

Supplementary materials of the role of Biodistricts in enhancing farms' labour productivity: a Post-Keynesian analysis

The diffusion of BDs in Italy

The first Italian BD was established in 2009 in Cilento, a coastal area in the Campania Region, to revitalise it by activating synergies between organic farming and the sustainable management of local resources required by the local National Park (Pugliese et al., 2015). Since then, BDs have expanded nationwide, encompassing diverse geographical areas and socio-economic contexts. Since the law doesn't provide specific parameters for identifying them, with recognition rules delegated to the Regions, the development of local organic farming varies markedly across districts. Especially, Figure S.1 shows BDs' state of acknowledgement according to Italian legislation: given that compliance rules vary considerably across regions, the criteria for recognition range from stringent parametric requirements to more general guidelines on governance and the effective presence of organic supply chains.

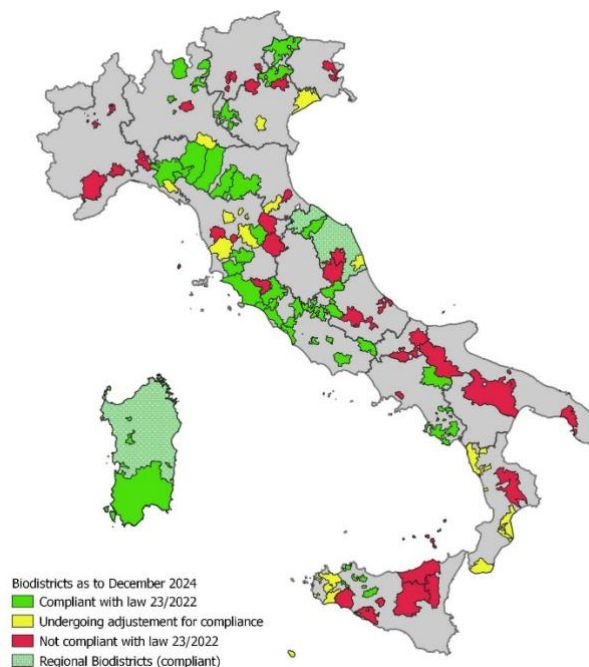


Figure S.1. Biodistricts in Italy and their status according to Law No. 23/2022.

Source: CREA elaboration on the National Registry of Biodistricts

Moreover, the actual level of operativity is not connected to the legal acknowledgement because the setting up of most of the BDs is the result of a bottom-up process started before the enactment of specific legislation. However, national statistics describe BDs as territories where the local specialisation in agriculture, particularly organic farming, is coupled with a strong presence of processors with a territorial certification (see Table S.1). This last information is connected to the actual presence of a structured local supply chain, given the requirements for Protected Designation of Origin (PDO)/Protected Geographical Indication (PGI) certification¹. According to the statistics provided by ISTAT², the average values of the share of Organic Utilised Agricultural Area relative to the total Utilised Agricultural Area (UAA) and the share of PDO in total food Processing are significantly higher than those of municipalities outside the BD (see Table S.2).

Table S.1. Territorial and productive features of Italian Biodistricts (BD)

Region	biodistricts (No.)	Share of regional territory in biodistricts	Outside biodistrict		Inside biodistrict	
			Organic UAA / total UAA (%)	PDO processors / Total food Processing (%)	Organic UAA / total UAA (%)	PDO processors / Total food Processing (%)
Piemonte	5	12.2	5.4	8.55	14.1	9.5
Valle D'Aosta	0	0	1.5	89.7	n/a	n/a
Lombardia	4	10.6	5.2	7.98	6.7	23.6
Trentino A. A.	4	2.8	8.8	8.1	20.5	1.1
Veneto	6	29.8	5.6	15.66	8.9	65.8
Friuli V. G	2	5.9	14.9	7.12	7.4	1.2
Liguria	1	12.9	7.2	11.17	13.5	0
Emilia-Romagna	7	45.1	14.9	24.22	29.5	52.7
Toscana	15	43.2	19.8	47.02	25.4	85.1
Umbria	1	4.9	16	26.43	44.4	0.9
Marche	3	100	n/a	n/a	23.6	15
Lazio	13	36.5	17	12.4	29.6	20.9
Abruzzi	2	12.3	11.8	10.27	19.2	6.8
Molise	1	13.5	5.6	4.02	9	9.1
Campania	3	18.6	11.4	12.12	14.1	6.3
Puglie	5	32.3	15.7	9.68	14.7	6.2

¹ PDO/GPI certification requires adherence to strict standards governing origin, production methods, and quality to ensure authenticity and traceability of products that originate in a specific place, region or country (Regulation (EU) no. 1151/2012 (article 5)).

