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Bio-districts and the territory: evidence from a regression approach

In recent years the bio-districts have been considerably spread in Italy. The bio-district can be defined as a locally rooted multifunctional project with the involvement of farms and institutions. Our research aims at assessing potential relations between territorial, socio-economic features and the presence of bio-districts in an area, by means of a logit regression analysis at municipal scale in Italy. Data have been collected from several sources, among which ISTAT digital databases. Main results show as farms with diversification activities and the presence of Local Action Groups are factors related to the rising of bio-districts in a territory. Moreover, the study highlights the role of bio-districts in disadvantageous and mountain areas, in developing effective territorial governance. In terms of policy implication, CAP 2023-2027 can constitute the ideal bench for testing bio-districts function playing a crucial role in reaching the objective set by the Farm to Fork strategy.

1. Introduction

1.1 Background and research purposes

In recent years the bio-districts have been considerably spread in Italy. Today there are at least 51 Italian bio-districts (Dara Guccione and Sturla, 2021) between established and in the process of being established, characterized by a different level of operations. The bio-district can be defined as a locally rooted multifunctional project (Fanfani et al., 2018) with the involvement of farms and institutions (Municipalities, Regions, Associations). Each institution should be the promoter of initiatives, discussions, elaborations that will lead to measures, to incorporate and coordinate activities meeting the needs of the territory (Sturla, 2018). The objectives are the development of local organic agriculture, the shortening of supply chains, food education and continuous training for operators. Moreover, the scope is to generate income through local products, to help slow down the progressive depopulation phenomena (Mazzocchi et al., 2021) and produce evident benefits in social and economic terms, focusing attention on the profitability and organization of the supply chain (Arru et al., 2019; Sturla, 2018).

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The bio-districts have their roots in the concept of industrial districts (Becattini, 1989). After the intuition of Marshall (1842-1924), according to which the economies of scale of large companies can be replaced by the external economies of the districts in which collaborate small businesses (Giuca et al., 2017), Becattini defines the industrial district "as a socio-territorial entity characterized by the active coexistence, in a limited territorial area, of a community and several industrial companies" (Becattini, 1989). Similarly, the peculiarity of agri-food Italian landscapes, consisting of territories with a strong productive specialization and characterized by high concentration of small farms, makes necessary the vertical integration in a system including the transformation, the marketing of products and business management, just like in industrial districts (Sturla, 2020).

Italian legislative decree 228/2001 "Orientation and modernization of the agricultural sector", in article 13, regulates Rural districts and Quality agri-food districts, applying for the first time the concept of "district" to the Italian agricultural system. Therefore, bio-districts could have an advantage compared to the other agricultural districts to foster local development (Carrosio, 2013). According to some scholars (Thomaidis and Papathanasiou-Zuhrt, 2018) local development should be based on the endogenous potential of the territory with an eye to the global system. This neo-endogenous approach, basically consisting in social innovation processes, can be supported by organic agriculture, seen as a complex system of cultural and social values. The contribution of organic agriculture to local development is twofold: organic farming activates the neo-endogenous potential of a territory, involving on the one hand the territorial system in terms of communication of agricultural sustainability, education to respect the environment, environmental protection. Moreover, organic farming works as a catalyst for participation in a territory, as it promotes not only knowledge and skills, but also values (Ruggeri et al., 2020). On the other hand, it includes global aspects, addressing the growing consumer demand for organic farming products. Finally, according to EU, the transition of the European agri-food sector towards a sustainable production and consumption model is a key element of the Green Deal which will be reached by several agricultural approaches, such as precision agriculture, agroecology, agro-forestry, stricter animal welfare standards and organic farming.

Nevertheless, the bio-districts in Italy are a diversified reality, not based on a single model, other than the organic farming values (Sturla, 2020). Italian bio-districts are born for different purposes, have different agricultural characteristics and involve territories that are very diversified one from each other. Our conjecture is that there are common traits that distinguish the bio-districts and some characteristics of the territory which can contribute to the rising and maintenance of this typology of territorial governance. More in detail, we hypothesize the existence of external and internal factors to the agricultural sector related to the presence of bio-districts in a territory. Anyway, at our knowledge, there is a lack of studies focused on bio-districts to analyse the relationship between territorial characteristics and presence of districts. Thus, our research aims at assessing potential relations between territorial, socio-economic features and the presence of bio-districts in an area, by means of a logit regression analysis at a municipal scale

in Italy. The paper is organized as follows. Section 1 details the literature review on bio-districts (1.2) and the regulation aspects (1.3). Section 2 presents methodology and data. The results are shown and discussed in section 3. Section 4 draws conclusions.

