bureau van Dijk.

Tab. 3. DEA model: descriptive statistics for efficiency score.

	Overall efficiency	Pure tecnica efficiency	Scale efficiency
Minimum value	0.01	0.24	0.01
1th Quartile	0.33	0.50	0.57
Median	0.48	0.72	0.92
Mean	0.53	0.72	0.77
3th Quartile	0.73	1	0.99
Maximum value	1.00	1.00	1.00
Standard deviation	0.28	0.26	0.29

Source: our elaboration based on data from AIDA - Bureau van Dijk.

The pure technical efficiency assumes an average value of 0.72, while the scale efficiency is equal to 0.77. These values indicate that, on average terms, the pure technical efficiency has roughly the same weight as the scale efficiency in influencing the inefficiency of the investigated sample, showing a value slightly lower than the scale efficiency.

A more in-depth analysis (Tab. 4) highlights that 47% of the total DMUs show a global efficiency score between 0.5<=E<1, while 20% of the sample has values below 0.3, revealing substantial productive inefficiency. If we analyze the results for both the models implemented in greater detail, we also notice that the DMUs that show ES=1 and slack zero in relation to the CRS model number seven (11% of the total).

These DMUs have a strong global technical efficiency, and they are both technically and scale efficient. Moreover, they operate at the most productive scale size (Tab. 5).

25 out of the 64 DMUs (about 39% of the sample) show a pure technical efficiency (ES=1 according to

Tab. 4. DEA model: efficiency score classes and relative number of sample companies.

Efficiency range	CRS Number of DMU	CRS Number of DMU (percentage)	VRS Number of DMU	VRS Number of DMU (percentage)
0<=E<0,1	3	*5%*	0	*0%*
0,1<=E<0,2	2	*3%*	0	*0%*
0,2<=E<0,3	8	*13%*	2	*3%*
0,3<=E<0,4	13	*20%*	6	*9%*
0,4<=E<0,5	8	*13%*	5	*8%*
0,5<=E<0,6	6	*9%*	11	*17%*
0,6<=E<0,7	7	*11%*	8	*13%*
0,7<=E<0,8	4	*6%*	4	*6%*
0,8<=E<0,9	3	*5%*	2	*3%*
0,9<=E<1	3	*5%*	1	*2%*
E=1	7	*11%*	25	*39%*
TOTAL	64	*100%*	64	*100%*

Source: our elaboration based on data from AIDA - Bureau van Dijk.

the VRS model). Eleven DMUs (17% of the total) have strong efficiency (ES – VRS=1 and zero slack on input and output).

The other 4 DMUs, although technically efficient, show scale inefficiency. In detail, one DMU operates at decreasing returns to scale 3 DMUs at increasing returns to scale. This means that the first company can achieve global technical efficiency by decreasing its size, while the others can achieve global technical efficiency by increasing their production scale.

The remaining 14 DMUs, besides showing scale inefficiency (all operate under IRS conditions), show weak efficiency, having positive slacks in relation to two of the inputs used for the analysis. These DMUs can reach maximum efficiency by increasing not proportionally the inputs and their own production scale.

3.2. Correlation analysis

Observing the correlation matrices of Spearman (r_s), calculated on the variables analysed, and their rela-

Tab. 5. DEA model: Efficiency score and slack analysis.

DMU Id. Number	slack.x1	slack.x2	slack.x3	slack.y1	eff_CRS	eff_VRS	Se	Returns to scale
8	0.00	0.00	0.00	0	1.00	1	1	CRS
74	0.00	0.00	0.00	0	1.00	1	1.00	CRS
17	0.00	0.00	0.00	0	1.00	1	1.00	CRS
63	0.00	0.00	0.00	0	1.00	1	1.00	CRS
55	0.00	0.00	0.00	0	1.00	1	1.00	CRS
180	0.00	0.00	0.00	0	1.00	1	1.00	CRS
28	0.00	0.00	0.00	0	1.00	1	1.00	CRS
15	0.00	0.00	0.00	0	0.99	1	1.00	DRS
46	0.00	0.00	0.00	0	0.99	1	0.99	IRS
10	0.00	0.00	0.00	0	0.90	1	0.90	DRS
126	0.00	0.00	0.00	0	0.89	1	0.89	IRS
97	0.00	0.00	1.65	0	0.76	1	0.76	IRS
171	0.00	0.00	12.37	0	0.51	1	0.51	IRS
100	0.00	0.00	0.03	0	0.48	1	0.48	IRS
102	0.00	88,017.58	0.00	0	0.46	1	0.46	IRS
103	0.00	3,106.71	0.00	0	0.42	1	0.42	IRS
157	0.00	0.00	0.61	0	0.39	1	0.39	IRS
143	0.00	0.00	2.31	0	0.35	1	0.35	IRS
162	0.00	160,324.47	0.00	0	0.34	1	0.34	IRS
123	0.00	3,085.32	1.38	0	0.30	1	0.30	IRS
134	0.00	9,354.65	0.00	0	0.23	1	0.23	IRS
79	0.00	58,204.22	5.34	0	0.18	1	0.18	IRS
253	0.00	0.00	0.04	0	0.07	1	0.07	IRS
223	0.00	34,593.37	0.00	0	0.05	1	0.05	IRS
188	0.00	0.00	0.01	0	0.01	1	0.01	IRS

Source: our elaboration based on data from AIDA - Bureau van Dijk.

Tab. 6. Spearman correlation index.

	Per capita turnover	ROI	ROE	ROA	Efficiency score CRS	Efficiency score VRS
Per capita turnover	1					
ROI	0.21	1				
ROE	0.13	0.68****	1			
ROA	0.18	0.95****	0.69****	1		
Efficiency score CRS	0.55***	0.49***	0.19	0.46**	1	
Efficiency score VRS	0.49****	-0.03	-0.01	-0.03	0.42***	1

p< .0001=**** ; p < .001=***; p < .01=** p < .05= *
Source: our elaboration based on data from AIDA - Bureau van Dijk.

Tab. 7. Kruskal Wallis test.

	Age<5 n=16	5<Age<10 n=29	Age>10 n=18	Kruskal Wallis test (p-value)
ROI				
Mean	0.71	2.68	8.46	8.78*
Median	2.67	3.75	9.38	0.01
ROE				
Mean	-0.5	-14.0	11.0	10.47*
Median	3.0	1.1	9.7	0.00
ROA				
Mean	0.47	1.18	5.68	8.70*
Median	1.80	2.55	4.95	0.01
Per capita turnover				
Mean	119,622	154,208	122,897	0.74
Median	110,310	129,810	126,190	0.12
Es – CRS				
Mean	0.42	0.53	0.62	4.23
Median	0.41	0.57	0.58	0.12

The Chi-square critical value is 5.99 (df =2 and alpha=0.05)
Source: our elaboration on data from AIDA - Bureau van Dijk.

tive significance tests (Tab. 6), we can notice that the per capita turnover shows weak and not statistically significant relationships with the profitability indexes, while its relationships with the efficiency scores (ES) obtained from the CRS DEA and VRS DEA model are positive and statistically significant. On the other hand, the profitability ratios show strong relationships between them. In addition, ROI and ROA show positive, moderate and statistically significant relationships with the ES obtained by implementing the CRS DEA model. Lastly, the efficiency scores obtained by implementing the CRS DEA model show a moderate and statistically significant positive relationship with the ES obtained by formalizing the VRS DEA model.

3.3. Kruskall Wallis test

The results of the Kruskal Wallis test are shown in Table 7. This analysis shows that there is a significant difference among the core values forthe three groups in terms of profitability, but not in terms of efficiency and productivity.

4. DISCUSSION

The profitability analysis shows that on average ROA and ROI have positive values for the set of observations included in the present paper. However, the sample has a negative value for ROE, which means that, in average terms, the companies under study are running at a loss and their economic imbalance is eroding the equity capital invested in the company. Nevertheless, in median terms, the three profitability indicators show values higher than zero, highlighting that 50% of the enterprise shave higher performances than average and positive ones. The result confirms the findings highlighted in the scientific literature (Garavaglia, 2009), according to which companies operating in the craft beer segment are able to achieve rather high levels of profitability.

On the side of the productivity analysis, the average per capita turnover of the macro category for the brewing sector, i.e. «Beverage industry» (code 11-ATECO 2007 classification) can be considered as the reference term. Since the sample is mainly made up of micro enterprises, this information is calculated considering only the firms belonging to code 11, and that count less

than 9 employees: for the beverage industry, this value reaches 238,151 euro, twice the value of the companies operating in the brewing sector (ISTAT, 2014).

The efficiency scores of the DEA-CRS model show values of about 0.5 on average. The breakdown of the global technical efficiency into technical efficiency and scale efficiency reveals that on average, the sources of inefficiency are to be found both in the inability of the managers to govern the inputs and in the fact that companies operate at sub-optimal levels of scale. Moreover, only 7 out of 64 companies are both technically and scale efficient.

The results of the correlation analysis highlight a strong linear positive relationship between profitability ratios. The productivity and efficiency indexes show a positive correlation. The CRS efficiency scores show positive butmoderate correlations (Spearman rho <0.5) with ROI and ROA. The profitability and productivity indexes showa weak and not statistically significant correlation.

The result is in line with the scientific literature, which points out that a company that achieves good results in terms of profitability not necessarily attains good performance in terms of productivity or efficiency. Especially for small-sized companies, performance strongly depends on the entrepreneur's contribution in terms of personal resources (capital and labour): in this case the imputed costs are consistent, and the net income for the entrepreneur provesto be very low. In such companies, the entrepreneur settles with a lower return level than the one attainable in the market (opportunity cost) for his/her invested capital and labour. In such conditions, the company operates with negative profit levels but positive income levels.

The Kruskal Wallis test was included because in the scientific literature, company age is considered a variable that can influence the company's performance (Coad *et al.*, 2013). Generally, companies that have been operating on the market for longer are associated with higher performance, both in terms of profitability and productivity. The higher levels of performance are attributable to learning by doing and selection effects (Coad *et al.*, 2013). However, the results are not always consistent with these considerations. In fact, in some cases «older» companies may be affected by senescence and inertia (Coad *et al.*, 2013), with consequent negative effects on productivity and profitability. For such companies, the propensity to have a lower return of imputed costs becomes higher.

In the case of our study, however, the test revealed a significant difference in terms of profitability but not in terms of efficiency and productivity among the core values for the three different groups identified. The reasons behind this result need to be further investigated. However, the higher profitability of those companies that operate in the market for several years is confirmed in the literature.

The description and the analysis of the results in terms of productivity/efficiency is more complex. The limitation of the technical/economic resources that small businesses face and that prevent them from investing in the company in terms of both workforce and equipment might be one of the reasons that lead to this result.

However, as highlighted above, the DEA model revealed that technical inefficiency is linked to both management limitations and very small-scaleproduction. Nevertheless, the small production scale of these companies may reflect a precise strategic choice and not a limit.

5. CONCLUSIONS

In recent years, the proliferation of microbreweries has gained international relevance and become a significant phenomenon in Italy, where it highlighted a national beer tradition for years «squashed» by both the strong vocation of the Italian wine production (Esposti *et al.*, 2016; Fastigi *et al.*, 2017; Garavaglia, 2015) and the typical Mediterranean model of food consumption (Marinelli *et al.*, 2014). In this paper, a performance investigation of the companies operating in the beer market was carried out, associating the analysis of technical efficiency with the more traditional analyses of profitability and productivity. The study allowed us to obtain information on both the state of health of the companies and the choices that the entrepreneur makes, according to the characteristics of the production reality he/she manages and the market in which he/she operates.

In this regard, the results of the analyses revealed that, in average terms, the companies examined operate atsignificantly lower levels of productivity than the average for the reference sector. Moreover, they operate under a condition of technical inefficiency. The breakdown of the global technical efficiency into technical efficiency and scale efficiency reveals that, on average, the sources of inefficiency are to be found both in the inability of the managers to governthe inputs and in the fact that companies operate at sub-optimal levels of scale. An explanation for these results can be the limitation of the economic/technical resources that the small companieshave to deal with and that prevent them from growing. However, the fact that the companies decided not to increase their production scale can also reflect a precise strategic choice of the microbreweries them-

selves: even if one of the main short-term objectives of MSMEs is to increase their size to reach the optimum level of scale, for craft breweries their «small» size may represent, on the contrary, a survival strategy for continuing to operate in their niche market.

The results can also be justified by the level of utilization of the plants in relation to their technical and operational potential. In this regard, an analysis conducted by Obi Art (2018) at national level on a sample of about 100 micro breweries showed that only a small percentage (<75%) of companies is exploiting their plants to maximum potential, thus using the available capital and workforce at a high level of efficiency. On the contrary, most of the companies showed a level of plant utilization not above 75% of the maximum utilization potential. In some cases, the companies were still in a phase of growth, having started their business only recently; in other cases, the companies reported some problems in increasing their production volumes due to the difficulties of placing further quantities of final product on the market.

In contrast to the previous analyses, profitability proved to be positive for two out of three indexes. This can be explained by the fact that the micro breweries under study operate in the higher quality «specialty beers» segment, and that the prices of their products, for example in large retail outlets, are more than double those of high-quality «specialty beers» of industrial origin (Unionbirrai ObiArt, 2018).

