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Cooperative Credit Banking and Local Economic Activity in Italy: A Finite Mixture Modelling Approach to Latent Spatial Regimes

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Abstract

Using a panel of Italian provinces (NUTS-3) over 2002–2022, this paper identifies latent territorial regimes in the relationship between cooperative credit banking and local economic activity through a finite-mixture modelling approach. The findings show that cooperative credit banking is strongly associated with local economic activity only within a smaller latent regime, while the relationship is weaker elsewhere. These regimes cut across conventional macro-regional divisions, indicating that the estimated role of cooperative credit banking depends on how spatial heterogeneity is modelled. The paper thus provides evidence that locally embedded banking is a context-dependent form of financial intermediation whose relevance varies across latent territorial configurations.

Keywords: Cooperative credit banks, Local economic activity, Spatial heterogeneity, Finite mixture models.
JEL classification: G21, O18, O43, R11.

1 Introduction

Cooperative credit banks (CCBs) have long been regarded as locally embedded financial institutions with a key role in fostering local economic development.[1] By relying on proximity to borrowers, relationship lending, and the accumulation of soft information, these smaller and locally oriented banks may alleviate informational frictions that constrain firms' access to credit (Berger and Udell, 2002; Berger et al., 2005; Petersen and Rajan, 1994). However, the relevance of CCBs to local economic activity is unlikely to be uniform across space: since their lending activity relies on proximity, repeated interactions, and community-based information, its association with local outcomes may depend on the territorial environments in which they operate (Ferri and Messori, 2000; Moretti, 2014).

Existing empirical works have only partially addressed the spatial heterogeneity underlying the relationship between CCBs and local economic activity, which is usually captured through pre-defined geographical partitions, such as macro-regions or the North–South divide in Italy (see, for instance, Cosci et al., 2023, 2025; Ferri and Messori, 2000). While informative, this strategy imposes spatial regimes ex ante and may overlook heterogeneity within conventional geographical areas. As a result, it remains unclear whether the role of CCBs varies only across administrative or macro-regional boundaries, or whether it follows latent territorial configurations.

This paper addresses this issue by adopting a finite-mixture modelling approach that allows latent spatial regimes to emerge from the data. Rather than assuming a homogeneous association or imposing geographical groups in advance, the model identifies unobserved classes of provinces characterised by different relationships between CCBs and local economic activity. This empirical strategy thus allows assessing whether the conventional macro-regional view provides only a partial representation of spatial heterogeneity in the cooperative credit banking–local economic activity nexus.

Italy is a suitable setting for this analysis because it combines a long tradition of cooperative banking with pronounced territorial disparities in economic structure, banking development, and local economic trajectories (Guiso et al., 2004). Studying Italian provinces over 2002–2022 therefore allows

[1] In Italy, CCBs correspond to *Banche di Credito Cooperativo*, cooperative banks with mutualistic purposes, member-based governance, and a statutory orientation toward local communities. For a detailed discussion of the institutional features and functioning of CCBs in Italy, see Catturani and Stefani (2016).

the role of CCBs to be examined across heterogeneous local environments within a common institutional framework. More broadly, the paper shows that conclusions about locally embedded financial institutions may depend on whether spatial heterogeneity is imposed through pre-defined partitions or modelled through latent territorial regimes.

2 Data and empirical strategy

The empirical analysis relies on a panel dataset comprising 103 Italian provinces (NUTS-3) over the period 2002–2022, constructed by combining multiple sources.

To proxy local economic activity, I use the natural logarithm of per capita value added, derived from the system of regional economic accounts maintained by the Italian National Institute of Statistics (Istat). As for the geographical distribution of CCBs, I use the standard measure of bank branches per 1,000 inhabitants, obtained from the Bank of Italy, which is generally regarded in the empirical literature as a proxy for access to banking services (Benfratello et al., 2008).[2]

I first estimate the average association between CCBs and local economic activity using OLS. Let Y_{it} denote the natural logarithm of value added per capita in province i and year t, and let $B_{i,t-1}$ denote lagged CCB branch density. The benchmark specification is:

$$Y_{it} = \alpha + \beta B_{i,t-1} + X'_{i,t-1}\gamma + \lambda_t + \mu_r + \varepsilon_{it}, \tag{1}$$

where $X'_{i,t-1}$ is the vector of lagged controls, λ_t denotes year fixed effects, and μ_r denotes NUTS-1 macro-regional fixed effects.