1.2 Literature on bio-districts

Following the increase of bio-districts and similar forms of multilevel governance also in Europe, literature on the subject is being developed. However, to date there are still few studies on the subject. The topics dealt with focus mainly on narration or the comparison of case studies (Belliggiano et al., 2019; Favilli et al., 2020; Pugliese et al., 2015; Stotten et al., 2017) on the definition and identification of tools to classify bio-districts and eco-regions (Franco and Pacino, 2015; Pugliese et al., 2016; Zanasi et al., 2020), on the construction of social networks that characterize the bio-districts (Dias et al., 2021), on the implementation of the bio-district tool using the agroecological (Dara Guccione and Sturla, 2021; Gargano et al., 2021; Guareschi et al., 2020) and the circular economy approach (Poponi et al., 2021).

Governance and structure of the first bio-district in Cilento have been analysed by Clemente et al. (2013), eliciting the phases of the organizational and social network building, to define some guidelines for other experiences. Other studies (Belliggiano et al., 2019) have focused on the comparison between bio-districts (Val Camonica, Varese Ligure) highlighting the differences in the agricultural area and landscape characterising the territorial context, by using multivariate analysis. More in detail, Belliggiano et al. (2019) give a distinct partition of the regional territories where the bio-districts are born, selecting the municipalities with affinity to them, for encouraging the replication of bio-districts including them in planning strategies for the future. Awareness of the differences among the Italian bio-districts and the eco-regions in Europe has led Zanasi et al. (2020) to develop an analytical framework in order to find a suitable classification tool to "reorder" these multi-actor governance structures.

In the light of the agroecology concept, some authors have tried to find similarities between Italian multifunctional farms characteristics with agroecological principles, confirming some common points between these two approaches (Gargano et al., 2021), in a bio-district territory. Similarly, Guareschi et al. (2020) investigate if bio-district can contribute to scale-up towards agroecological agriculture in the context of Parma bio-district, finding that it facilitates a relationship between organic and agroecological agriculture, diffusing organic agriculture although some weaknesses of bio-district tool remain, among which the difficulty of governing a territory and participatory processes with many stakeholders. Finally, contributions such as that of Poponi et al. (2021), enrich the panorama of literature by analysing the existing contributions through the interpretative key of the circular economy by taking as a case study the Etruscan Roman Bio-District.

1.3 Italian regulations on bio-districts

An explicit and formal recognition of agricultural districts is given by Legislative Decree 228/2001 (Idda et al., 2002). Legislative Decree 228/2001 "Orientation and modernization of the agricultural sector", in article 13 "Rural districts and quality agri-food districts" defines rural districts and quality agri-food districts. Some researchers (Albisinni, 2010) argue that this decree shows important omissions (e.g., agro-industrial districts (Careri and Saija, 2008)), because it does not consider the great diversity of the agri-food sector, the heterogeneity of supply chains and the different ways of relating to the territory, environment, and local economic system (Sturla, 2019).

The "stability law" n.205, in 2017, tries to fix these omissions. This law establishes the criteria, methods, and procedures for the implementation of interventions and, in art.1 paragraph 499, creates the food districts. Food districts were made for four reasons: firstly, to provide opportunities and resources for the growth and enhancement of both supply chains and territories; secondly, to give impetus to existing districts; thirdly, to encourage the birth of new realities through the possibility of access to dedicated funding; lastly, to highlight the role of the local community and the relationships that can weave with agri-food chains (Fanfani et al., 2018). This law has a fundamental role in the regulatory history because, for the first time (Sturla, 2019), the definition of bio-districts and biological districts is given in article 2 paragraph 449. Until then, bio-districts had organized themselves independently, taking on multiple nuances in the definition and other key aspects: identification, characteristics of agriculture, attention given to the link with the territory, actors involved (Pugliese, 2016).

In advance of national legislation, some individual regions and provinces have made explicit reference to bio-districts, adopting norms that define parametric criteria for their identification, although very different from each other. These regulations have remained in force as established by the above-mentioned law. Currently, four regions and one autonomous province have specific legislation for bio-districts: Liguria (L.R. 66/2009); Sardinia (L.R. 16/2014); Lazio (L.R. 11/2019); Tuscany (L.R. 51/2019), and Independent Province of Trento (L.P. 16/2021). Lazio and Tuscany have a specific law, while in other regions the definition is put within broader laws on organic agriculture (Liguria and Trento) or agriculture in general (Sardinia) (Viganò, 2019). The districts recognized by regional laws respond to stringent parametric criteria. This is because the administrations tend to have a "classic" (or economic) conception of the biological district, in which the presence of productive requirements is the basis for future development actions (Dara Guccione and Sturla, 2021).