The results of our analyses also showed the coexistence of companies operating at high levels of performance in terms of profitability, productivity and efficiency and companies that, on the contrary, are in critical conditions. This is confirmed by the scientific literature, according to which, in Western markets, few MSMEs are able to succeed and grow, while the majority remain small, or exit the market definitively (Birley, Westhead, 1990; Lewis, Churchill, 1983). As indicated in the literature for other countries (Cabras, Bamforth, 2015), Italy is also undergoing some transformations within the craft beer segment. These changes reveal thatonly a limited number of brewing companies are expanding significantly (both in terms of employees and turnover), while most of them remain very small and only operate in local markets. This phenomenon is still in an embryonic stage and represents a topic to develop with further studies, through which the factors that determine positive or negative performance for craft breweries can be identified.

A further development of this paper may consider the integration of further variables in the model, variables that can also be of a qualitative nature, and that take into account the characteristics of the entrepreneur/manager, the skills of the workforce and the investments that micro breweries make in research and innovation.

The scientific literature suggested different approaches for the evaluation of company performance, approaches based on the use offinancial, non-financial performance indexes or a combination of both (Chenall, Smith, 2017; Devinney *et al.*, 2009; Ndurupati *et al.*, 2011). Specific models have been proposed for small companies, in particular the Resource-Based View (RBV) has already been applied to the beer sector by Duarte Alonso *et al.* (2016).

The results of this further analysis might show how, in many cases, entrepreneurial choices are made not only to serve economic objectives, butare also inspired by non-economic personal aspirations and sometimes antithetical to profitmaximization. The apparent inconsistency of some of the results reported in this paper would then find detailed explanations, representing a form of resilience of the companies that compensate for lower performance by accepting lower levels of income for those production inputs directly provided by the entrepreneur.

It would be interesting to analyse the results obtained for specific categories of micro breweries. Among them, agri breweries (Francioni *et al.*, 2019) play an interesting role. These are a type of craft brewery only recently recognized by the Italian legal system, and represent a peculiarity because they are the link between the primary sector and the beer processing sector, the latter always considered as an exclusively industrial production system.

REFERENCES

IRI infoscan. Available at: https://www.iriworldwide.com/it-IT/company/about-IRI

Bureau van Dijk (2015). AIDA-Italian company information and business intelligence. Available at: https://aida.bvdinfo.com/version-2018221/Login.serv?product=aidaneo&SetLanguage=en

Camere di Commercio (2017). Anagrafe Nazionale delle imprese. Available at: http://www.registroimprese.it/l-anagrafe-nazionale-delle-imprese

ISTAT (2010). Data warehouse of the 9th industry and Services census 2011. Available at: http://datiCensimentoindustriaeservizi.istat.it/Index.aspx?lang=en&SubSessionId=286d23f3-7622-4e49-b2e0-e072592a33c3

Alvarez R., Crespi G. (2003). Determinants of technical efficiency in small firms. *Small business economics*, 20(3): 233-244. https://doi.org/10.1023/A:1022804419183

Aquilani B., Laureti T., Poponi S., Secondi L. (2015). Beer choice and consumption determinants when craft beers are tasted: An exploratory study of consumer preferences. *Food quality and preference*, 41: 214-224. https://doi.org/10.1016/j.foodqual.2014.12.005

Aragón Sánchez A., Sánchez Marín G. (2005). Strategic orientation, management characteristics, and performance: A study of Spanish SMEs. *Journal of Small Business Management,* 43(3): 287-308. https://doi.org/10.1111/j.1540-627X.2005.00138.x

Argent N. (2018). Heading down to the local? Australian rural development and the evolving spatiality of the craft beer sector. *Journal of rural studies*, 61: 84-99. https://doi.org/10.1016/j.jrurstud.2017.01.016

Assobirra (2016). Annual report 2016. Available at: https://www.assobirra.it/wp-content/uploads/2017/11/annual_report_2016.pdf (accessed 03 October 2019).

Banker Rajiv D., Abraham Charnes, William Wager Cooper (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management science*, 30(9): 1078-1092. https://doi.org/10.1287/mnsc.30.9.1078

Baumann J., Kritikos A.S. (2016). The link between R&D, innovation and productivity: Are micro firms different?. *Research Policy*, 45(6): 1263-1274. https://doi.org/10.1016/j.respol.2016.03.008

Beck N., Swaminathan A., Wade J.B., Wezel F.C. (2018). Industry clusters and organizational prototypes: Evidence from the Franconian brewing industry. *Journal of Management*, 45(7): 2978-3008. https://doi.org/10.1177/0149206318773411

Bentzen J., Smith V. (2018). Entry, Survival, and Profits: The Emergence of Microbreweries in Denmark. In: Garavaglia C., Swinnen J. (eds) *Economic Perspectives on Craft Beer.* Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-58235-1_6

Birley S., Westhead P. (1990). Growth and performance contrasts between «types» of small firms. *Strategic management journal*, 11(7): 535-557. https://doi.org/10.1002/smj.4250110705

Blackburn R.A., Hart M., Wainwright T. (2013). Small business performance: business, strategy and owner-manager characteristics. *Journal of small business and enterprise development*, 20(1): 8-27. https://doi.org/10.1108/14626001311298394

Bogetoft P., Otto L. (2015). Benchmarking with DEA and SFA, R package version 0.26. Available at: https://cran.r-project.org/web/packages/Benchmarking/Benchmarking.pdf (accessed 03 October 2019).

Brock W.A., Evans D.S. (1989). Small business economics. *Small Business Economics*, 1(1): 7-20. https://doi.org/10.1007/BF00389913

Cabras I. (2018). Beer on! The Evolution of Micro-and Craft Brewing in the UK. In Garavaglia C., Swinnen J. (eds) *Economic Perspectives on Craft Beer.* Palgrave Macmillan, Cham: 373-396. https://doi.org/10.1007/978-3-319-58235-1_14

Cabras I., Bamforth C. (2016). From reviving tradition to fostering innovation and changing marketing: the evolution of micro-brewing in the UK and US, 1980–2012. *Business History*, 58(5): 625-646. https://doi.org/10.1080/00076791.2015.1027692

Cannatelli B., Pedrini M., Grumo M. (2017). The effect of brand management and product quality on firm performance: The Italian craft brewing sector. *Journal of Food Products Marketing*, 23(3): 303-325. https://doi.org/10.1080/10454446.2014.949989

Carroll G.R., Swaminathan A. (2000). Why the microbrewery movement? Organizational Dynamics of Resource Partitioning in the U.S. Brewing Industry. *American Journal of Sociology*, 106(3): 715-762. Available at: https://www.jstor.org/stable/10.1086/318962 (accessed 03 October 2019).

Cassell C., Nadin S., Gray M., Clegg C. (2002), Exploring human resource management practices in small and medium sized enterprises, *Personnel Review*, 3(6): 671-692. https://doi.org/10.1108/00483480210445962

Charoenrat T., Harvie C. (2014). The efficiency of SMEs in Thai manufacturing: A stochastic frontier analysis. *Economic Modelling*, 43: 372-393. https://doi.org/10.1016/j.econmod.2014.08.009

Chaudhuri K., Kumbhakar S.C., Sundaram L. (2016). Estimation of firm performance from a MIMIC model. *European Journal of Operational Research*, 255(1): 298-307. https://doi.org/10.1016/j.ejor.2016.05.005

Chenhall R.H., Langfield-Smith K. (2007). Multiple perspectives of performance measures. *European Management Journal*, 25(4): 266-282. https://doi.org/10.1016/j.emj.2007.06.001

Coad A., Segarra A., Teruel M. (2013). Like milk or wine: Does firm performance improve with age?. *Structural Change and Economic Dynamics*, 24: 173-189. https://doi.org/10.1016/j.strueco.2012.07.002

Colen L., Swinnen J.F. (2010). Beer Drinking Nations. The Determinants of Global Beer Consumption. LICOS Discussion Paper No. 270/2010. http://dx.doi.org/10.2139/ssrn.1752829

Cook W.D., Tone K., Zhu J. (2014). Data envelopment analysis: Prior to choosing a model. *Omeg*a, 44: 1-4. https://doi.org/10.1016/j.strueco.2012.07.002

Cooper W.W., Seiford L.M., Tone K. (2006). *Introduction to data envelopment analysis and its uses: with DEA-solver software and references*. Springer Science & Business Media. USA. ISBN-10: 0-387-28580-6

Day D.L., Lewin A.Y., Li H. (1995). Strategic leaders or strategic groups: A longitudinal data envelopment analysis of the US brewing industry. *European Journal of Operational Research*, 80(3): 619-638. https://doi.org/10.1016/0377-2217(94)00141-X

De Andrés J., Landajo M., Lorca P. (2009). Flexible quantile-based modeling of bivariate financial relationships: The case of ROA ratio. *Expert Systems with Applications*, 36(5): 8955-8966. https://doi.org/10.1016/j.eswa.2008.11.021

Dimara E., Skuras D., Tsekouras K., Tzelepis D. (2008). Productive efficiency and firm exit in the food sector. *Food Policy*, 33(2): 185-196. https://doi.org/10.1016/j.foodpol.2007.08.003

Donadini G., Porretta S. (2017). Uncovering patterns of consumers' interest for beer: A case study with craft beers. *Food Research International*, 91: 183-198. https://doi.org/10.1016/j.foodres.2016.11.043

Donadini G., Fumi M.D., Kordialik Bogacka E., Maggi L., Lambri M., Sckokai P. (2016). Consumer interest in specialty beers in three European markets. *Food research international,* 85: 301-314. https://doi.org/10.1016/j.foodres.2016.04.029

Dong yhun O., Dukrok S. (2013). Non paraeff: Non parametric Methods for Measuring Efficiency and Productivity. R package version 0.5-8. Available at: https://CRAN.R-project.org/package=nonpaaeff (accessed 03 October 2019).

Duarte Alonso A., Bressan A., Sakellarios N. (2016). A resource based approach in the context of the emerging craft brewing industry. *European Business Review*, 28(5): 560-582. Doi:10.1108/EBR-12-2015-0176.

Dyson R.G., Allen R., Camanho A.S., Podinovski V.V., Sarrico C.S., Shale E.A. (2001). Pitfalls and protocols in DEA. *European Journal of operational research*, 132(2): 245-259. https://doi.org/10.1016/S0377-2217(00)00149-1

Esposti R., Fastigi M., Viganò E. (2017). Italian craft beer revolution: do spatial factors matter? *Journal of Small Business and Enterprise Development*, 24(3): 503-527. doi:10.1108/JSBED-12-2016-0191

Fanelli R.M. (2018). Have beer markets in European Union countries converged?. *Economia Agro-Alimentare,* 3: 445-477. DOI: 10.3280/ECAG2018-003010

Fanelli R.M., Felice F. (2014). Un'applicazione dell'analisi multivariata e della convergenza non parametrica all'industria birraria italiana. *Rivista di Economia Agraria*, 69(1): 7-30. DOI: http://dx.doi.org/10.13128/REA-16305

Fastigi M., Cavanaugh J. R. (2017). Turning passion into profession: A history of craft beer in Italy. Gastronomica: *The Journal of Critical Food Studies*, 17(2): 39-50. DOI: 10.1525/gfc.2017.17.2.39

Fastigi M., Viganò, Esposti R. (2018), The Italian microbrewing experience: features and perspectives, *Biobased and Applied Economics*, 7(1): 59-86. DOI: 10.13128/BAE-24048

Fernández E., Iglesias-Antelo S., López-López V., Rodríguez-Rey M., Fernandez-Jardon C.M. (2018). Firm and industry effects on small, medium-sized and large firms' performance. *BRQ Business Research Quarterly*, 22(1): 25-35. https://doi.org/10.1016/j.brq.2018.06.005

Foreman-Peck J., Makepeace G., Morgan B. (2006). Growth and profitability of small and medium-sized enterprises: Some Welsh evidence. *Regional Studies*, 40(4): 307-319. https://doi.org/10.1080/00343400600725160

Francioni B., Curina I., Masili G., Viganò E. (2019). Global sourcing processes in the Italian agricultural breweries. *British Food Journal*, 121(10): 2277-2295. https://doi.org/10.1108/BFJ-03-2019-0181

G.U. (Gazzetta Ufficiale della Repubblica Italiana) (2016). LEGGE 28 luglio 2016, n. 154. Deleghe al Governo e ulteriori disposizioni in materia di semplificazione, razionalizzazione e competitività dei settori agricolo e agroalimentare, nonché sanzioni in materia di pesca illegale (16G00169). Anno 157, numero 186.

Garavaglia C. (2018) The Birth and Diffusion of Craft Breweries in Italy. In: Garavaglia C., Swinnen J. (eds) *Economic Perspectives on Craft Beer*. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-58235-1_9

Garavaglia C. (2009). Struttura di mercato e concorrenza nell'industria birraria in Italia. *L'industria*: 523-549. DOI: 10.1430/30006.