Since CCB branch density may be endogenous to local economic conditions, I then estimate IV-2SLS models. Following Minetti et al. (2021), I use the provincial density of rural and artisan banks in 1936 as an external instrument. This instrument captures the historical persistence of cooperative banking and is predetermined with respect to contemporary outcomes, as it reflects the distribution of local banks before the 1936 Fascist banking reform reorganised and centralised the Italian banking system. The first-stage equation is:

[2] An alternative proxy could be the total volume of loans issued by CCBs. However, such loan data are not available at the NUTS-3 level.

$$B_{i,t-1} = \pi_0 + \pi_1 \text{Rural_banks}_i + X'_{i,t-1}\pi_2 + \lambda_t + \mu_r + u_{it}, \tag{2}$$

while the second-stage equation is:

$$Y_{it} = \alpha + \beta \widehat{B}_{i,t-1} + X'_{i,t-1}\gamma + \lambda_t + \mu_r + \varepsilon_{it}. \tag{3}$$

Province fixed effects are not included in the static IV specifications because the external instrument is time-invariant at the provincial level and would therefore be absorbed.[3]

As additional IV specifications, I use Lewbel-type generated instruments (Lewbel, 2012), which exploit heteroscedasticity in the first-stage residuals. [4] Let $\hat{u}_{it}$ be the residual from the reduced-form equation for CCB branch density and let Z_{it} denote a subset of exogenous covariates. The generated instruments are constructed as:

$$H_{it} = (Z_{it} - \bar{Z})\hat{u}_{it}. \tag{4}$$

I estimate IV specifications using: (i) the external historical instrument only; (ii) Lewbel-generated instruments only; and (iii) both the historical and generated instruments.

Finally, I estimate a dynamic System-GMM specification to account for persistence in local economic activity and further address potential endogeneity (Arellano and Bover, 1995; Blundell and Bond, 1998). The dynamic model is:

$$Y_{it} = \rho Y_{i,t-1} + \beta B_{i,t-1} + X'_{i,t-1}\gamma + \lambda_t + \eta_i + \varepsilon_{it}, \tag{5}$$

where η_i captures unobserved province-specific heterogeneity. In this specification, the external historical instrument is included and all independent variables are treated as predetermined; lags $(1, 3)$ are used as GMM-style instruments in the differenced equation, while lag $(0, 0)$ of first differences is used for the levels equation.

Following the empirical literature on the role of cooperative organisation in fostering regional economic growth (Coccorese and Shaffer , 2021; Terzo et al., 2024) , the vector of controls includes the following variables: (a) the natural logarithm of population density, to capture agglomeration economies; (b) life

[3] NUTS-1 fixed effects are included to control for broad macro-regional heterogeneity while preserving cross-provincial variation in the historical instrument.

[4] Lewbel's strategy for instrumenting the density of BCC branches is adopted, for example, in Terzo (2025).

expectancy at birth, to proxy human capital development and broader socio-economic conditions; (c) the employment shares in the secondary and primary sectors, to account for local productive specialisation; (d) the structural dependency ratio, to control for demographic structure; (e) the natural logarithm of trade openness, to account for the degree of integration of local economies with external markets; and (f) the density of non-CCB bank branches, to account for the overall availability of banking services and distinguish the role of CCBs from that of the broader local banking system.[5]

Tables 4 and 5 in the Appendix report descriptive statistics and pairwise correlations for the variables included in the analysis. The correlation matrix does not indicate serious multicollinearity concerns.