The Regional Law 66/2009 of the Liguria Region, the strictest among those issued (Dara Guccione and Sturla, 2021), provides that an organic district to be recognized has the following requirements: at least 13% of the regional organic operators must be present in the area; producers must represent at least 75% of the total number of organic operators; the percentage incidence of organic farms on total farms must be higher than the national and regional incidence of at least 4%; the

percentage incidence of the organic UAA on the total UAA of the area must be at least 6% higher than the national and regional. Moreover, the district must insist on a total area of at least 250 km^2. The Tuscan law also requires that at least 30% of the UAA of the area is cultivated with organic methods and a minimum number of operators and municipalities adhering. Including in the development plan a forecast of the increase of organic UAA is one of the priority criteria for the recognition of bio-districts. Other regional laws are less demanding. The L.R. 11/2019 of the Lazio Region simply establishes a minimum number of partners adhering to the District Agreement (2 farms and 2 municipalities) while the L.R. 16/2014 of the Sardinia Region emphasizes the need for a "presence on site of an economically relevant horizontal supply chain, built from organic production with activities closely interconnected activities concerning production sectors other than the primary one, aimed at the marketing and enhancement of organic production".

Recently, in Trentino, the legislation on organic production has been issued, with the provincial law July 28, 2021, n. 16. Regarding the criteria for the establishment of a bio-district, the law gives only general indications on the characteristics of the territory:

- the significant presence of agricultural products obtained by the organic method;
- the protection of typical local productions and cultivation methods;
- the presence of significant landscape areas, expression of the identity of the territory and/or provincial protected areas;
- the limited use of phytosanitary products.

At the national level, institutions are working to create a common discipline. On January 13th, 2021 the Senate Committee on Agriculture voted unanimously for the approval of the bill on organic farming: ddl n.988 "Provisions for the protection, development and competitiveness of agricultural production, agribusiness and aquaculture with organic method". Article 13 of this law contains specifications about the requirements of the bio-district, its constitution and the action of the subjects involved. It defines the bio-district as "local production systems, even of interprovincial or interregional character, with a strong agricultural vocation in which are significant:

- the cultivation, breeding, processing and food preparation of organic products in accordance with the regulations;
- organic primary production that is located in a supra-municipal territory".

They are also characterized by their environmental value. The law provides that within them there are "landscape relevant areas". Lastly, they are assigned specific purposes to support organic agriculture, both from the point of view of conversion and through the enhancement of local productions.

The experience of bio-districts is not limited to the national territory. Thanks to the initiative of IN.N.E.R. (International Network of Eco-Regions) a similar governance model is present in other European countries[1].

[1] There are currently four eco-regions in Portugal, two in Spain and two in Slovakia that adopt IN.N.E.R. guidelines (Dara Guccione and Sturla, 2021). IN.N.E.R. is an international network

However, the prototype organic district was born in France, in the Drôme river valley, as a joint initiative of four farmers' cooperatives that have initiated a collective program to develop local organic farming (Stotten et al., 2017). But it is in German-speaking Switzerland that the concept of the biological district as a body capable of initiating an integrated local development process, finds its greatest expression. In addition to these, there are over twenty eco-regions in Austria, although they vary greatly in many ways.

Because of the popularity of this approach, a new regulation on organic farming has been issued (Reg (EU) n. 848/2018), which will become operational as of 1st January 2022. It aims to revise and strengthen the EU rules on organic production and labelling of organic products. In addition, it introduces major innovations, such as group certification, which may facilitate the achievement of the objectives of organic districts and the activities of their operators.

2. Methodology

2.1 Conceptual framework

The study implements an econometric model based on a logit regression, using as a dependent variable the presence of bio-district in the municipalities, a dummy variable, testing socio-territorial and agricultural factors as explanatory variables. In the bio-district the promotion of organic products is combined with the promotion of the territory in order to achieve the development of its economic, social and cultural potential (Triantafyllidis et al., 2019). This can be carried on by involving the territorial actors, such as farmers, associations, institutions. According to Assiri et al. (2021) the presence in a territory of different elements and activities, both material and immaterial, allow the success of bio-districts, where biological and environmental characteristics are immersed in a peculiar economic and social context. Starting from this premise, explanatory variables have been selected, considering economic and social aspects of bio-districts, together with environmental and territorial factors to investigate how these elements are related to the rising of this typology of territorial governance in area. Among explanatory factors, variables related to agriculture features of an area are fundamental, being bio-districts tolls funded on the primary sector. At the same time, studies on industrial districts confirm the recognition of the role played by the territory in development processes and suggest the existence of new variables, not strictly technical, which influence the decisions of economic agents and condition the dynamics of the local socio-economic transformation (Romano, 2000). Thus, we include in the model socio-territorial parameters, since bio-districts start with the aim to develop organic agriculture in areas in which employment supporting measures can strongly help social development.

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of bio-districts which aims to allow an advantageous exchange of experiences between the existing district realities on the European territory, established in December 2014.

Starting from the framework proposed by Assiri et al. (2021), our model comprehends explanatory variables regarding economic, territorial, social aspects, that are grouped into three sets (Table 1): Control variables, Agricultural variables and Socio-territorial variables. Moreover, we included Italian regions as dummy variables, to test the characteristics of each region influencing the existence of bio-districts in municipalities.

The description of the variables is in Table 1. The Control group includes Population density and per capita income variables, which can be considered territorial/economic variables, useful to assess the stability of the model.