Garavaglia C., Castro D. (2018). The recent advent of micro producers in the Spanish brewing industry. In: Swinnen J. (eds) *Economic Perspectives on Craft Beer:* 345-372. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-58235-1_13

Hall B.H., Lotti F., Mairesse J. (2009). Innovation and productivity in SMEs: empirical evidence for Italy. *Small Business Economics*, 33(1): 13-33. https://doi.org/10.1007/s11187-009-9184-8

Hani M., Cheriet F. (2012). The Mediterranean brewery industry: consolidation, restructuring and recent developments. *New Medit,* 11(3): 22-34. Available at: http://newmedit.iamb.it/static_content,185,185,newmedit.htm (accessed 16 January 2020).

Hoff A. (2007). Second stage DEA: Comparison of approaches for modelling the DEA score. *European Journal of Operational Research*, 181(1): 425-435. https://doi.org/10.1016/j.ejor.2006.05.019

Horvath M., Schivardi F., Woywode M. (2001). On industry life-cycles: delay, entry, and shakeout in beer

brewing. *International Journal of Industrial Organization*, 19(7): 1023-1052. https://doi.org/10.1016/S0167-7187(01)00062-5

Howard Philip H. (2013). Too Big to Ale? Globalization and Consolidation in the Beer Industry. http://dx.doi.org/10.2139/ssrn.2268705

ISTAT (2009). Classificazione delle attività economiche Ateco 2007: derivata dalla Nace Rev. 2. Istat, servizio produzione editoriale. Avelino. Available at: http://www.istat.it/it/files/2011/03/metenorme09_40classificazione_attivita_economiche_2007.pdf?title=Classificazione+Ateco+2007+-+01%2Fott%2F2009+-+Ateco+2007+-+Volume+integrale.pdf

Kurniawati D., Yuliando H. (2015). Productivity improvement of small scale medium enterprises (SMEs) on food products: case at Yogyakarta province, Indonesia. *Agriculture and Agricultural Science Procedia*, 3: 189-194. https://doi.org/10.1016/j.aaspro.2015.01.037

Lewis V.L., Churchill N.C. (1983). The Five Stages of Small Business Growth (1983). *Harvard Business Review*, 61(3): 30-50. Available at SSRN: https://ssrn.com/abstract=1504517 (accessed 10 January 2020).

Mahmood M. (2004). The productivity performance of Australian manufacturing SMEs. *Journal of new business ideas and trends*, 2(1): 21-28. Available at: http://www.jnbit.org/upload/Mahmood-2-1-2004.pdf (accessed 16 January 2020).

Marinelli N., Fabbrizzi S., Sottini V.A., Sacchelli S., Bernetti I., Menghini S. (2014). Generation Y, wine and alcohol. A semantic differential approach to consumption analysis in Tuscany. *Appetite*, 75: 117-127. https://doi.org/10.1016/j.appet.2013.12.013

McLaughlin R., Reid N., Moore M. (2014) The Ubiquity of Good Taste: A Spatial Analysis of the Craft Brewing Industry in the United States. In: Patterson M., Hoalst-Pullen N. (eds) *The Geography of Beer*: 131-154. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-7787-3_13

OJ (*Official Journal of the European Union*) (2003). COMMISSION RECOMMENDATION of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises. 2003/361/EC. L 124/36, 20/5/2003

Padula G., Novelli E., Conti R. (2015). SMEs inventive performance and profitability in the markets for technology. *Technovation*, 41: 38-50. https://doi.org/10.1016/j.technovation.2015.01.002

Pilar P.G., Marta A.P., Antonio A. (2018). Profit efficiency and its determinants in small and medium-sized enterprises in Spain. *BRQ Business Research Quarterly*, 21(4): 238 – 250. https://doi.org/10.1016/j.brq.2018.08.003

Pollack J., Adler D. (2016). Skills that improve profitability: The relationship between project management, IT skills, and small to medium enterprise profitability. *International Journal of Project Management*, 34(5): 831-838. https://doi.org/10.1016/j.ijproman.2016.03.004

Prowle M., Lucas M., Barnes S., Lowth G. (2017). Improving Productivity in UK SMEs: A Research Study. Centre for Innovation and Productivity Gloucestershire Business School, University of Gloucestershire. DOI:10.13140/RG.2.2.31683.20003

R Core Team (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available at: URL https://www.R-project.org/.

Reid G.C. (2003). Trajectories of small business financial structure. *Small Business Economics,* 20(4): 273-285. https://doi.org/10.1023/A:1022915308274

Rose R.C., Kumar N. (2006). The influence of organizational and human resource management strategies on performance. *Performance improvement*, 45(4): 18-24. https://doi.org/10.1002/pfi.2006.4930450406

Sellers R., Alampi Sottini V. (2016). The influence of size on winery performance: Evidence from Italy. *Wine Economics and Policy*, 5(1): 33-41. https://doi.org/10.1016/j.wep.2016.03.001

Sellers Rubio R. (2010). Evaluating the economic performance of Spanish wineries. *International Journal of Wine Business Research*, 22(1): 73-84. https://doi.org/10.1108/17511061011035215

Serafini P. (2009). Ricerca operativa. *Springer Science & Business Media*. Milano. ISBN 978-88-470-0845-8

Setiawan M., Effendi N., Heliati R., Waskito A. (2019). Technical efficiency and its determinants in the Indonesian micro and small enterprises. *Journal of Economic Studies*, 46(6): 1157-1173. https://doi.org/10.1108/JES-08-2018-0298

Swaminathan A. (1998). Entry into new market segments in mature industries: Endogenous and exogenous segmentation in the US brewing industry. *Strategic Management Journal*, 19(4): 389-404. https://doi.org/10.1002/(SICI)1097-0266(199804)19:4<389::AID-SMJ973>3.0.CO;2-0

Taymaz E. (2002). Are small firms really less productive? An analysis of productivity differentials and firm dynamics. In International Workshop on "The Post-entry Performance of Firms: Technology, Growth and Survival", University of Bologna. Available at: https://www.researchgate.net/profile/Erol_Taymaz/publication/254751090_Are_Small_

Firms_Really_Less_Productive_An_Analysis_of_Productivity_Differentials_and_Firm_Dynamics/links/550bd65d0cf265693cef9d43.pdf (accessed 10 January 2020).

Toro Gonzalez D. (2018) The Craft Brewing Industry in Latin America: The Case of Colombia. In: Garavaglia C., Swinnen J. (eds) *Economic Perspectives on Craft Beer*. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-58235-1_4

Tremblay V.J. (1985). Strategic groups and the demand for beer. *The Journal of Industrial Economics*, 183-198. DOI: 10.2307/2098681

Tremblay V.J., Iwasaki N., Tremblay C.H (2005). The Dynamics of Industry Concentration for U.S. Micro and Macro Brewers. *Review of Industrial Organization*, 26(3): 307-324. https://doi.org/10.1007/s11151-004-8114-9

Unionbirrai (2018). Birre artigianali italiane. La filiera e le prospettive di mercato. Report (2018). Available at: https://www.unionbirrai.it/it/news/report-ub-obi-art-2018-birra-artigianale-filiera-italiana-e-mercato/ (accessed 03 October 2019).

Van Beveren I. (2012). Total factor productivity estimation: A practical review. *Journal of economic surveys*, 26(1): 98-128. Available at: https://onlinelibrary.wiley.com/doi/full/10.1111/j.1467-6419.2010.00631.x (accessed 16 January 2020).

Weersink A., Probyn Smith K., Von Massow M. (2018) The Canadian Craft Beer Sector. In: Garavaglia C., Swinnen J. (eds) *Economic Perspectives on Craft Beer*, 89-113. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-58235-1_3

Wen M. (2015). Uncertain Data Envelopment Analysis. *Springer*. ISBN 978-3-662-43801-5

Wesson T., De Figueiredo J.N. (2001). The importance of focus to market entrants: A study of microbrewery performance. *Journal of Business Venturing*, 16(4): 377-403. https://doi.org/10.1016/S0883-9026(99)00049-X

Zhou H., Yang Y., Chen Y., Zhu J. (2018). Data envelopment analysis application in sustainability: The origins, development and future directions. *European Journal of Operational Research*, 264(1): 1-16. https://doi.org/10.1016/j.ejor.2017.06.023

REA | ITALIAN REVIEW OF AGRICULTURAL ECONOMICS

Firenze University Press
www.fupress.com/rea

Citation: A. Di Fonzo, C. Liberati (2020) Consumers are unaware about European legislation on communication of the health benefits conveyed by claims. An empirical survey. *Italian Review of Agricultural Economics* 75(1): 51-59. doi: 10.13128/rea-11742

Received: October 27, 2019

Revised: January 17, 2020

Accepted: March 18, 2020

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.

Consumers are unaware about European legislation on communication of the health benefits conveyed by claims. An empirical survey

Antonella Di Fonzo[1], Claudio Liberati[2]

[1] *University of Cassino and Southern Lazio*
[2] *CREA - Research Centre for Agricultural Policies and Bioeconomy*

Abstract. This paper investigates how consumers knowledge of the EC list (reg. (EU) 432/2012) can affect their understanding of health claims (*HC*). Despite the existence of a rigorous regulation on the communication of health benefits attributed to functional foods (reg. (EC) 1924/2006), there are still doubts about the efficacy of legislation. In fact, the information conveyed by *HC* does not always reach the consumer in a clear and understandable way, making the consumer skeptical. This paper proposes an empirical analysis to verify if this effect could be mitigated in case that the consumer knew the European register of *HC*. The results show how consumers skepticism is linked to trust and assessment problems that contribute to limit the *HC* efficacy and provide new elements to improve the health benefits regulation.

Keywords: functional food, regulation, health claims, credence goods, food choice.
JEL codes: Q01, Q1, M31, D12.

1. INTRODUCTION

Nowadays, consumers are increasingly interested in the relationship between consumption and its effect on health. This interest generated the need to respond to a growing demand for information about the health benefits of food products, especially in the case of functional foods. In this context reg. (EC) 1924/2006 was introduced in order to assure consumers that *HC* posted on the label or used by advertising are correct, understandable and scientifically tested. In fact, one of the specific objectives of reg. (EC) 1924/2006 (art. 13) is that the information conveyed by the *HC* reaches «well understood by the average consumer» in a clear and understandable way. If the legislation does not achieve this main goal consequently, consumers will remain skeptical towards the purchase and consumption of functional foods and regulation will lose its efficacy.

This paper proposes an empirical analysis to verify if *HC* legislation helps to alleviate consumers skepticism by providing them with a clear and

intelligible health information. Since it does not always occur, it creates confusion among consumers in the choice of healthy foods (Meijboom, 2007) because they do not seem to understand claims. Concerns about the effects of food on personal health are the reason for a progressive expansion of the functional foods consumption. The estimates of the size of market for functional food are not consistent (Bech-Larsen, Grunert, 2003; van Trijp, van der Lans, 2007; Jago, 2009; Falguera *et al.,* 2012), yet studies agree on rapid growth of the sector in the near future though the regulation does not push innovation in the EU food sector (Khedkar *et al.*, 2017). Regulation and information are key issues that can potentially hinder future growth (Vicentini *et al.*, 2016). Recent studies show that there is a high percentage of consumers who are interested to functional foods consumption for disease prevention (Plasek *et al.*, 2020).

The relevance of the sector has made functional food an interesting research field in the scientific debate. Despite the positive trend registered in health-food consumption (Lau *et al.*, 2013; Grunert, 2017) consumers seem to be skeptical toward the purchase of functional foods (Krystallis, Chrysochou, 2012; Fenko *et al.*, 2016), although the effects on health are based on scientific evidence (reg. (EC) 1924/2006). According to the study provided by Nelson (1970), functional foods are configured as credence goods. This feature as credence good may create, in the absence of public intervention, a market failure deriving from erroneous assessment by consumers of expected health benefits. To mitigate the effects of information asymmetry a European register of health was established (reg. (EU) 432/2012[1]) where each claim specifies the health benefits associated with functional food whereby an authorization to use has been issued. After its adoption, some doubts remain in the literature about the ability of the register to solve the asymmetry in practice (Bech-Larsen, Scholderer, 2007; van Trijp 2009; Walker, 2017).

This paper provides an empirical survey on 202 purchasers of Italian food to evaluate the efficacy of European Commission's list. In fact, the information conveyed by HC seems not to reach always the consumer in a clear and understandable way. This consideration means that European legislation does not always reach its goals. For this reason the paper aims to identify any systematic determinant of trust and assessment problems. Results reveal how the efficacy of the information conveyed by *HC* is undermined by two factors. The first relates to an erroneous assessment of *HC* by consumers. The second concerns the rules that producers must comply with in order to obtain authorization for use of *HC*. These rules, although rigorous seems to be unknown to consumers.

The efficacy information analysis on the *HC* was made using different approaches from the experimental to the theoretical-empirical. Currently, in the economic literature, the studies about efficacy of rules are relatively rare and not systematic. This paper intends to contribute on debate to setting an adequate and effective European legislation on *HC* because functional food is becoming a sector of particular importance that can reduce the risk of disease.