² Data have been retrieved from the 7th agriculture census (<https://esploradati.istat.it/databrowser/#/en/censimentoagricoltura>) and from the Atlas of Italian Municipalities (<https://aster.istat.it/>)

Basilicata	1	13.1	18.94	5.64	24.23	5.48
Calabria	4	28.6	27.7	14.32	26.8	12.7
Sicilia	8	34.9	20.7	9.52	23.5	10.2
Sardegna	2	100	n/a	n/a	8.2	10.8
Italy	87	29.7	13.93	7.45	18.40	12.33

Source: Authors' estimations on the Italian National Institute of Statistics

Table S.2. T-tests for differences in mean values of territorial and productive features outside vs inside biodistricts (BD)

	Organic UAA / total UAA (%)				PDO processors / Total food Processing (%)		
	Obs.	Mean	t	Pr(T > t)	Mean	t	Pr(T > t)
Outside BD	5943	10.2%	-16.16	***	12.6%	-5.9	***
Inside BD	1776	17.7%			23.0%		

Source: Authors' estimations on the Italian National Institute of Statistics

Descriptive statistics of the variables

Table S.3. Summary statistics

Variable	Obs	Modes	Mean	Std. Dev.	Min	Max
dPROD	121,234		8.805977	6.869455	0.115578	791.6
dVA	121,234		10.50628	1.269238	2.095	16.641
dKL	121,620		11.69107	1.529998	2.207275	19.37725
BD	122,318	1 (30,541) 0 (91,777)				
UAA	122,290		2.666268	1.359159	-4.60517	8.144702
LEGAL FORM	122,318	1 (104498) 2 (14922) 3 (442) 4 (63) 5 (405) 6 (131) 7 (428) 8 (1260) 9 (10) 10 (88) 11 (2) 12 (27) 13 (11) 14 (3) 15 (22) 16 (6)				
MANAG_SYS	122,318	1 (62410) 2 (41677) 3 (13545) 4 (2411) 5 (887) 6 (1388)				
OTE_CODE	122,318	1 (32147) 2 (7797) 3 (36767) 4 (25317) 5 (5089) 6 (8463) 7 (998) 8 (5740)				
BD_rin	122,318	0 (121631) 1 (687)				
BD_CN	122,318	0 (103625) 1 (18693)				
BD_MZ	122,318	0 (91777) 1 (30541)				
BD_nozsva	122,318	0 (108620) 1 (13698)				
BD_young	122,318	0 (95798) 1 (26520)				
Exp	3,984		1.050629	0.712634	0	2.484907

Note: For the dummies BD, BD_rin, BD_CN, BD_MZ, BD_nozsva and BD_young, the value 1 means that the farm is located in the biodistrict and has the characteristic under consideration, otherwise it is equal to 0. The modes of LEGAL FORM are: 1) Sole proprietorship; 2) Simple partnership; 3) General partnership (s.n.c.); 4) Limited partnership (s.a.s.); 5) Joint-stock company (s.p.a.); 6) Limited liability company (s.r.l.); 7) Partnership limited by shares (s.a.p.a.); 8) Cooperatives (with limited or unlimited liability); 9) Social cooperative; 10) Producers' association; 11) Other recognized or unrecognized association; 12) Public entity; 13) Other profit-oriented legal form (Consortium); 14) Other non-profit legal form (Foundation); 15) Common ownership or collective lease; 16) Other type. The modes of MANAG_SYS are equal: 1 = Direct management with only family members; 2 = Direct management with a majority of family members; 3 = Direct management with a majority of non-family members; 4 = With employees; 5 = With contract work only; 6 = Other forms of management. For OTE_CODE, modes equal: 1 = Specialist field crops; 2 = Specialist horticulture; 3 =

Specialist permanent crops; 4 = Specialist grazing livestock; 5 = Specialist granivores; 6 = Mixed cropping; 7 = Mixed livestock holdings; 8 = Mixed crops-livestock

Robustness check

A robustness check analysis is carried out to consider potential territorial spillover and to consider BD as a treatment, by employing alternatives specification of the GMM model and Staggered Difference-in-Differences. With reference to Table S.4 regarding the GMM model, in column 1, the interaction terms BD_REGj describe the joint effect of variable BD and the belonging region j ; in column 2, variable BD_INT_{it} measures the share of municipalities in a BD of the total municipalities in a given Province; in column 3, dummy variables YBD_{it} , $YBD1_{it}$, and in column 4, the dummy variable $YBDM_{it}$ are aimed at checking for a “treatment effect” connected to the institution of a BD. Specifically, the variable YBD_{it} equals 1 when the difference between the year when the farm has been surveyed and the year of the establishment of the belonging BD is equal to zero; $YBD1_{it}$ equals 1 if the same difference is equal to 1, while $YBDM_{it}$ equals 1 whenever the year of the survey is greater than the year of the establishment of the BD, therefore accounting for the years following the institution of a BD. All results corroborate the previous analysis. Column 1 reports interactions between BDs and belonging regions as a check for possible territorial interactions. The fact that most of the interactions with regions are positive and significant suggests a connection between the institutional and productive milieux and BDs and proves that the “BD effect” is not driven by omitted variables connected to local context. Moreover, when local effects are captured through interactions with regions and provinces in columns 1 and 2, the coefficients of UAA_{it} become significant and negative, indicating that, once territorial spillovers are accounted for, within-region variation is revealed. Columns 3 and 4, instead, through the variables YBD and $YBDM$, show how the institution of the BD has elicited a “post-biodistrict effect”. While YBD indicates that the creation of a BD is associated with a positive impact on growth productivity, as if its institutions acted as an element of induced discontinuity in the time series, $YBDM$ ’s slight significance suggests that, in the years following the establishment of a biodistrict, local farms have experienced higher growth in productivity.