The Agricultural variables group includes parameters related to the agricultural characteristics of an area: the presence of organic farms, presence of small farms, farms producing PGI or PDO, direct selling in farms, farmers' age, utilized agricultural area (UAA). We take into consideration the presence of organic farms in the area where bio-districts have taken place. Organic farming is not only a way to produce sustainable food but is the bearer of a value system based on healthiness of productions, environmental care, living ecological system and fairness to the environment (Stotten et al., 2017), thus the presence of organic farms in an area, could foster territorial projects in which organic principles are foundations of the system, as the bio-districts are. Moreover, the territorial development of rural and agricultural areas in Italy could take advantage from organic productions, given the growing market success that organic products have had in the last twenty years, as confirmed by the data regarding the agricultural areas grown organically and the number of farms in constant increase (Sinab, 2021).

Small farms practicing livestock and crops cultivations at small scale can influence the arise of bio-districts, because they are often the target of this kind of regulation system (Sturla et al., 2020). In fact, these farms often opt for alternative solutions for selling their products and solving competitiveness problems (Corsi et al., 2020). According to Mazzocchi et al. (2020), in the past 40 years the Italian trend in farm number records a continuous decrease of small enterprises, those with less than 5 ha, thus they should be the most interested in searching for alternative supply chain system.

Farms producing PDO and PGI products, as well as direct selling farms, should be more sensitive to short supply chains than other typologies of enterprises, and interested to diversify their own activities (Mazzocchi et al., 2020; Monaco et al., 2016). Similarly, bio-districts represents a model to manage food supply chain involving the promotion of the territory, for example by the co-management process between farms and tourist offer in an area (Favilli et al., 2020). So, the existence of these typologies of productions and services in a territory could encourage the bio-districts spread.

Farmers' age is often impacting on farms innovation for the interest of young farmers generation to be involved in new projects having an open-mindedness approach (Mazzocchi et al., 2020). As an example, many studies (Meraner et al., 2015; Rivaroli et al., 2016,) have confirmed a relationship between the young farmers and the diversification degree of farms. Similarly, the young farmers are more prone to organic farming than the old ones because they are usually more inter-

Table 1. Description of variables.

Variable name	Group	Indicator (measure unit)	Source
Bio-district	Dependent variable	presence of bio-district in the municipality (dummy)	CREA, 2021
Population density	Control variable	number of municipality inhabitants/mq of municipality (in/mq)	ISTAT, 2019
Per capita income	Control variable	average income of a municipality (€)	MEF, 2019
Regions	Control variable	belonging of municipality to a Region (dummy)	ISTAT, 2010
UAA	Agricultural variable	utilized agricultural area in each municipality in 2010 (ha)	ISTAT, 2010
Small farms	Agricultural variable	farms in the municipality with less than 2 ha of UAA (number)	ISTAT, 2010
PDO-PGI	Agricultural variable	farms producing PGI or PDO in a municipality (number)	ISTAT, 2010
Farmer's age	Agricultural variable	average of famers' age of a municipality (years)	ISTAT, 2010
Direct selling in farms	Agricultural variable	direct sale farms in each municipality (number)	ISTAT, 2010
Organic farms	Agricultural variable	organic farms in each municipality (number)	ISTAT, 2010
Altitude	Socio-territorial variable	0 = plain municipalities; 1 = hills and mountain municipalities (dummy)	ISTAT, 2010
Non-profit associations	Socio-territorial variable	non-profit associations in a municipality (number)	ISTAT, 2018
LAG	Socio-territorial variable	presence of Local Agricultural Group (LAG) in a municipality (dummy)	CREA, 2021
Unemployment rate	Socio-territorial variable	number of unemployed / number of inhabitants per municipality (index)	ISTAT, 2019

ested to innovative agricultural practices. As a matter of fact, the UAA surface in a territory may influence the rising of bio-districts, because of the availability of agricultural areas in which bio-districts can take place.

Socio-territorial factors are: altitude of the municipality, unemployment rate of the municipality, presence of non-profit associations, presence of Local Action Groups (LAGs). Among the socio-territorial factors, the altitude of the municipality is a proxy of mountain disadvantageous areas (Mazzocchi and Sali, 2021) and can be related to the bio-district localization. Our hypothesis is that municipalities

located in mountain disadvantageous areas are more interested in being included in bio-districts projects. In fact, the idea is to combine nature protection with economic development, for which bio-district approach as a model of territorial governance could be winning (Stotten et al., 2017).

From a socio-economic point of view, rural areas are the most interested in finding new forms of territorial economic development, in places where agricultural space is generally available (Mazzocchi and Sali, 2021). The unemployment rate can influence the rising of bio-districts in disadvantageous areas, to ameliorate working conditions of populations. The presence of non-profit associations may be related to the social capital that allows to develop territorial networks and start projects. In fact, according to Favilli et al. (2020) a bunch of multiple actors work in specific territories to collaborate creating networks, making more efficient the process to facilitate innovation process.