2. BACKGROUND

2.1. Functional food literature framework

The term «functional food» refers to fresh or processed foods that, if included in a balanced diet, can help to improve the consumer well-being and state of health (eg. Diplock *et al.*, 1999). A scientific consensus was reached on the definition of functional food. Specifically a food can be defined as functional «if a beneficial effect on one or more biological functions of the organism is demonstrated».[2] Subsequently, the scientific literature proposed a classification of functional food (e.g. Bigliardi, Galati, 2013). Precisely the topic has been widely covered also in the law literature (e.g. Petrelli, 2011; Strambi, 2016). In recent decades, agri-food companies have relied on health features in an attempt to create greater value for the consumer and differentiate their offerings. However, this strategy found a constraint in the credence nature of functional foods health attributes, because not all consumers believe in the health benefits associated with functional foods. Consumers are not able to fully assess the health effects of functional foods. In fact the conditions are created for a possible market failure due to an asymmetry of information. According to a typical Akerlof model (1970), the deviation to the social optimum (perfect information) can emerge for two interrelated reasons. Whilst consumers could exhibit a willingness to pay for functional foods less than that in the case of complete information, producers could act opportunistically and try to induce the consumer to overestimate non-functional foods. In this context, producers do not necessarily have incentives to provide correct information to consumers (e.g. Russo, Tufi 2016, unlike Milgrom, Roberts, 1986). Information asymmetry on functional foods, therefore, can distort purchasing behavior and productive allocation to the detriment of consumers and high quality producers.

[1] The list of authorized indications was established by reg. (EC) 432/2012 and subjected to continuous updates.

[2] The European Commission Concerted Action on Functional Food Science in Europe (FUFOSE).

Some studies have identified the imperfect consumer information as a significant determinant of the gap between potential demand and expressed demand for functional foods (Annunziata *et al.*, 2011) despite the legislator prepared a regulatory intervention aimed at encouraging correct information to consumers and the markets efficiency (the reg. (EC) 1924/2006). Information and communication plays an important role in reducing this phenomenon. Often correct labeling of functional foods is identified as a desirable solution for limiting the effects and the presence of asymmetric information (Malla *et al.*, 2005). The regulation does not define the term of «functional food» but regulates nutrition and *HC*, in particular how companies can convey information to the consumer on the product label or through advertising to prevent the release of false information and prevent market failure. To provide full transparency to consumers and food operators a European public registry contains a list of nutrition and *HC* to be authorized to use or rejected. The *HC* is the main tool used by companies to inform consumers of the healthy effects of functional foods, if these are not well known (Annunziata *et al.*, 2012). Some studies suggest that *HC* are mostly perceived positively by consumers (Van Buul *et al.*, 2015) and allow them to make informed purchase choices (Leathwood *et al.*, 2007).

Empirical studies highlight two problems in reading *HC*. The first concerns the assessment, or the ability of the consumers to interpret (understand) the claim correctly and to evaluate the effects on health (Tonkin *et al.*, 2016). Secondly it concerns the trust that consumers have in the claims that are correctly understood. Empirical evidences show that skepticism in consumption negatively affects the demand for functional foods (Fenko *et al.*, 2016) especially when consumers perceive functional foods like pharmaceutical food rather than a substitute for the conventional food (Stein, Rodriguez-Carezo, 2008).

Other empirical studies on functional foods demand have jointly analyzed the issues of trust and assessment, trying to estimate a synthetic indicator of consumer attitude: his willingness to pay (WTP) that depends on both trust and understanding of the claims. In particular, the literature investigated the factors influencing the WTP for functional foods and, consequently, influencing consumption decisions (Vecchio *et al.*, 2016; Pappalardo *et al.*, 2016; Annunziata *et al.*, 2016, Wongprawmas *et al.*, 2015). Although consumers are willing to allocate part of their income to purchase food products with health benefits (Larue *et al.*, 2004), the sector's profit margins depend on the producers' ability to identify the right consumers target for each specific product (Bonanno, 2012).

In general, studies agree on a strictly positive WTP of consumers, who recognize that functional foods, consumed in a balanced lifestyle, offer potential for improving health (Van Trijp *et al.*, 2007; Krystallis *et al.*, 2008; Goetzke *et al.*, 2014). However, many research studies highlight confusion in consumers perceptions and assessments (eg. Williams *et al.*, 2005).

Despite of the existing regulation, empirical studies confirm assessment problems and, to a lesser extent, trust problems. These results gave rise to a literature aimed at understanding the motivational aspects of functional foods consumption and to assess the communication efficacy (Verbeke, 2008; Tudoran *et al.*, 2009.; Visschers *et al.*, 2010; Grunert, *et al.,* 2011; Dean *et al.*, 2012; Wills *et al.*, 2012; Nocella *et al.*, 2012; Chan *et al.*, 2013; Lähteenmäki, 2013, Hung *et al.*, 2017). The answer to this growing demand for correct information translates into the proposal by some authors to make changes to the rules relating to claims (Chan *et al.*, 2005) and in the use of a qualitative-quantitative approach that shows how an acceptable number of consumers can understand nutrition and health information (Leathwood *et al.*, 2007).

Our paper contributes to this literature to evaluate the problems of trust and assessment in functional foods demand, and to identify any systematic components and regulatory proposals able to mitigate the information problem.

3. METHODOLOGY, SURVEY PROCEDURES AND MATERIALS.

This paper reports the results of an empirical survey on consumers of Italian food products – testing for the existence of trust and assessment problems and to identify any exogenous factor systematically associated with them. The qualitative data used in this research were obtained through questionnaires, conducted online. Cross-sectional data were collected from 202 Italian consumers. The self-administered questionnaire contained questions with closed-ended response alternatives and used samples and standardized questions in order to carry out a structured interview.

The content validity of the questionnaire was ascertained with a pre-test and from a pilot survey. Subsequently, a database was developed to support the processing in order to systematize the collected data into STATA and SPAD dataset.

Compared to the existing literature, it does not pursue exact quantification of consumer's WTP and does not provide quantitative estimates of the distortion in

the evaluation. The choice is driven by the purpose of obtaining an assessment that is robust with respect to the assumptions informing quantitative estimates of WTP.

Methodological approach relies on consolidated data reduction techniques. The advantage of this approach is the ability to analyze separately the two issues. The survey also captured the demographic profile of the respondents. Table 1 describes the characteristics of the participants by gender, age, education. Generally, respondents are female and the age classes are not homogeneous distribution. With regard to the educational level, mostly consumers had a high school diploma (38.61%) and graduation degree (33.66%).

The questionnaire was designed to analyze three areas of priority: i) knowledge of the legislation and the validation process of claims by third parties (European Commission registry); ii) the ability to discriminate true claims from false ones iii) the ability to understand the meaning and implications of the claim. Our goal is to test empirically the hypothesis that European Commission registry really affects the understanding of the *HC*.

Questionnaire was divided into three sections. The first section collects general information of interviewee and verifies consumers' knowledge of functional foods and *HC*, the frequency and motivation to purchase, the identification of communication tools that influence the foods purchasing process, functional and correct assessment of *HC*. The second section analyzes the influence of *HC* regulation during the process of purchasing functional foods. The questions were structured in order to investigate consumer awareness about the existence of the European register of *HC* and its main function, aimed at preventing the circulation on the market of claims not approved. The respondent was asked to indicate according to his knowledge, if *HC* authorized by EU register and attributed to some Italian «private label» of famous functional foods, were true, false, or confirm the hypothesis of a lack of information with a «do not know». In particular, the merchandise categories are milk/dairy products and cereal food products where have been considered as functional ingredients plant sterols/probiotics and dietary fiber. In addition, according to the answers given participants were asked to indicate their motivation through the proposed structured alternatives (Tab. 2).

At this point, the respondent is asked to indicate which of some proposed solutions could be more effective to increase confidence in the information conveyed by the *HC*. Among the solutions, the interviewees proposes by the establishment of a European public register just to confirm or not that they are knowledge about. The third and final section aims to test whether consum-

Tab. 1. Respondents' distribution by socio-demographic profiles (n=202).

	Freq.	Percent	Cum.
Age			
15-24	11	*5.45*	*5.45*
25-34	69	*34.16*	*39.60*
35-44	55	*27.23*	*66.83*
45-54	38	*18.81*	*85.64*
55-64	21	*10.40*	*96.04*
65-74	8	*3.96*	*100.00*
Total age	202	*100.00*	
Gender			
Female	120	*59.41*	*59.41*
Male	80	*39.60*	*99.01*
Missing Value	2	*0.99*	*100.00*
Total gender	202	*100.00*	
Education			
Graduation	68	*33.66*	*33.66*
High school diploma	78	*38.61*	*72.28*
Middle school diploma	11	*5.45*	*77.72*
Phd/Master/Specialization	30	*14.85*	*92.57*
Professional qualification	15	*7.43*	*100.00*
Total education	202	*100.00*	

Tab. 2. Items defining about the understanding and trust in the health claim.

Health claim	Knownledge degree	Motivation
A. Bifidobacterium BB12 (or bifidus) promotes the balance of intestinal flora.	True	1. I know it because seen/ heard through Tv/ Radio/ Web. (T1) 2. I trust of the information in health claims. (T2) 3. Usually, I use products that have this health claim. (T3)
B. Beta-glucans that help maintain normal blood cholesterol levels.	False	1. False I know the properties of the health component (F1). 2. False I feel that is misleading (F2). 3. False I don't trust the content of health claims (F3).
C. Vitamin K, zinc and manganese that help maintain bone health.	I do not know	1.From the health claim I do not understand the health benefits .(NK1) 2. I can not associate the active ingredient of the health claim with health benefits mentioned. (NK2) 3. I know other foods that provide the same healthy benefits. (NK3)
D. Plant sterols that help reduce blood cholesterol.		
E. Zinc and folic acid that help the immune system function.		

ers are aware of the existence of an institution responsible for ensuring that the benefits conveyed by the *HC* is substantiated by scientific evidence.

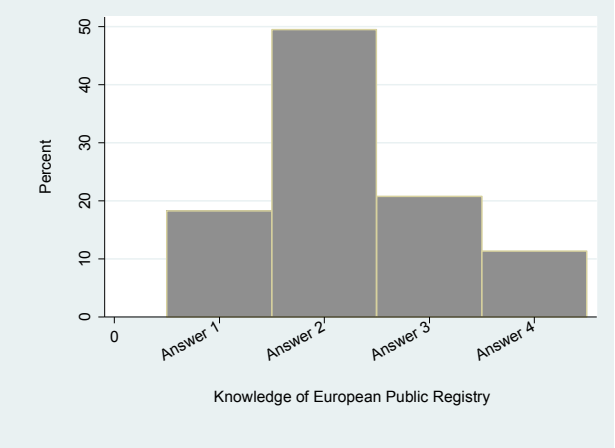
4. RESULTS AND DISCUSSIONS.

The results reveal how the information efficacy conveyed by *HC* is undermined by two factors, based on information asymmetries in the market. The first, relates to an erroneous assessment of *HC* by consumers. The second concerns the rules that producers must comply in order to obtain authorization for use of *HC*. These rules, although stringent, seem to be unknown to consumers. In fact, consumers do not seem to know the regulation establishing a European register of *HC*. Consumers have been asked indirectly to express their opinion about the knowledge of the EC registry or rather to answer the question on the possible solutions to be adopted to increase belief in the information convoyed by *HC* (Fig. 1).

The questionnaire developed items to collect information about consumers' knowledge and belief regarding specific HC. Then consumer profile by applying clustering techniques to each group of question was built. The interpretation of each cluster provides us a parsimonious representation of individual consumers' beliefs and understanding toward each *HC* proposed. Table 3 illustrates the four emerging clusters and their interpretation. Also, in Appendix Figure A.1., A.2. and A.3. reports for each cluster socio-demographic aspects. Cluster analysis results show an identification of the elements that affect the trust and assessment of the claim and can be interpreted as consumers' attitude.

χ^2-test is used to evaluate if there were the conditions to analyze into the clusters and for each claim considered the knowledge of the public registry. It appeared that most respondents, they do not know in the public register even mentioning the most famous claim. All claims considered are significantly associated with the lack of information about the public register ($p<0,01$) (Tab. 4).

Fig. 1. Consumer knowledge of the European public registry (%).



Answer 1: Organization of public information events; Answer 2: Establishment of a European public register; Answer 4: Increased supply of food with health claims; Answer 5: Increase in purchasing behavior with health reasons.

A χ^2 association test allowed to reject the null hypothesis of independence between the *HC* and the public registry form at 99% confidence level. The test statistic χ^2, which is larger than the critical value $\chi^2(0.01,24) = 42,98$. The data supports the conclusion of an association between the lack of understanding of the claim and the knowledge of the EC registry.

In particular, results show that consumers have serious difficulties to make a proper assessment of the health benefits provided by the *HC* (for example, they are unlikely to associate the active ingredient to the HC with the benefit the healthy conveyed). Furthermore, the lack of information of consumers about the regulation that supports the communication of health benefits is manifested in two different aspects. At first,

Tab. 3. Consumers profiling for assessing to health claims in the EC registry.