The previous specifications provide benchmark estimates of the average relationship between CCBs and local economic activity. However, they do not directly address whether this relationship differs across latent territorial configurations. To move beyond average effects, I estimate a Finite Mixture Model (FMM), which belongs to the broader class of latent class approaches and allows unobserved groups to be identified from the data rather than imposed ex ante (Vermunt and Magidson, 2002). In this framework, provinces are probabilistically assigned to latent regimes, each characterised by a specific relationship between CCBs and local economic activity. Latent class and finite mixture models provide a flexible way to account for unobserved heterogeneity and have been widely used in applied econometrics, including applications to growth models and panel-data settings (e.g., Alfò et al., 2008; Martínez-Zarzoso and Maruotti, 2011). The FMM analysis is based on non-overlapping three-year averages, which attenuate short-term fluctuations and make the estimated classes more likely to reflect persistent territorial configurations. Let $C_i \in \{1, \ldots, K\}$ denote the latent class of province i. Conditional on class k, the model is:

$$Y_{it} = \alpha_k + \beta_k B_{i,t-1} + X'_{i,t-1}\gamma_k + \varepsilon_{kit}, \qquad \varepsilon_{kit} \sim N(0, \sigma_k^2). \tag{6}$$

The observed density is a weighted sum of class-specific densities:

$$f(Y_{it}) = \sum_{k=1}^{K} \pi_k \phi\left(Y_{it}; \alpha_k + \beta_k B_{i,t-1} + X'_{i,t-1}\gamma_k, \sigma_k^2\right), \tag{7}$$

[5] Table 6 in the Appendix provides detailed definitions, measurement units, and sources for all variables included in the analysis.

where π_k is the class-membership probability. The number of classes is selected by comparing information criteria, class size, posterior classification quality, and substantive interpretability.

3 Estimation results

Table 1 reports the estimation results of the OLS, IV-2SLS, and Sys-GMM models. The coefficient of CCB branch density is positive across all specifications, suggesting that the average association is not driven by a specific estimation strategy.

The IV diagnostics support the reliability of the instrumental-variable estimates: the Kleibergen–Paap statistics indicate that the instruments are relevant, while the overidentification tests do not provide evidence against their validity. Similarly, the System-GMM diagnostics are reassuring since there is no evidence of second-order serial correlation, the Hansen/Sargan test does not reject the overidentifying restrictions, and the number of instruments remains limited relative to the number of provinces. Compared with the OLS estimates, the IV and Sys-GMM estimates show a higher coefficient for the key variable of interest, suggesting a potential attenuation bias in the OLS estimates due to measurement error.

I then examine whether this average association masks latent spatial heterogeneity by estimating the FMM specifications. Before discussing the class-specific estimates, I compare alternative specifications with different numbers of latent classes. The choice is based not only on information criteria, but also on convergence, class size, and substantive interpretability, since mixture models with too many classes may fit the data better while producing unstable or uninformative regimes.

As shown in Table 2, the two- and three-class models provide very similar BIC values, with the two-class specification only marginally favoured. However, the three-class model substantially improves the AIC and offers a more informative representation of latent heterogeneity in the CCB–local economic activity relationship. The four-class solution is discarded because it fails to converge and produces unstable estimates, suggesting overfitting. For these reasons, the three-class specification is retained as the preferred FMM model. As a robustness check, Appendix Table 7 reports the two-class FMM specification. The results confirm the presence of latent heterogeneity, although the three-class model provides a more informative decomposition of

Table 1: Benchmark estimates

	OLS	IV ext.	IV Lewbel	IV ext.+Lewbel	Sys-GMM
Lagged dependent variable	–	–	–	–	0.802***
	–	–	–	–	(0.046)
CCB branches	0.348**	0.486*	0.408***	0.413**	0.436**
	(0.141)	(0.295)	(0.150)	(0.190)	(0.180)
Other bank branches	0.342**	0.375***	0.356**	0.358***	0.008
	(0.141)	(0.138)	(0.140)	(0.134)	(0.034)
Secondary employment	-0.462*	-0.457*	-0.460*	-0.460*	0.211
	(0.261)	(0.256)	(0.257)	(0.257)	(0.147)
Primary employment	-1.532***	-1.531***	-1.532***	-1.532***	-0.376
	(0.386)	(0.381)	(0.380)	(0.380)	(0.416)
Dependency ratio	-0.006**	-0.006*	-0.006*	-0.006*	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.001)
Life expectancy	0.083***	0.079***	0.081***	0.081***	0.001
	(0.014)	(0.014)	(0.015)	(0.014)	(0.003)
Log population density	0.020	0.025	0.022	0.022	0.028
	(0.025)	(0.025)	(0.025)	(0.024)	(0.020)
Log trade openness	0.020	0.020	0.020	0.020	0.007
	(0.013)	(0.013)	(0.013)	(0.013)	(0.007)
Time fixed effects	Yes	Yes	Yes	Yes	Yes
NUTS-1 fixed effects	Yes	Yes	Yes	Yes	No
Observations	2,060	2,060	2,060	2,060	1,957
R-squared	0.826	0.825	0.826	0.826	–
Kleibergen–Paap Wald F	–	42.051	53.290	140.921	–
Hansen/Sargan p-value	–	–	0.479	0.203	0.284
AR(1) p-value	–	–	–	–	0.000
AR(2) p-value	–	–	–	–	0.397
Number of instruments	–	–	–	–	55