Lastly, we include in the model the Local Agricultural Group (LAG) because it results from a network of active subjects constituting a public-private partnership, which could be functional to the rising of other forms of territorial governance, such as bio-districts. In fact, the reasons for the growth of some local contexts reside precisely in community-type factors (local culture, diffusion of small family businesses, etc.) (Sturla, 2020; Cozzi et al., 2020).

Thus, these parameters could have an impact on the presence of bio-districts in an area, fostering their diffusion.

2.2 Econometric model and data

Our dependent variable measures the event of bio-district formation at the municipality level and this variable is binary in nature (0 = no bio-district presence, 1 = bio-district presence), thus we estimate the likelihood of bio-district formation using a logit model (Rothaermel and Boeker, 2008). Data have been collected from several sources, among which ISTAT digital databases (VI Census of Agriculture, 2010; XV Census of Population and Habitat, 2011), CREA databases and MEF.

The logit regression is a nonlinear regression model used when the dependent variable is dichotomous, to assess the probability that an observation can generate one or the other value of the dependent variable. More in detail, the outcome variable, Y', is the probability of bio-district formation /non-formation based on a nonlinear function with two outcomes. The logit model is estimated by a maximum likelihood procedure with which efficient, consistent and normally distributed estimators are obtained.

We use the following specification:

$$ln\left(\frac{Y_I}{1-Y_I}\right) = \alpha + \sum \beta_i X_i \tag{1}$$

where α is the constant, X_i is the vector of the independent and control variables for the municipality i and β_i is the vector of coefficients.

We used the *glm* command from the Stats package in the R 4.1.1 software[2] to estimate the logit model.

As a baseline model to which compare our results against, we present the outcome with only the control variables and Regions dummy variables. Indeed, Model 1 in Table 3 reports the effect of the control variables on the dependent variable. Moreover, we have included Italian regions as dummy variables, to test the characteristics of each region influencing the existence of bio-districts in municipalities. Abruzzo region has been selected by the software as the reference level for comparing the results of other Regions. Thus, the results mean the deviation of regions from the baseline. The choice of the Region's dummy variable to be eliminated is made automatically by the software because the results do not change. The elimination of a level from the regression, in our case the Abruzzo dummy variable, is employed exclusively to obtain a baseline from which to comment on the other levels, in our case the other Regions' dummy variables. Furthermore, Abruzzo is one of the Regions with average values as regards the dependent variable, i.e., the presence of bio-districts, so it fits well as baseline.

Model 2 shows the effects of the control variables and Regions dummy variables plus the Agricultural variables group on the dependent variable. The results of the controls and Regions dummy variables plus the Socio-territorial independent factors on the dependent variable are pointed out in Model 3. Finally, Model 4 presents the results for the full model with odds ratios when all variables are included (Regions dummy variables, control variables, agricultural variables, and socio-territorial variables).

The coefficients from the models can be difficult to interpret because they are scaled in terms of logs. Another way to interpret logistic regression models is to use the antilog to estimate the coefficients into odds ratios. This procedure allows for a better understanding and comparison of coefficients in the full model (see Model 4 in Table 3).

We measured the Akaike Information Criterion (AIC) and the log-likelihood to assess the goodness of fit of the logit models. A common way to compare models is using the Likelihood Ratio (LR) test. The LR test evaluates the evidence in the data to support the extra complexity of nested models.

3. Results and discussion

Our sample includes 8,094 Italian municipalities and the descriptive statistics of explanatory variables are shown in Table 2.

In the model all the continuous variables have been considered in their natural logarithm form; for the other variables, we employ the dummy form (LAG, Altitude) or the interval 0-1 (Unemployment rate).

[2] R is a language and environment for statistical computing and graphics.

Table 2. Descriptive statistics.

Variables	min	max	mean	standard deviation	variance coefficient	observation
Bio-districts	0	1	0.09	0.28	3.28	8094
Population density	0	12224	297.42	634.89	2.13	8094
Per capita income	481920	49314358907	105007624.18	755169820.40	7.19	7854
UAA	0	44973	1588.35	2736.54	1.72	8094
Small farms	0	4599	101.23	222.55	2.20	8094
PDO-PGI farms	0	1023	22.36	55.27	2.47	8094
Farmers' age	0	72	5.49	16.93	3.08	8094
Direct selling farms	0	1069	33.43	64.41	1.93	8094
Organic farms	0	446	5.58	15.92	2.85	8094
Altitude	0	2035	357.53	297.56	0.83	8094
Non-profit associations	0	12436	37.21	203.32	5.46	8094
LAG	0	1	0.62	0.49	0.79	8094
Unemployment rate	3	29.5	9.04	5.21	0.58	7843

The correlation analysis between explanatory variables results in a strong correlation between Income and Non-profit associations variables, and UAA and Organic farms variables, suggesting a similar influence on the dependent variable – bio-district formation; thus, to avoid multicollinearity issues, we have eliminated Non-profit associations and UAA variables from the models.