Emerging consumers profile		Cluster description
Cluster 1/4	Moderately unaware consumers	Consumers who are unable to associate the active ingredient to the healthy effects conveyed by claims. However, they could potentially know the public register.
Cluster 2/4	Aware consumers	Consumers who trust the content of health claims they could potentially know the public register.
Cluster 3/4	Moderately aware consumer	Consumers who trust the content of health claims, because they listen on TV, they could potentially know the public register.
Cluster 4/4	Unaware consumers	Consumers who consider the claims to be misleading or that associate claim with other foods of usual consumption (provide the same health benefit). These consumers say they do not know the public register).

Tab. 4. χ^2 Pearson-Test for different healt claim.

Health Claims	Consumers profile	T1	T2	T3	F1	F2	F3	NK1	NK2	NK3
Bifidobacterium BB12 promotes the balance of intestinal flora.	Moderately unaware consumers	10	6	2	1	0	1	2	19	1
	Aware consumers	2	22	2	0	1	0	0	1	1
	Moderately aware consumers	22	1	0	0	24	20	0	2	0
	Unaware consumers	8	9	28	1	23	4	18	23	11
	χ^2 (24) = 224.4917 Pr = 0.000									
Beta-glucans that help maintain normal blood cholesterol levels.	Moderately unaware consumers	1	1	0	0	2	3	1	34	0
	Aware consumers	1	15	0	0	0	0	7	6	0
	Moderately aware consumers	14	0	0	0	2	0	5	2	2
	Unaware consumers	4	3	13	5	24	5	26	9	17
	χ^2 (24) = 245.0168 Pr = 0.000									
Vitamin K, zinc and manganese that help maintain bone health.	Moderately unaware consumers	1	2	2	1	3	1	0	32	0
	Aware consumers	1	21	1	1	0	0	1	3	1
	Moderately aware consumers	16	1	3	0	0	0	1	3	1
	Unaware consumers	4	4	13	15	5	5	36	3	21
	χ^2 (24) = 297.7506 Pr = 0.000									
Plant sterols that help reduce blood cholesterol.	Moderately unaware consumers	1	5	4	0	0	0	1	30	1
	Aware consumers	3	20	0	0	1	1	0	4	0
	Moderately aware consumers	19	1	1	0	0	0	1	2	1
	Unaware consumers	9	5	13	8	13	6	27	7	18
	χ^2 (24) = 249.8423 Pr = 0.000									
Zinc and folic acid that help the immune system function.	Moderately unaware consumers	0	1	3	1	1	0	5	30	1
	Aware consumers	0	18	0	1	2	0	1	4	3
	Moderately aware consumers	10	0	0	1	1	7	7	6	0
	Unaware consumers	2	3	12	13	16	7	25	5	23
	χ^2 (24) = 243.0051 Pr = 0.000									

consumers do not know the legal existence of the system that imposes strict requirements that manufacturers must meet to obtain approval of a *HC*. On the other hand, consumers are completely unaware of the existence of the European public *HC* register and of the body responsible for certifying the scientific proof of the health benefits communicated by them, prior to issuing the authorization for use. The information conveyed by *HC* does not always reach the consumer in a clear and understandable way. This effect could be mitigated if the consumer knew the European register of *HC*.

5. SUMMARY AND CONCLUSIONS.

Consumers have serious difficulties to make a proper assessment of the health benefits provided by the *HC* (for example, they are unlikely to associate the active ingredient to the HC with the benefit the healthy conveyed). This lack of information about regulation could be due in part to the omission by producers and/or large buyers (in the case of a functional private label foods) of a normative reference on the package which relates to the European registry of *HC*. This confusion could be fueled by the existence under a private label itself of products aimed at improving the wellbeing and health, they both functional and nutritional, whose information is transmitted respectively by the *HC* and nutrition claims. Both products prelude to obtain beneficial effects on health by feeding the consumer a wrong perception of the health consumer. A clear distinction between a health food and a nutritional food would mean directing health-conscious consumers exclusively towards the purchase of functional foods to detriment of nutritional foods demand, tracing a clear line between the two demand segments (e.g sodium-free foods would end up being purchased exclusively by those requiring a low-salt diet).This deviation in health aspect perception induces the consumer to buy the food product regardless of the type of claim declared. These considerations contribute

to the current challenge pursued by European policy to stimulate better communication of the benefits offered by functional foods to ensure a better understanding of the information from legal sources, which we assume that they have greater reliability.

REFERENCES

Akerlof G.A. (1970). The Market for Lemons: Quality Uncertainty and the Market Mechanism. *Quarterly Journal of Economics*, 84(3): 488-500. DOI.org/10.2307/1879431.

Annunziata A., Vecchio R., Kraus A. (2016). Factors Affecting Parents' Choices of Functional Foods Targeted for Children. *International Journal of Consumer Studies*, 40(5): 527-535. DOI.org/10.1111/ijcs.12297.

Annunziata A., Vecchio R. (2012). Consumer Perception of Functional Foods: A Conjoint Analysis with Probiotics. *Food Quality and Preferences,* 28(1): 348-355. DOI: 10.1016/j.foodqual.2012.10.009.

Annunziata A., Vecchio R. (2011). Functional Foods Development in the European market: A Consumer Perspective. *Journal of Functional Foods*, 3(1): 223-228. DOI.org/10.1016/j.jff.2011.03.011.

Bech-Larsen T., Grunert K.G. (2003). The Perceived Healthiness of Functional Foods: A Conjoint Study of Danish, Finnish and American Consumers' Perception of Functional Foods. *Appetite,* 40(1): 9-14. DOI.org/10.1016/s0195-6663(02)00171-x.

Bech-Larsen T., Scholderer J. (2007). Functional Foods in Europe: Consumer Research, Market Experiences and Regulatory Aspects. *Trends in Food Science & Technolo-gy*, 18(4): 231-234. DOI.org/10.1016/j.tifs.2006.12.006.

Bigliardi B., Galati F. (2013). Innovation trends in the food industry: the case of functional foods. *Trends in Food Science & Technology*, 31(2): 118-129.

Bonanno A. (2012). Some Like it Healthy: Demand for functional and Conventional yogurts in the Italian market. *Agribusiness,* 28(1): 67-85. DOI.org/10.1002/agr.20288.

Chan C., Patch C., Williams P. (2005). Australian Consumers are Sceptical about but Influenced by Claims about Fat on Food Labels. *European Journal of Clinical Nutrition*, 59(1): 148-151. DOI.org/10.1038/sj.ejcn.1602038 .

Chan C., Kam B., Coulthard D., Pereira S., Button P. (2013). Food Product Information: Trusted Sources and Delivery Media. In ACIS 2013: *Proceedings of the 24th Australasian Conference on Information Systems:* 1-13. RMIT. Melbourne 4-6 December.

Commission reg. (EU) 432/2012 of 16 May 2012 establishing a list of permitted HC made on foods, other than those referring to the reduction of disease risk and to children's development and health.

Commission reg. (EU) 1047/2012 amending reg. (EC) 1924/2006 with regard to the list of nutrition claims.

Dean M., Lampila P., Shepherd R., Arvola A., Saba A., Vassallo M., Claupein E., Winkelmann M., Lähteenmäki L. (2012). Perceived Relevance and Foods with Health Related Claims. *Food Quality and Preference*, 24(1): 129-135. DOI.org/10.1016/j.foodqual.2011.10.006 .

Diplock A.T., Aggett P.J., Ashwell M., Bornet F., Fern E.B., Reberfroid M.B. (1999). Scientific Concepts of Functional Foods in Europe Consensus Document. *British Journal of Nutrition,* 81(1): 1-27. DOI.org/10.1017/s0007114599000471 .

Falguera V., Aliguer N., Falguera M. (2012). An Integrated Approach to Current Trends in Food Consumption: Moving Toward Functional and Organic Products?. *Food Control*, 26(2): 274-281. DOI.org/10.1016/j.foodcont.2012.01.051 .

Fenko A., Kersten L., Bialkova S. (2016). Overcoming Consumer Scepticism Toward Food Labels: The role of Multisensory Experience. *Food quality and preference*, 48(1): 81-92. DOI.org/10.1016/j.foodqual.2015.08.013 .

Ford G.T., Hastak M., Mitra A., Ringold D.J. (1996). Can Consumers Interpret Nutrition Information in the Presence of a HC? A Laboratory Investigation. *Journal of Public Policy & Marketing* 15(1): 16-27. DOI.org/10.1177/074391569601500102.

Goetzke B., Nitzko S., Spiller A. (2014). Consumption of Organic and Functional Food. Matter of Well-Being and Health? *Appetite*, 77(1): 96-105. DOI.org/10.1016/j.appet.2014.02.012.

Grunert K.G., Scholderer J., Rogeaux M. (2011). Determinants of Consumer Understanding of HC. *Appetite*, 56(2): 269-277. DOI.org/10.1016/j.appet.2011.01.009.

Grunert K.G. (2017). The health trend. In *Consumer trends and new product opportunities in the food sector:* 229-236. Wageningen Academic Publishers. DOI.org/10.3920/978-90-8686-852-0_2.

Hung Y., Grunert K.G., Hoefkens C., Hieke S., Verbeke W. (2017). Motivation Outweighs Ability in Explaining European Consumers' Use of HC. *Food quality and preference*, 58(1): 34-44. DOI.org/10.1016/j.foodqual.2017.01.001.

Khedkar S., Bröring S., Ciliberti S. (2017). Exploring the Nutrition and HC reg. (EC) 1924/2006: What is the impact on innovation in the EU food sector? *Inter-*

national journal of food sciences and nutrition, 68(1): 10-17.

Krystallis A., Maglaras G., Mamalis S. (2008). Motivations and Cognitive Structures of Consumers in their Purchasing of Functional Foods. *Food Quality and Preference*, 19(6): 525-538. DOI: 10.1016/j.foodqual.2007.12.005.

Krystallis A., Chrysochou P. (2012). Do HC and Prior Awareness Influence Consumers' Preferences for Unhealthy Foods? The Case of Functional Children's Snacks. *Agribusiness*, 28(1): 86-102. DOI. org/10.1016/j.foodqual.2007.12.005.

Leathwood P.D., Richardson D.P., Sträter P., Todd P.M., van Trijp H.C. (2007). Consumer Understanding of Nutrition and HC: Sources of Evidence. *British Journal of Nutrition*, 98(3): 474-484. DOI.org/10.1017/s000711450778697x .

Lähteenmäki L. (2013). Claiming Health in Food Products. *Food Quality and Preference*, 27(2): 196-201. Available at: org/10.1016/j.foodqual.2012.03.006 .

Larue B., West G.E., Gendron C., Lambert R. (2004). Consumer Response to Functional Foods Produced by Conventional, Organic, or Genetic Manipulation. *Agribusiness: An International Journal*, 20(2): 155-166. DOI.org/10.1002/agr.20006 .

Lau T.C., Chan M.W., Tan H.P., Kwek C.L. (2013). Functional Food: a Growing Trend Among the Health Conscious. *Asian Social Science*, 9(1): 198.

Jago D. (2009). Functional Foods, Market Trends. In Functional Foods Symposium, Amsterdam, April.

Malla S., Hobbs J.E., Perger O. (2005). Estimating the Health Care Savings from Trans Fat-Free Canola in Canada. *Acta Agriculturae Scand Section C*, 2(3-4): 175-184. DOI.org/10.1080/16507540500534911 .

Meijboom F.L. (2007). Trust, Food, and Health. Questions of Trust at the Interface between Food and Health. *Journal of Agricultural and Environmental Ethics*, 20(3): 231-245. DOI.org/10.1007/s10806-007-9035-z .

Milgrom P., Roberts J. (1986). Relying on the Information of Interested Parties. *The RAND Journal of Economics*: 18-32. DOI.org/10.2307/2555625 .

Nelson P. (1970). Information and consumer behavior. *Journal of political economy*, 78(2): 311-329. DOI. org/10.1086/259630.

Nocella G., Kennedy O. (2012). Food HC–What Consumers Understand. *Food Policy*, 37(5): 571-580. DOI.org/10.1016/j.foodpol.2012.06.001 .

Pappalardo G., Lusk J.L. (2016). The Role of Beliefs in Purchasing Process of Functional Foods. *Food quality and preference*, 53(1): 151-158. DOI.org/10.1016/j.foodqual.2016.06.009 .

Petrelli, L. (2011). I prodotti della salute. In *Rivista di diritto alimentare* 3/2011, Anno V. Available at: http://www.rivistadirittoalimentare.it/rivista/2011-03/PETRELLI.pdf.

Plasek B., Lakner Z., Kasza G., Temesi Á. (2020). Consumer Evaluation of the Role of Functional Food Products in Disease Prevention and the Characteristics of Target Groups. *Nutrients*, 12(1): 69.

Regulation (EC) 1924/2006 of the European Parliament and of the Council of 20 December 2006 on nutrition and HC made on foods.

Russo C., Tufi E. (2016). Consumer Behavior Under Conflicting Information Provided by Interested Parties: Implications for Equilibrium in the Market for Credence Goods. *Recent patents on food, nutrition and agriculture*, 8(1): 4-8. DOI.org/10.2174/2212798408666160129103651.