Notes: The dependent variable is the natural logarithm of value added per capita. All explanatory variables are lagged by one year. Cluster-robust standard errors at the provincial level are reported in parentheses. The external instrument is the provincial density of rural and artisan banks in 1936. Lewbel instruments are generated from heteroskedasticity-based moment conditions. First-stage IV estimates are available upon request. In the System-GMM specification, the external instrument is included and all independent variables are treated as predetermined; lags $(1, 3)$ are used as GMM-style instruments in the differenced equation, while lag $(0, 0)$ of first differences is used for the levels equation. To limit instrument proliferation, these instruments are collapsed. AR(1) and AR(2) report the Arellano–Bond tests for first- and second-order serial correlation in the first-differenced residuals. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 2: Selection of the number of latent classes

Classes	Log pseudolik.	AIC	BIC	Class probabilities	Decision
2	483.168	-904.337	-767.116	0.806; 0.194	Parsimonious
3	534.094	-974.187	-766.142	0.390; 0.408; 0.202	Preferred
4	567.433	-1010.865	-736.423	–	Not retained

Notes: Models are estimated on non-overlapping three-year averages and include the full set of controls, time dummies, and cluster-robust standard errors at the provincial level. The four-class model is not retained because convergence is not achieved and the estimates display signs of overfitting.

the territorial regimes.

Table 3 reports the class-specific estimates for the preferred three-class FMM specification, showing that the positive average association found in the benchmark models conceals substantial latent heterogeneity. In Class 1, representing about 39% of the sample, the coefficient of CCB branch density is positive but not statistically significant. In Class 2, accounting for about 41%, the association is positive and significant, but moderate in size. Class 3, which represents about 20%, displays a substantially larger coefficient, identifying a smaller regime in which the association between CCBs and local economic activity is particularly strong.

Table 3: Finite mixture estimates: three latent classes

	Class 1	Class 2	Class 3
CCB branches	0.494	0.621***	1.884***
	(0.529)	(0.150)	(0.385)
Other bank branches	0.714**	0.851***	0.196
	(0.329)	(0.185)	(0.247)
Log population density	-0.010	0.084***	0.118***
	(0.033)	(0.032)	(0.043)
Secondary employment	0.576**	-0.055	-1.215***
	(0.230)	(0.224)	(0.402)
Primary employment	-2.032***	-0.913*	-3.838***
	(0.584)	(0.528)	(1.168)
Dependency ratio	-0.006	0.006*	-0.004
	(0.007)	(0.003)	(0.006)
Life expectancy	0.026	0.117***	-0.085
	(0.024)	(0.021)	(0.058)
Log trade openness	0.043***	0.015	0.021
	(0.017)	(0.021)	(0.075)
Time fixed effects	Yes	Yes	Yes
Class probability	0.390	0.408	0.202
Residual variance	0.003	0.003	0.012

Notes: The dependent variable is the natural logarithm of value added per capita. The model is estimated on 618 province-period observations obtained from non-overlapping three-year averages. Cluster-robust standard errors at the provincial level are reported in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

To visualise the spatial distribution of the latent regimes, each province is assigned to the class with the highest average posterior probability across the six three-year periods. Figure 1 maps the resulting classification. Class 3, where the coefficient of CCB branch density is largest, includes a selective group of provinces located in different parts of the country, rather than a single contiguous area. At the same time, Classes 1 and 2 are spread across several macro-regions, indicating substantial within-area heterogeneity. This evidence supports the view that the CCB–local economic activity relationship

is better understood through latent territorial regimes than through predefined geographical partitions.