We have carried out additional tests (see Table 3) to detect possible multicollinearity problems by means of Variance Inflation Factors (VIFs) for all the models and have found multicollinearity not to be a problem, being them lower than the cut-off point of 5 (O'Brien, 2007).

Regressions results are shown in Table 3, with the four models calculated, Model 1, 2, 3 and 4. As highlighted in par. 2, the robustness of our findings is tested by the use of alternative model specifications. As highlighted in Table 3, Model 2, including the Agricultural group variables, performs better than Model 1 (LR test: 42.324(5); AIC: 4,137.68). Similarly, Model 3, comprehending the Socio-territorial group variables, improves significantly compared to Model 1 and also to Model 2, resulting in LR: 97.091(3); AIC: 4,078.92. This means that Socio-territorial group variables have a higher influence than the other group of variables on the dependent, and a better fitting model. Lastly, Model 4 shows the best performance among the alternative specifications, with LR: 152.82(8); AIC: 4,033.19. Thus, Model 4 is the best fitting model of our work.

Following the comments to the result of the full model, starting from Regions' dummy variables. We have included in the models Italian regions, with the aim to assess the influence of the characteristics of each region on the presence of bio-

Table 3. Logistic regression model results.

	Dependent variable: Presence of Organic District				
	Model 1	Model 2	Model 3	Model 4	
	Control variables	Agricultural variables	Socio-terr. Variables	Full model	Odds Ratios
Constant	-2.850*** (0.275)	-3.060*** (0.279)	-5.037*** (0.356)	-5.505*** (0.368)	0.004
Small_farms_		-0.001*** (0.0003)		-0.0001 (0.0003)	1.000
PDO-PGI		0.003*** (0.001)		0.004*** (0.001)	1.004
Farmer's_age		0.003 (0.002)		0.003 (0.002)	1.003
Direct selling		0.003*** (0.001)		0.002*** (0.001)	1.001
Organic_farms		0.003 (0.002)		0.002 (0.003)	1.002
Altitude			0.001*** (0.0002)	0.001*** (0.0002)	1.147
LAG			0.524*** (0.119)	0.520*** (0.120)	1.682
Unemployment_rate			0.125*** (0.017)	0.137*** (0.018)	1.682
Population density	-0.002*** (0.0002)	-0.002*** (0.0002)	-0.001*** (0.0002)	-0.001*** (0.0002)	0.999
Per capita income	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	1.000
Basilicata	-13.624 (209.562)	-13.541 (208.521)	-13.523 (208.759)	-13.455 (208.145)	0.000
Calabria	0.780** (0.324)	0.724** (0.329)	-0.543 (0.388)	-0.779* (0.402)	0.459
Campania	0.815** (0.323)	0.848*** (0.324)	0.320 (0.336)	0.299 (0.338)	1.349
Emilia-Romagna	-0.504 (0.451)	-0.565 (0.454)	0.293 (0.459)	0.345 (0.462)	1.412
Friuli Ven. Giu.	0.539 (0.384)	0.656* (0.385)	1.365*** (0.394)	1.610*** (0.397)	5.005
Lazio	0.989*** (0.322)	1.094*** (0.324)	1.304*** (0.325)	1.417*** (0.327)	4.125
Liguria	0.272 (0.405)	0.411 (0.406)	0.608 (0.408)	0.817** (0.410)	2.264
Lombardy	0.865*** (0.295)	1.000*** (0.297)	1.789*** (0.310)	2.048*** (0.315)	7.750
Marche	0.693* (0.369)	0.733** (0.370)	1.164*** (0.373)	1.274*** (0.376)	3.574

	Dependent variable: Presence of Organic District				
	Model 1	Model 2	Model 3	Model 4	
	Control variables	Agricultural variables	Socio-terr. Variables	Full model	Odds Ratios
Molise	1.893*** (0.337)	2.062*** (0.339)	1.891*** (0.338)	2.057*** (0.340)	7.825
Piedmont	0.439 (0.300)	0.551* (0.302)	0.938*** (0.304)	1.126*** (0.307)	3.083
Apulia	1.598*** (0.325)	1.755*** (0.346)	0.717* (0.375)	0.535 (0.402)	1.707
Sardinia	-2.658** (1.039)	-2.647** (1.039)	-2.885*** (1.043)	-2.868*** (1.043)	0.057
Sicily	2.167*** (0.299)	2.203*** (0.306)	0.991*** (0.351)	0.856** (0.362)	2.353
Tuscany	1.568*** (0.319)	1.442*** (0.322)	2.175*** (0.327)	2.115*** (0.330)	8.287
Tr. Alto Adige	-0.788 (0.496)	-0.914* (0.505)	-0.101 (0.507)	-0.166 (0.516)	0.847
Umbria	-1.515 (1.042)	-1.631 (1.043)	-1.224 (1.043)	-1.324 (1.045)	0.266
Veneto	1.835*** (0.297)	1.875*** (0.300)	2.686*** (0.311)	2.822*** (0.314)	16.818
Observations	7,608	7,608	7,608	7,608	
Log Likelihood	-2,064.003	-2,042.841	-2,015.457	-1,987.595	
Akaike Inf. Crit.	4,170.006	4,137.682	4,078.915	4,033.189	
LR test(Df)		42.324(5)***	97.091(3)***	152.82(8)***	
VIF	1.068	1.706	2.605	2.688	