Table S.4: Robustness check, Interactions BD/Regions and post-biodistrict effects

	(1) $dPROD_{it}$	(2) $dPROD_{it}$	(3) $dPROD_{it}$	(4) $dPROD_{it}$
$dPROD_{it-1}$	-0.0816* (-1.86)	-0.169*** (-4.75)	-0.0921** (-2.14)	-0.0981** (-2.23)
dVA_{it}	0.613*** (3.29)	0.603** (2.47)	0.547*** (3.32)	0.606** (2.49)
dKL_{it}	3.941*** (2.73)	1.343 (1.47)	3.757** (2.44)	3.534** (2.29)
BD_PIE	5.947** (2.57)			
BD-LOM	5.137** (2.49)			
BD_TRE	0.178 (0.24)			
BD_VEN	0.973 (1.30)			
BD_FVG	1.316 (1.40)			
BD_LIG	-0.303 (-0.12)			
BD_ER	0.972* (1.66)			
BD_TOS	0.972*** (2.69)			
BD_UMB	18.20* (1.82)			
BD_LAZ	0.719* (1.79)			
BD_ABR	2.824** (2.07)			
BD_MOL	0.678 (0.63)			
BD_CAM	1.600** (2.29)			
BD_PUG	1.899** (2.57)			
BD_BAS	7.094** (2.15)			
BD_CAL	3.057** (2.09)			
BD_SIC	2.911** (2.10)			
UAA_{it}	-0.342* (-1.94)	-1.057*** (-2.70)	0.162 (0.62)	0.527 (1.26)
BD_INT_{it}		1.407 (0.84)		
YBD_{it}			14.63** (1.99)	
YBD_{it+1}			15.32 (1.60)	
$YBDM_{it}$				12.28* (1.82)
Constant	0.309 (1.15)	7.348 (1.34)	-0.247 (-0.47)	-0.236 (-0.12)
$LEGAL_FORM^3$	Yes	Yes	Yes	Yes

³ The Italian FADN database identifies the following legal forms of farms: 1) Sole proprietorship; 2) Simple partnership; 3) General partnership (s.n.c.); 4) Limited partnership (s.a.s.); 5) Joint-stock company (s.p.a.); 6) Limited liability company (s.r.l.); 7) Partnership limited by shares (s.a.p.a.); 8) Cooperatives (with limited or unlimited liability); 9) Social cooperative; 10) Producers' association; 11)

<i>Dummies</i>				
<i>MANAG_SYS</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Dummies</i>				
<i>OTE_CODE</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Dummies</i>				
<i>Regional</i>	<i>No</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
<i>Dummies</i>				
<i>Year dummies</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Observations	62777	10652	62777	62777
Hansen test (p-value)	0.0842	0.574	0.191	0.288
AR (1) (p-value)	0.0000306	6.20e-12	0.00000712	0.0000230
AR (2) (p-value)	0.198	0.469	0.764	0.989

t statistics in parentheses; * p<0.1, ** p<0.05, *** p<0.01

Finally, to further assess the robustness of our findings and address potential concerns related to identification and model specification, we complement the baseline GMM estimates with a staggered Difference-in-Differences (DiD) approach using the Callaway and Sant’Anna (2021) estimator to exploit the staggered introduction of BDs (considered as the treatment) across Italian municipalities. Table S.5 reports the pre- and post-treatment averages, confirming the robustness of the main findings and showing a positive and statistically significant impact of BDs on labour productivity growth at the national level in the post-treatment. In contrast, the absence of significant pre-treatment average effects supports the validity of the parallel trends assumption. Regional heterogeneity persists, thus suggesting that the effectiveness of BDs on labour productivity depends on the local socio-economic context.

Table. S 5 Robustness check, Staggered Difference-in-Differences estimates

	Italy	North	Central	South
	Coef. (z value)	Coef. (z value)	Coef. (z value)	Coef. (z value)
Pre-treatment average	-0.432 (-1.57)	-0.068 (-0.44)	-0.478 (-0.61)	-0.263 (-1.15)
Post-treatment average	0.341** (-2.35)	0.363* (-1.81)	-0.131 (-0.59)	0.138 (-0.66)
No. observations	76,341	34,164	11,188	30,312

Other recognized or unrecognized association; 12) Public entity; 13) Other profit-oriented legal form (Consortium); 14) Other non-profit legal form (Foundation); 15) Common ownership or collective lease; 16) Other type.

References

- Callaway, B., & Sant'Anna, P. H. C. (2021). Difference-in-differences with multiple time periods. *Journal of Econometrics*, 225(2), 200–230.
- Pugliese, P., Antonelli, A., & Basile, S. (2015). *Case study fact sheet. Bio-distretto Cilento-Italy*.