Stein A.J., Rodriguez-Carezo E. (2008). Functional Foods in the European Union. Institute for Prospective Technological Studies, European Commission JRC, Seville, Spain. Available at: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC43851/jrc43851.pdf.

Strambi G. (2016). La disciplina europea sulle indicazioni nutrizionali e sulla salute: dieci anni di applicazione controversa. *Agricoltura, Istituzioni e Mercati*. DOI 10.3280/AIM2016-001003.

Tonkin E., Meyer S.B., Coveney J., Webb T., Wilson A.M. (2016). The Process of Making Trust Related Judgements Through Interaction with Food Labelling. *Food policy*, 63(1): 1-11. DOI.org/10.1016/j.foodpol.2016.06.007 .

Tudoran A., Olsen S.O., Dopico, D.C. (2009). The Effect of Health Benefit Information on Consumers Health Value, Attitudes and Intentions. *Appetite*, 52(3): 568-579. DOI.org/10.1016/j.appet.2009.01.009 .

Van Buul J.V., Brouns F.J. (2015). Nutrition and HC as Marketing Tools. *Critical Reviews in Food Science and Nutrition*, 55(11): 1552-1560. DOI.org/10.1080/10408398.2012.754738 .

Van Trijp H.C., Van der Lans I.A. (2007). Consumer Perceptions of Nutrition and HC. *Appetite*, 48(3): 305-324. DOI.org/10.1016/j.appet.2006.09.011 .

Van Trijp H.C.M. (2009). Consumer Understanding and Nutritional Communication: Key Issues in the Context of the New EU Legislation. *European Journal of Nutrition* 48(1): 41-48. DOI.org/10.1007/s00394-009-0075-1.

Vecchio R., Van Loo E.J., Annunziata A. (2016). Consumers' Willingness to Pay for Conventional, Organic and Functional Yogurt: Evidence from Experimental Auctions. *International Journal of Consumer Studies*, 40(3): 368-378. DOI.org/10.1111/ijcs.12264 .

Verbeke W. (2008). Impact of Communication on Consumers' Food Choices: Plenary Lecture. *Proceedings of the Nutrition Society*, 67(3): 281-288. DOI. org/10.1017/s0029665108007179.

Vicentini A., Liberatore L., Mastrocola D. (2016). Functional Foods: Trends and Developement of the Global Market. *Italian Journal of Food Science* 28(2): 338-351. DOI.org/10.14674/1120-1770/ijfs.v211.

Walker M.J. (2017). Health and Nutrition Claims – Guidance, Regulation and Self-Regulation. *Nutrition* Bullettin 42(1): 69-79. DOI.org/10.1111/nbu.12251.

Visschers V.H., Hess R., Siegrist M. (2010). Health Motivation and Product Design Determine Consumers' Visual Attention to Nutrition Information on Food Products. *Public health nutrition*, 13(7): 1099-1106. DOI.org/10.1017/s1368980009993235 .

Williams P. (2005). Consumer Understanding and Use of HC for Foods. *Nutrition Reviews*, 63(7): 256-264. DOI.org/10.1111/j.1753-4887.2005.tb00382.x .

Wills J.M., Genannt Bonsmann S.S., Kolka M., Grunert K.G. (2012). European Consumers and HC: Attitudes, Understanding and Purchasing Behaviour. *Proceedings of the Nutrition Society*, 71(2): 229-236. DOI.org/10.1017/s0029665112000043.

Wongprawmas R., Pappalardo G., Canavari M., Bazzani C., Drichoutis A., Pecorino B. (2015). Disponibilità a pagare per l'acquisto di alimenti funzionali: evidenze da un esperimento di scelta non-ipotetico. *Rivista di Economia Agraria*, 70(3): 327-344. ISSN 0035-6190 (print) ISSN 2281-1559 (online).

APPENDIX

Fig. A.1. Gender distribution in consumer profiles (%).

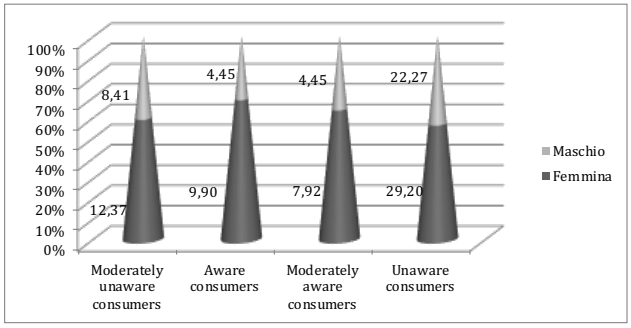


Fig. A.2. Age classes distribution in consumer profiles (average values).

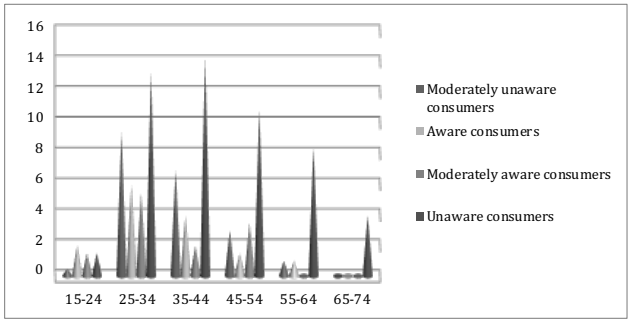
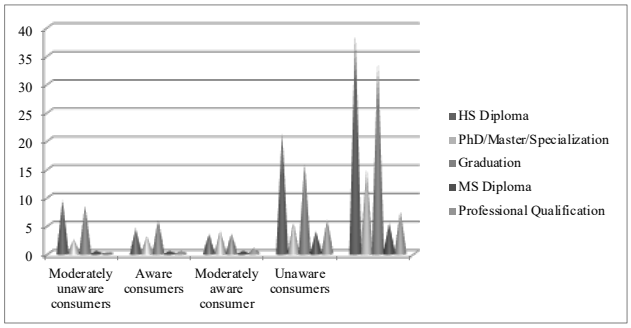


Fig. A.3. Education distribution in consumer profiles (average values).



REA | ITALIAN REVIEW OF AGRICULTURAL ECONOMICS

Firenze University Press
www.fupress.com/rea

Citation: C. Menna, F. Gandolfi, M. Passari, M. Cannellini, G. Trentin, T. Del Giudice, C. Cavallo, I. Cigliano (2020) Farm advisory services and knowledge growth in Italy: comparison among three regional intervention models. *Italian Review of Agricultural Economics* 75(1): 61-70. doi: 10.13128/rea-11743

Received: November 5, 2019

Revised: February 14, 2020

Accepted: March 18, 2020

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.

Farm advisory services and knowledge growth in Italy: comparison among three regional intervention models

Concetta Menna[1], Ferdinando Gandolfi[2], Maria Passari[2], Marcello Cannellini[3], Giorgio Trentin[4], Teresa Del Giudice[5], Carla Cavallo[5], Imma Cigliano[6]

[1] *CREA - Research Centre for Agricultural Policies and Bioeconomy – Naples, Italy*
[2] *Campania Regional Authority – Naples, Italy*
[3] *Emilia-Romagna Regional Authority – Bologna, Italy*
[4] *Veneto Regional Authority – Mestre, Italy*
[5] *University of Naples - Italy*
[6] *Upfront Advisory S.r.l. - Naples, Italy*

Abstract. The profound changes in European policy for farms advisory services (FAS) require a period of experimentation and results observation before the new CAP 2021-2027. This paper focuses on Measure 2 of Rural Development Programme (RDP) 2014-2020. The paper is focused on the description of case studies in three Italian regions: Campania, Emilia-Romagna and Veneto. Different Measure 2 – sub-measure 2.1 models are analyzed through a qualitative approach, using a conceptual framework adapted by Birner et al. (2009). The paper contributes to the ongoing debate in the scientific literature on the strengths and weakness of policy intervention focused on tailored advisory services to force a broader Agricultural Innovation System.

Keywords: knowledge, innovation, European knowledge policy.
JEL codes: O13, Q16, Q18.

1. INTRODUCTION

Innovation in the agricultural sector is considered the main strategy to improve food production, multifunctionality and agricultural sustainability. In this scenario, policy makers worldwide and especially in the European Union (EU) are structuring a new toolbox to implement more efficient public policy to foster knowledge and innovation in rural areas. Among the most important tools, agricultural advisory services have regained importance (Knierim *et al.*, 2017). Moreover, the framework developed for the next programming period 2021-2027 stresses the importance of interaction among different operators working in the field of agricultural information, through the establishment of new networks and new subjects, like operational groups (Van Oost, 2013; Hermans *et al.*, 2015; Moschitz *et al.*, 2015; Van Oost, 2018).

In the COM 392/2018 proposal for CAP 2021-2027 - Rules on support for strategic plans to be drawn up by Member States under the Common Agricultural Policy (CAP Strategic Plans) and financed by the EAGF and by the EAFRD, the EU's priority is to promote a knowledge-based rural economy with stronger interventions for knowledge transfer and advisory measures.

Several studies have sought to investigate the dimensions of advisory services as main tool to foster innovation adoption (Cristiano *et al*., 2015; Cristiano, 2012; Storti *et al*., 2010; Vagnozzi, 2008).

There is an ever greater need for knowledge in this domain due both to far-reaching changes in the agricultural sector and the new economic, environmental and social challenges that the sector is facing. New dimensions have been assigned to agriculture, in terms of strategies, policies and objectives to better support genesis processes of shared and coproduced knowledge (Cristiano *et al*., 2015). In this scenario, the role of the advisor as a bridge between farms, training and innovation is pivotal to create mutual learning, and open innovation construction and diffusion, in an environment of mutual trust and encouragement (Koutsouris, 2012). This process also fosters connections and interaction among actors within the innovation process (Klerkx *et al*., 2012a and 2012b).

The profound changes in the European policy for farms advisory services (FAS) require a period of experimentation and results observation before the new CAP 2021-2027. Several factors working together could create the conditions to reach all types of potential beneficiaries, however small and marginal, of agricultural services (Eastwood *et al*., 2017) and to avoid a «result paradox» (Benvenuti, 2000; Bartoli *et al*., 2014; De Rosa, 2014). This paper focuses on Measure 2 of Rural Development Programme (RDP) 2014-2020. The Measure is composed by 3 sub-measures that support a wide range of operations for advisory services well connected to different European priorities for rural development. The aim is to promote the use of farms advisory services for improving the sustainable management and economic and environmental performance of agricultural and forestry small and medium-sized farms. This Measure also promotes the training of advisors in order to improve the quality and effectiveness of the advice offered and to better meet farmers' needs.

Only few Italian regions have implemented this public intervention. The paper is focused on the description of case studies in three Italian regions: Campania, Emilia-Romagna and Veneto. These regions have implemented, using Measure 2 – sub-measure 2.1 (support for the use of advisory services) of Rural Development Plan 2014-2020, three different public intervention models to develop the supply of farms advisor services (FAS), to stimulate higher rates of farmer participation in agricultural services and to empower human capital and farmers' attitudes to innovation (EU SCAR, 2012; Touzard *et al*., 2015). The paper contributes to the ongoing debate in the scientific literature on the strengths and weakness of policy intervention focused on advisory services to force a broader Agricultural Innovation System. The key point is to build tailored models of providing and financing advisory services following peculiarities of regional agriculture. The debate about appropriate models for modern FAS is affected by the existence of few empirical studies.

2. MATERIALS AND METHODS

Different Measure 2 – sub-measure 2.1 models are analyzed through a qualitative approach, using a conceptual framework adapted by Birner *et al.* (2009). The conceptual framework for the design and analysis of agricultural advisory services considers five different dimensions: contextual factors, the agricultural advisory services characteristics, services performance, services impact and the central role of the clients (Birner *et al*., 2009). In particular, the study focuses on agricultural advisory services characteristics. Indeed, due to the initial stage of implementation of the measures in the different regions, the impact of the FAS and the role of clients are not yet detectable. Moreover the contextual factors are not analyzed in this study because it focuses exclusively on the implementation of the European policy for the development of regional agricultural advisory services. To analyze agricultural advisory services characteristics, four different aspects have been considered: governance structure, capacity, management and advisory methods.

The governance structures variables focus on financing model of agricultural advisory services. The structure could be financed by public sector, by private sector or by farmer-based organizations. The capacity variables are related to human capital characteristics (number of advisors, skills, experience). The management variables focus on management style and on procedures for monitoring and evaluating advisory activities. The advisory methods focus on methods that are used by the field staff of agricultural advisory services in their interaction with farmers (Birner *et al*., 2009).

After description of the policy models based on the available public documents, the regional approaches are compared using the described aspects. Our empirical research is divided into two parts. The first is devoted

to describing the three intervention models proposed by the Regional Authorities of Campania, Veneto and Emilia-Romagna. In the second part of the study, data, available in funding applications, related to farm requirements, advisors characteristics and budget and expenditure progress will be analyzed. In Campania, Veneto and Emilia-Romagna, as Measures 2 sub-measures 2.1 are in an early stage of implementation, data are scant. However, the available information provides insights for interesting reflections.