Notes: *p<0.1; **p<0.05; ***p<0.01; standard errors are in parentheses; regional reference level (omitted) = Abruzzo.

districts in an area. In fact, Regions are characterized by different administrative and legal principles governing the entire regional area, thus potentially influencing the rising and maintenance of bio-districts. As shown in Table 3, several Regions' variables resulted to be significant. Concerning these factors, the regression coefficients show the deviation of each region from the baseline, which in our model is Abruzzo.

Only two regional areas result to have negative signs of the coefficients, Sardinia and Calabria, meaning that belonging to these two regions does not influence the presence of bio-districts in an area if compared to the baseline. In fact, Sardinia counts only one bio-district in its territory, although a second bio-district is now being defined (Sinab, 2020). Other Region variables have coefficients with positive signs. More in detail, we can note a great attention to the bio-district opportunity by many Northern Italian regions, as Lombardy, Piedmont, Veneto, Friuli-Venezia Giulia, and Liguria, resulting in positive coefficients. That is, being in the territory of these Regions positively influences the existence of a bio-district in an area, if compared to the benchmark. Probably, also the geography of these Regions plays a role in influencing the rising of bio-districts, mainly referred to the fact that Northern Regions are characterized by large mountain areas, classified as disadvantageous territories, where bio-district can lead to economic development. Moreover, Liguria is the first Region in which a regional law regulating bio-districts was approved (L.R. 66/2009).

Among the regions of the Central Italy, Tuscany and Marche show a significant positive deviation from the baseline. Tuscany has approved in 2019 its regional law on bio-districts and counts 7 bio-districts in its area, and in Marche region is placed the largest bio-district in Italy and Europe (Federbio, 2021).

Going to the south of the peninsula, among Southern regions only Molise shows a positive deviation from the baseline, probably because it has a small territory extension with a high percentage of rural areas, where 2 bio-districts are born.

The Control variables group includes Population density (coefficient: -0.001; odds ratio: 0.999) and per capita income (coefficient: 0.000; odds ratio: 1.000), remaining stable in all the four models. Only the population density variable shows a negative relationship with the dependent variable, demonstrating a higher probability that bio-districts arise in a territory with low density population. This result is linked to the fact that bio-district is a tool conceived with the aim of developing the rural territory, often characterized by low population density. The urgency to create new economic opportunities in rural areas is also attested by the fact that 40% of the European territory in which 30% of the population lives, is affected, or will be affected by demographic decline in the coming decades, as found by the research project 'Escape', of the ESPON study program (Escape, 2020). Policy actions for declining rural areas should reflect broader social objectives than economic growth, such as inclusion, well-being, community services and an ecological transition, which are objectives very close to those of bio-districts.

Among agricultural factors, PDO-PGI farms and Direct selling in farms have a relationship with the dependent. PDO-PGI variable (coefficient: 0.004; odds ra-

tio: 1.004) includes farms particularly interested in the valorisation of their productions, because they strongly invest in quality (Mazzocchi et al., 2020). Then, farms producing PDO and PGI are more interested in territorial projects that can revitalize the area in which they work, promoting the territory. In fact, as highlighted by Galli et al. (2010) among the objectives included in Reg. 510/2006 denomination of origin productions indirectly should favour the local development of the territory of origin, especially in rural areas, safeguarding their identity and the continuation of traditions and cultural activities related to the product.

Direct selling in farms (coefficient: 0.002; odds ratio: 1.004) variable indicates the farms interested in developing new market channels to implement their income, that can be interested in new socio-economic projects, as bio-districts. Moreover, this variable represents the proximity between producers and consumers and the arising of personal relationships between them (Corsi et al., 2020), which can be the basis for the development of networks capable of supporting the creation and maintenance of bio-districts. The positive relation between this variable and the presence of bio-districts confirms these remarks.

Socio-territorial group includes three statistically significant factors: Altitude (coefficient: 0.001; odds ratio: 1.147), LAG (coefficient: 0.520; odds ratio: 1.682) and Unemployment rate (coefficient: -0.137; odds ratio: 1.682).

Confirming our hypothesis, Altitude is positively related to the bio-districts presence, thus the localization in disadvantageous areas (Mazzocchi & Sali, 2021) seems to influence the rising of this territorial governance structure. In fact, on one hand, bio-district is born to support small farmers, rural communities, rural areas suffering depopulation process, as the mountain and hill areas can be. On the other hand, several mountain areas need a new economic model based on endogenous characteristics of the territory, such as nature, environment, extensive agriculture, traditions; bio-district model comprehends both the involvement of the territorial community carrier of identity, tradition, culture and the issue of nature by stimulating the adoption of organic agriculture techniques.

LAG variable is strongly and positively related to the dependent, thus a network of active subjects as the LAGs encourages the bio-district presence. The presence of LAGs guarantees the development of social networks that connect interest groups, associations, local institutions present in the territory, thus can serve as a basis for the development of bio-districts, confirming our hypothesis. The LAGs are local partnerships functional to the implementation of LEADER actions. Over the years, the LEADER approach to local development "has proved to be an effective tool for promoting the development of rural areas, fully suited to the multisectoral needs of endogenous rural development thanks to its "bottom-up" approach" (Reg UE 1305/2013). In fact, the LEADER approach is also confirmed in the 2023-2027 programming. The bottom-up approach, the need for a public-private partnership, the network of stakeholders and actors that it puts in place for local economic development, makes LEADER a valuable tool for planning and territorial governance.

Lastly, according to the idea that bio-districts should produce evident benefits in social and economic terms, the Unemployment rate is negatively related to

the dependent: that is, where a social fragility in economic terms exists, is more probable the development of bio-districts. In fact, in some areas with bio-districts, there are very important unemployment phenomena, especially among young people (Sturla, 2020). In some cases, the problem of unemployment is strictly linked to legality, also due to the strong presence of migrants who can easily fall prey to the phenomena of illegal hiring. Sturla et al. (2020) affirm as in the case of Valle del Simeto bio-district, one of its objectives is to encourage greater involvement of young people and migrants in the management of farms.

4. Conclusions

At our knowledge few contributions in literature try to assess the characteristics of bio-districts also because they are new governance tools that, most likely, will further be implemented, thanks to the new legal framework of Reg. (EU) No 848/2018 that will be effective from 2022. Main results regard agricultural and socio-territorial factors, because the presence of PDO-PGI productions, Direct selling in farms and presence of LAGs are related to the rising of a bio-district.

The reason is probably because the development of new market channels for better income and being part of a new socio-economic project, such as bio-districts, are crucial factors for these farms, and the presence of LAGs can be the basis for the development of networks capable of supporting the creation and maintenance of bio-districts. As a matter of fact, whenever a bio-district is not a direct expression of a LAG's development strategy, it is anyway the result of a socio-economic milieu conducive to territorial collaboration, attested by the presence of the LAG. Similarly, the disadvantageous areas as the mountain territory, are the ideal place for the rising of bio-districts, as confirmed by the Altitude variable. According to our results, bio-districts, besides pursuing their core mission of spreading organic production method and supporting small farms, can address different functions and scopes, more related to territorial management and development, thus reinforcing the idea that they could become a reliable subject for the governance of local development according to more inclusive, multi-actor and transdisciplinary approaches.

The upcoming CAP programming period will constitute the ideal bench for testing these functions, although some bio-districts have been already proved as capable of fostering valuable cooperation initiatives to the benefit of the organic supply chain and its actors already in the programming period 2014-2022 (e.g., Val di Vara, Bio Venezia, Colli Euganei). Even though one could argue that bio-districts are not the only type of territorial partnership in the wide panorama of Italian rural development that deserves policy makers' attention, they must be acknowledged as the only cooperation initiatives that is based on a specific set of values (those of organic farming) and, as such, capable of activating actors that go well beyond the agro-food supply chain at the point of involving local administrations, schools, and consumers. This is a point of strength that make them instrumental in connecting local supply chains to local demand, for instance, or for the

adoption of an integrated approach to development policies, where different tools (smart villages, strategies for inner areas, etc) could converge pivoting around the development of organic supply chain and their integration with other economic sectors (Ho.Re.Ca., handicraft and healthcare).

Moreover, bio-districts could play a crucial role in reaching the objective set by the Farm to Fork strategy, by supporting the conversion of small farmers and easing group certification as operationalized by the Reg (EU) No 848/2018. Furthermore, the contents of the EU Biodiversity Strategy also start from a premise: farmers play an essential role in preserving biodiversity. Thus, since organic agriculture also means a bigger environmental protection than conventional agriculture, the diffusion of bio-districts also fulfils the function of putting the EU Biodiversity Strategy into practice. As the bio-districts are gaining greater consideration among policy makers, the analyse proposed in this paper provides the bio-districts analytical bases on which builds their strategies. This work is a first step in this direction, although limited by the scarce availability of updated databases and difficulty in finding deeper information about existing bio-districts. The next step can be the implementation of the model with panel data, once they will be available, in order to be more effective in the investigation of bio-districts dynamics.

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