3. REGIONAL POLICY MODEL

3.1. Emilia-Romagna Region

The Regional Authority of Emilia-Romagna has implemented Measure 2 – sub-measure 2.1 model based on three main needs: Focus area 01[1] - Fostering innovation, cooperation and the development of the knowledge base in rural areas, Focus area 02 - Strengthening the links between agriculture, food production and forestry and research and innovation, Focus area 03 - Fostering lifelong learning and vocational training in the agricultural and forestry sectors. The governance structure is based on public calls for financing Measure 2 interventions. Regarding to capacity features, beneficiaries of public calls are consultants with documented experience in the field covered by the call for tenders. For consultants and their advisory bodies to apply, the Regional Authority requires approval. The selection of proposals is based on three criteria: 1) compliance with the needs and objectives of the Focus areas set in the calls, 2) requested budget, 3) feasibility of the objectives. On the part of the target group, farmers' age and intervention areas falling within zone C (intermediate rural areas), zone D (areas with development problems), within parks and nature reserves and within vulnerable zones identified under the Nitrates Directive are higher valued evaluated characteristics. The advisory methods have to match with thirteen advisory topics proposed by the Emilia-Romagna region (Tab. 1).

The Emilia-Romagna model is structured into two steps and is based on a list of consulting projects approved by the Regional Authority. Farmers can make their choices among the various possibilities included in the catalogue. The two phases are:

Tab. 1. List of advisory activities in the Emilia-Romagna Region.

Topics
Precision farming and HW and SW applications of precision agriculture
Antibiotic resistance control techniques
Biosecurity and animal welfare
Biodiversity and defence of crops from invasive wildlife
Conservative agriculture and reduction of footprint
Water waste and livestock effluent treatment techniques
Organic agriculture
Methods to reduce nitrates in aquifers
Low-impact defence for control of adversity in agriculture
Adaptation to climate change due to changes in water regimes
Qualitative optimization of water resources
Innovative technologies for irrigation and water saving
Techniques for reducing GHG and ammonia emissions in farms

Source: own elaboration.

1 to evaluate and publish a consultancy project on the «green catalogue» and contextual recognition / accreditation of an advisory body;
2 to identify the farmer concerned and to set the level of economic support.

The two phases can be implemented over different time spans, even weeks or months, rarely one or two years. The main peculiarity of the Emilia-Romagna governance model, which differentiates from all other regions in Italy and almost all European regions, is that a substantial part of the extension service is paid for by farmers. The latter pay 40% of the consultancy costs, plus 22% VAT and 4% for consultants' social security fund, while the Regional Authority only reimburses 60% of the cost. In practice, this funding structure leads to an almost equal split between public and private. The funds can be booked upon application and the funds granted follow a monthly ranking. To guarantee continuous availability until 2020, the total dedicated amount (€ 3 million) was divided into nine parts, each activated every four months. To date, six of the 36 rankings scheduled have already been concluded. The monitoring of advisory services is done through the reporting documents. The intervention model doesn't focus on specific advisory methods.

3.2 Veneto Region

The governance structure is based on beneficiaries of Measure 2 sub-measure 2.1 that are public or private advisory bodies or advisory networks (as described by a special regulation on network aggregation forms) with

[1] Focus area: European priorities for Rural Development are broken down into specific areas of intervention, known as Focus Areas (FAs). The RDP sets out quantified targets against selected FAs outlining the Measures and their allocated funding that will be used to reach these targets.

documented experience in the field included in the calls and with requirements as provided for by the Ministerial Decree of 3 February 2016 concerning «Establishment of the farm advisory system in agriculture».

Advisory services consist of a set of interventions carried out by advisory bodies to support farms for technological / managerial / market changes necessary to improve their competitiveness and achieve sustainable use of production factors. Therefore, services aim to increase the economic and environmental performance of farms.

To improve advisors' specific skills and to better specify capacity peculiarities, each tender has specific requirements to identify beneficiaries.

The selection of proposals is based on a set of criteria, regarding capacity, advisory methods and management futures, that can be summarized in the following six below: 1) suitable skills to conduct consulting activities, 2) characteristics of advisory approach and project, 3) compliance with the needs and objectives of the focus areas set in the calls, 4) compliance with the horizontal objectives, 5) targeting of farmers, 6) coherence with needs of intervention area. Public calls are published for Measure 2 – sub-measure 2.1 interventions. The financial support provided by the Veneto Regional Authority amounts to 100% of the intervention. There are 18 advisory topics proposed by the regional authority (Tab. 2).

The quantity of advisory activities is estimated using standard costs. For each advisory service, the related protocols were prepared. This guide briefly describes the aims and objectives, the specific technical aspects for the service implementation, especially the minimum number of visits to farms, the intermediate and final outputs and the cost. With regard to the latter aspect, for each protocol a specific analysis was carried out to identify the number of specific working hours (Consultant Work Hours - CWH) demanded from the consultant generally required to perform such services. The unit cost of the advisory service was determined by multiplying the CWHs by the standard cost (42 euros / hour).

Agricultural advisory activities are divided into two types:

- basic consultancy;
- specialized consultancy.

3.3 Campania Region

Beneficiaries of Measure 2 - sub-measure 2.1 are advisory bodies with requirements envisaged by the Ministerial Decree of 3 February 2016 concerning «Establishment of the farm advisory system in agriculture». Members of advisory bodies have to:

Tab. 2. Lists for advisory activities in the Veneto Region.

Advisory activities	Hours of work	Unit cost for advisory activities (euro)
Optimization of production factors, overcoming critical points, developing opportunities, also through the use of RDP measures	15	630
Advice on safety in the company to improve the organization and working conditions	12	504
Credit access opportunities.	25	1,050
Starting farm activities	25	1,050
Introduction of innovative, medicinal or non-food crops into the company	25	1,050
Consulting aimed at launching direct sales.	25	1,050
Advice aimed at preparing a marketing and communication plan	20	840
Consulting for management digitalization	20	840
Consultancy aimed at mapping and managing risks for the agricultural company	15	630
Animal welfare-oriented advice (dairy cattle)	35	1,470
Animal welfare-oriented advice (beef cattle)	25	1,050
Advice on conditionality (vegetable)	12	504
Advice on conditionality (animal)	12	504
Sustainable management of specialized crops: viticulture	30	1,260
Sustainable management of specialized crops: fruit growing	30	1,260
Sustainable management of specialized crops: horticulture	30	1,260
Sustainable management of specialized crops: floriculture and nursery	30	1,260
Advice on conversion to organic agricolture	30	1,260

Source: own elaboration.

Tab. 3. Lists for advisory activities in the Campania Region.

Topics	Advisory activities
Innovative agricultural production	1 - 45 - 61 - 64
Biomarketing	2
Organic Farming	3 - 4 -5 - 6 - 7 - 8
Biodiversity	9
Landscape	10
Agriculture, Forestry and Pasture Activities harmonisation	11
Improvements in Energy Efficiency and Biogas	12 - 55
Organic Fraction Management from either Livestock and Oil Mill Wastes	13 - 24 - 60
Improving Economic Performance and Productivity of Livestock Farms and Dairies & Farm Buildings Upgrade	14 - 15 - 17 - 18
Actions to safeguard the integrity of livestock and to combat zoonoses	16
Processing of livestock products - food safety	19 - 21
Development of associative and cooperative forms	20 - 27 - 69
Animal welfare and animal welfare voluntary certification systems	22 - 23
IT and digital technologies	25 - 43 - 56 - 73
Workplace health and safety in Agricultural/Forestry Enterprises	26 - 48
Estimate and evaluation of damages	29 - 57 - 58
Damage prevention	30 - 31 - 59
Sustainable forest management and activities related to mushrooms and truffles	32 - 38 - 39 - 41
Collection and management of forest reproductive material	33 - 40
Prevention of natural disasters (fires and hydrogeological instability)	34 - 35 - 36 - 37
Management control and development of the agricultural enterprise	44 - 46 - 47
Developing a business plan in order to get access to credit	49
Income integration and multi-functionality	50 - 51 - 52
Introduction of investing activities and their ex ante evaluation in farm gate sales	53 - 54
Plant products processing - food safety	62
Phytopathological crises	63
Viticulture	65 - 66
Olive cultivation	67 - 68
Irrigation and fertigation	70
Product quality certification systems	28 - 42 - 74 - 75 - 76 - 77
Fodder production farming and pasture management	71 - 72

Source: own elaboration.

- be registered in professional associations and boards for the respective advisory areas;
- be qualified for listing in professional associations or colleges;
- have at least three years' work experience as consultants in the field of technical assistance or consultancy or in the areas for which the consultant intends to provide the service.

Governance structure of Measure 2 is based on tenders with multiple lots, published for financing interventions. Each tender includes different advisory services to fund. The aims of this approach are to divide the possible advisor services in order to increase attraction for small-and-medium-sized advisory bodies and reduce the number of bureaucratic procedures.

To improve management of advisory services, Regional Authority has implemented an inventory of advisory activities, comprising a set of activities analytically described and also provides advisory bodies with useful information to draw up the project (amount, focus area etc).

To identify the best methodology for applying Measure 2, a «Regional Catalogue of Advisory Activities» (77 activities) was discussed by the Committee of Professions and Professional Associations/Colleges (Tab. 3). To better define farmers' needs, advisory methods, connections among different actors to facilitate innovation diffusion and to establish priorities for FAS, the Regional Authority set up the Orientation Committee of the Agriculture Advisory System (D.G.R. n. 112 - 07.03.2017).

The Committee approved on 6 September 2017:
- Regional catalogue of Advisory Activities;
- Context Analysis – to identify object and territorial distribution of the possible services.

Regarding capacity, highly qualified technical staff is awarded with reference developed in the areas of the contract. Furthermore, on the part of the target group, farmers and rural entrepreneurs involved in agritourism, traditional catering, hotel reception, rural tourism, tourist services (guiding, organization of incoming tourism, management of sites of interest, museums, etc.), crafts (woodworking; stone working; artistic and traditional ceramics and terracotta, etc.) could be recipients of advisory services. Each farm could receive advisory services for an amount of 1,500 euros per year. To date, three tender procedures have been activated with a total amount of € 9,600,000.

4. RESULTS

Following the dimensions included in the adapted conceptual framework (Birner *et al.*, 2009), it is possible to summarize main results of analysis. Regarding to governance structure, Veneto, Emilia-Romagna and Campania have implemented, using Measure 2 of their Rural Development Programme, contracting out financed by public sector to develop advisory services. The results show three different intervention models to implement sub-measure 2.1. Emilia-Romagna, Veneto and Campania have the same objective: to foster extension services for different and more modern farm sizes. As the public procedure to activate intervention, Emilia-Romagna and Veneto have chosen calls, while Campania has chosen tender.

The capacity variables are strategic in all regional interventions. Skills, experience, training of advisors are well defined. Member States are obliged to provide a Farm Advisory System for all farmers but they cannot use Measure 2 to implement this. Public documents seem to show that Campania is currently implementing this strategy. Indeed, advisory bodies that present proposals for M2 funds have to demonstrate requirements as envisaged by the Ministerial Decree of 3 February 2016 concerning «Establishment of the farm advisory system in agriculture». However, it is important to point out that in Campania, Veneto and Emilia-Romagna, Measure 2 sub-measure 2.1 is intended to support activities that go beyond the obligatory provision of advice under the farm advisory system.

Related to amount of economic effort made for advisory services, the support rate for measure interventions ranges from 50% (Emilia-Romagna) to 100% (Campania and Veneto). The amount of economic effort made for advisory services represents a strategic variable of capacity dimension.

The management variables fit to the objectives of Measure 2 at different levels. The advisory services funded by Rural Development Programme, are indirectly demand-driven because regional authority defines farmers' needs and sometimes advisory methods in the calls to finance Measure 2 sub-measure. This peculiarity requires new ability to facilitate the interaction between multiple stakeholders and the use of adaptive planning methods (Birner *et al.*, 2009).

Finally, in the regional models the advisory methods are not described and innovative advisory methodologies are not encouraged. Farmers' needs are often recalled and translated into types of services to be provided, but the lack of more effective methodologies for detection of needs is a crucial aspect because the intervention design in all regions focuses on providing tailored extension services for specific problems. The challenge is to match farmers' demands and needs.

Regional lists for advisory activities are rich and focus on traditional and innovative farmers' needs. The catalogue produced by Emilia-Romagna contains 13 topics (Tab. 4). To date, 628 farms have been involved. The preferred topics concern nitrate reduction and integrated pest management; followed by animal welfare and

Tab. 4. Lists for advisory activities and involved farms related to calls until May 2019 in the Emilia-Romagna Region.

Topics	Farms (n.)
Precision farming and HW and SW applications of precision agriculture	15
Antibiotic resistance control techniques	23
Biosecurity and animal welfare	77
Biodiversity and defence of crops from invasive wildlife	37
Conservative agriculture and reduction of footprint	1
Water waste and livestock effluent treatment techniques	46
Biological agriculture	65
Methods to reduce nitrates in aquifers	147
Low-impact defence for control of adversity in agriculture	127
Adaptation to climate change due to changes in water regimes	1
Qualitative optimization of water resources	8
Innovative technologies for irrigation and water saving	24
Techniques for reducing GHG and ammonia emissions in farms	57
Total	628

Source: own elaboration.

organic agriculture by number of farms. More modern topics such as precision farming, carbon footprint reduction, adaptation to climate change and optimization of water resources fail to go beyond 30 farms involved. To date, 19 advisory bodies have been involved, comprising 76 consultants. All consultants belonged to the professional area of agronomists and veterinarians.

From the analysis of the projects approved it emerges that the average cost of an advisory service consultancy is 1,036 euros, ranging from a minimum of 380 and a maximum of 1,480 euros. It should be noted that the average cost of the services evaluated qualitatively as «very high» was 998 euros, hence a little more contained than the average of all the proposals.

The catalogue produced by the Veneto Regional Authority contains 18 topics (Tab. 5). To date, 7,851 farms have been involved. The most popular areas are related to cross compliance and improvements in work organization. Sustainable viticulture and input optimization follow the first two topics, with about 500 farms involved. More modern areas consist in innovative production, marketing, risk management and sustainable horticulture, without exceeding 50/60 farms per area. Importantly, no farm chose the topic related to digitalization. To date, 259 consultants have been involved, including 202 agronomists and veterinarians.

The catalogue produced by Campania contains 31 topics from 77 activities in the Regional catalogue (Tab. 6). To date, 8,059 farms have been involved. The most popular topics are related to assessment and development of a short supply chain, management control, water management and sustainable bioenergy, fertigation strategy, biogas production, diversification and multifunctionality. These are followed by food and job safety. Areas like marketing or activities related to forests and biodiversity conservation do not exceed 100 farms involved. To date, 67 advisory bodies have been involved, consisting of 386 consultants; 45% of consultants are agronomists or veterinarians, the rest from other disciplines (architecture, engineering, law, business consultancy etc.).

Tab. 5. Lists for advisory activities and involved farms related to calls until May 2019 in the Veneto Region.

Topics	Farms (n.)
Management consulting aimed at achieving economic optimization of production factors, at overcoming critical points, at developing opportunities, also through the use of RDP measures	544
Advice on safety to improve organization and working conditions	1472
Advice on credit access opportunities.	384
Starting farm activities	100
Introduction of innovative, medicinal or non-food crops	24
Direct sales	161
Marketing and communication plan	56
Management digitalization	0
Mapping and managing risks for the agricultural company	48
Animal welfare-oriented advice (dairy cattle)	474
Animal welfare-oriented advice (beef cattle)	249
Advice on conditionality (vegetable)	3166
Advice on conditionality (animal)	332
Sustainable management of specialized crops: viticulture	191
Sustainable management of specialized crops: fruit growing	551
Sustainable management of specialized crops: horticulture	62
Sustainable management of specialized crops: floriculture and nursery	35
Conversion to organic agriculture	2
Total	7851

Source: own elaboration.

5. CONCLUSIONS

The role of agricultural advisory services is changing thanks to innovation adoption and the current European Agricultural Policy approach. Regional authorities are advancing financial and managerial reforms to improve new policy design. Given the need for modernization of the rural and agricultural sector, the present emphasis on participation of stakeholders in programmes and community demand-driven projects seems correct.

The aim of Measure 2 sub-measure 2.1 - Aid for obtaining advisory services - is well specified in the regional models. Fostering advisory services for different and more modern farm with public intervention is a complex process involving many stakeholders with different needs and behaviours. Advisory services should represent the link between these different subjects. In particular, advisors should connect the agricultural and research sectors. Modern advisory services have to identify farmers' needs and have to translate them into tailor-made innovations. To implement this process an innovative approach has to be followed to create a governance structure and local networks among different participants.

In Campania, Veneto and Emilia-Romagna, since Measures 2 sub-measures 2.1 are in an early stage of implementation there are few data. However, the available information provides insights for interesting reflection. The first concerns the modern monitoring mecha-

Tab. 6. Lists for advisory activities and involved farms related to calls until May 2019 in the Campania Region.

Topics	Farms (n.)
Innovative agricultural production	282
Biomarketing	61
Organic Farming	292
Biodiversity	157
Landscape	139
Agriculture, Forestry and Pasture Activities harmonisation	11
Improvements in Energy Efficiency and Biogas	484
Organic Fraction Management from either Livestock and Oil Mill Wastes	302
Improving Economic Performance and Productivity of Livestock Farms and Dairies & Farm Buildings Upgrade	363
Actions to safeguard the integrity of livestock and to combat zoonoses	10
Processing of livestock products - food safety	216
Development of associative and cooperative forms	217
Animal welfare and animal welfare voluntary certification systems	109
IT and digital technologies	255
Workplace health and safety in Agricultural/Forestry Enterprises	444
Estimate and evaluation of damages	157
Damage prevention	483
Sustainable forest management and activities related to mushrooms and truffles	151
Collection and management of forest reproductive material	0
Prevention of natural disasters (fires and hydrogeological instability)	53
Management control and development of the agricultural enterprise	613
Developing a business plan in order to get access to credit	171
Income integration and multi-functionality	427
Introduction of investing activities and their ex ante evaluation in farm gate sales	684
Plant products processing - food safety	406
Phytopathological crises	177
Viticulture	24
Olive cultivation	222
Irrigation and fertigation	679
Product quality certification systems	224
Fodder production farming and pasture management	246
Total	8059

Source: own elaboration.

nism that is able to capture and follow major changes and the policy output. This programming period represents the first attempt at a new scheme, implemented by regional authorities, to collect and analyze digitized proposals and characteristics of those involved. The second is represented by target groups of Measure 2. According to current data, the number of farmers involved in extension activities is not large. This applies especially to the most innovative issues (digital innovation, robotics, precision farming, international marketing) and to more complex or not very immediate environmental issues (biodiversity, water management, forestry). This weakness could be mitigated by more efficient communication strategies targeting farmers and by an innovative role and greater interaction among different Measures. In particular, Measure 1 dedicated to knowledge transfer, Measure 2 for advisory services to support businesses and Measure 16 that foresee the creation of partnerships among more than one actor could act together. In all cases, training and advice supported by Measure 1 and Measure 2 should target the needs of rural businesses and Measure 16 should facilitate a new approach to cooperation by farmers, advisors and researchers.

The last insight concerns the characteristics of consultants. Advisory services have to respond more effectively to the needs of farmers and other rural actors. Modern consultants need to be able to give holistic solutions to specific problems experienced by farmers. Extension officers need to be retrained in order to integrate a broad spectrum of specific issues with a view to giving farm-tailored advice. Farmers' needs are often highlighted in the Measure 2 but the lack of more effective methodologies for detection of needs remains a crucial aspect. The challenge to match farmers' demands and needs is not yet won.

This article has applied a conceptual framework (Birner *et al.*, 2009) that could represent a guide to analyse different implemented models of advisory services. The aim of the analysis is to reduce the failure of advisory services linked to the lack of connection with the real farmers' needs. The profound changes in future CAP 2021-2027 for farms advisor services (FAS) require new developments in this research area.

REFERENCES

Bartoli L., De Rosa M., La Rocca G. (2014). *Which Organizational Models Stimulate Higher Access To Agricultural Extension Services? Empirical Evidence From Italy,* 171: 2016-2088.

Benvenuti B. (2000). "Assistenza tecnica e divulgazione agricola tra tradizione e rinnovamento", in Caldarini C., Satta M. (Eds.): *Formazione e divulgazione*, Rome, Inea.

Birner R., Davis K., Pender J., Nkonya E., Anandajayasekeram P., Ekboir J., Cohen M. (2009). From best practice to best fit: a framework for designing

and analyzing pluralistic agricultural advisory services worldwide. *Journal of agricultural education and extension*, 15(4): 341-355.

Commissione Europea (2010a). "Europa 2020. Una strategia per una crescita intelligente, sostenibile e inclusiva" (COM(2010) 2020).

Commissione Europea (2011c). "Common Agricultural Policy towards 2020, Impact assessment, annex 7, Research and Innovation", SEC 1153/2011 final/2, 20.10.2011.

Commissione Europea (2018). Regolamento del Parlamento Europeo e del Consiglio sul finanziamento, sulla gestione e sul monitoraggio della politica agricola comune e che abroga il reg. (UE) 1306/2013, COM 393/2018 final, 1.6.2018.

Commissione Europea (2011a). DG AGRI "Common agricultural policy towards 2020. Impact assessment".

Commissione Europea (2011b). "Proposta di Regolamento del Parlamento europeo che istituisce il programma quadro di ricerca e innovazione (2014-2020) Orizzonte 2020)" COM 809/2011, 30.11.2011.

Cristiano S. (2012). Politica di sviluppo rurale e sistema della conoscenza e dell'innovazione in agricoltura. *Agriregionieuropa*, 8.

Cristiano S., Proietti P., Striano M. (2015). Il ruolo dei servizi di consulenza nei processi di innovazione. *Agriregionieuropa*, 11.

De Rosa M. (2014). *Il riposizionamento funzionale dell'agricoltura e il rinnovato ruolo dei servizi di sviluppo agricolo*. FrancoAngeli.

Eastwood C., Klerkx L., Nettle R. (2017). Dynamics and distribution of public and private research and extension roles for technological innovation and diffusion: Case studies of the implementation and adaptation of precision farming technologies. *Journal of Rural Studies*, 49: 1-12.

EIP-AGRI (2014). The European innovation partnership "agricultural productivity and sustainability" or EIP-AGRI and the service point. In: Proceedings: Workshop Establishing Operational Groups under Rural Development Programmes.

EU SCAR (2012). Agricultural knowledge and innovation systems in transition – a reflection paper, Brussels.

EU SCAR (2013). Agricultural knowledge and innovation systems towards 2020 – an orientation paper on linking innovation and research, Brussels.

European Commission (EC) (2012). Agricultural knowledge and innovation systems in transition – a reflection paper. Discussion Paper EUSCAR, Brussels. Available at: http://ec.europa.eu/research/bioeconomy/pdf/ki3211999enc_002.pdf (accessed October 2014).

Hermans F., Klerkx L., Roep D. (2015). Structural conditions for collaboration and learning in innovation networks: using an innovation system performance lens to analyse Agricultural Knowledge Systems. *The Journal of Agricultural Education and Extension*, 21(1): 35-54.

Klerkx L., Schut M., Leeuwis C., Kilelu C. (2012a). Advances in knowledge brokering in the agricultural sector: towards innovation system facilitation. *ids Bulletin*, 43(5): 53-60.

Klerkx L., Van Mierlo B., Leeuwis C. (2012b). Evolution of systems approaches to agricultural innovation: concepts, analysis and interventions. In *Farming Systems Research into the 21st century: The new dynamic:* 457-483. Springer, Dordrecht.

Knierim A., Labarthe P., Laurent C., Prager K., Kania J., Madureira L., Ndah T.H. (2017). Pluralism of agricultural advisory service providers–Facts and insights from Europe. *Journal of rural studies*, 55: 45-58.

Koutsouris A. (2012). Facilitating Agricultural Innovation Systems: a critical realist approach. *Studies in Agricultural Economics*, 114(1316-2016-102761): 64-70.

Moschitz H., Roep D., Brunori G., Tisenkopfs T. (2015). Learning and innovation networks for sustainable agriculture: processes of co-evolution, joint reflection and facilitation: 1-11.

Regione Campania (2019). Conferenza Agricola Regionale – ascolto del territorio e primi risultati dei tavoli tematici.

Regione Campania, Programma di Sviluppo Rurale 2014-2020 versione 6.1 versione adottata dalla CE con decisione del 12.09.2018.

Regione Emilia-Romagna, Programma di Sviluppo Rurale 2014-2020, versione 8.2 approvata con Decisione della Commissione Europea C 8506/2018 final del 5 dicembre 2018, successivamente acquisita con delibera di giunta regionale n. 2138 of 10 December 2018.

Regione Veneto, Programma di Sviluppo Rurale 2014-2020, versione 7.1 approvata con DGR 1458/2018.

Storti D., Zumpano C., Mantino F., Murano R., Cesaro L., Monteleone A., Ascione E. (2010). Le politiche comunitarie per lo sviluppo rurale. Rapporto 2008/2009: Il quadro degli interventi in Italia.

Touzard J.M., Temple L., Faure G., Triomphe B. (2015). Innovation systems and knowledge communities in the agriculture and agrifood sector: a literature review. *Journal of Innovation Economics & Management*, (2): 117-142.

Vagnozzi A. (2008). "Stato di attuazione del sistema di consulenza: approccio delle regioni e prime analisi dai PSR", in Atti del Seminario PSR e consulenza in agricoltura, Portici (Naples), 16 April 2008.

Van Oost I. (2013). Innovation Support Services. Presentazione tenuta in occasione del seminario "Programming Innovation in Rural Development – Linking Science and Practice", Berlin, 25-26 November 2013.

Van Oost I. (2018). Building the innovation ecosystem for the future. Presentazione tenuta in occasione del seminario "EIP-AGRI: dal progetto del gruppo operativo all'impatto", Spoleto, 17-18 October 2018.

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.

€ 26,00