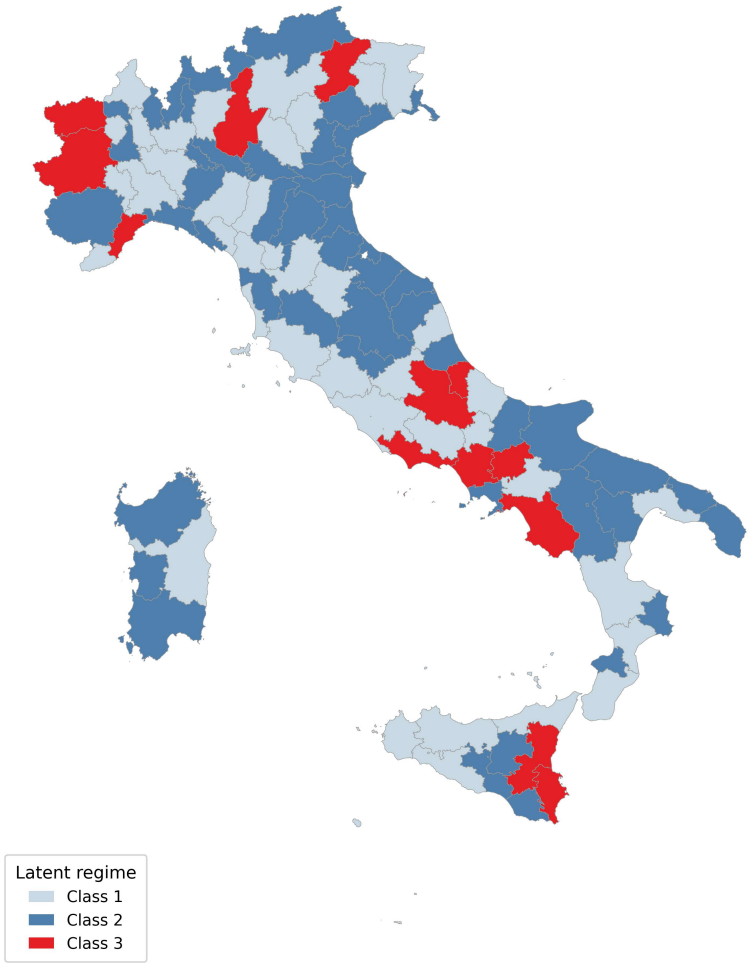


Figure 1: Latent spatial regimes based on posterior class assignment

The discrete classification is complemented by Figure 2, which reports the average posterior probability of belonging to each latent class. This provides information on the intensity of class membership and on the extent to which some provinces lie closer to the boundary between regimes.

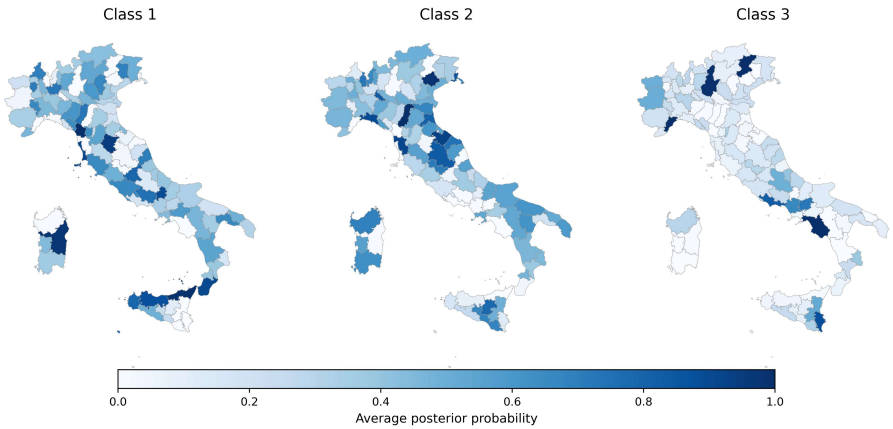


Figure 2: Average posterior probability of belonging to each latent regime

The posterior-probability maps confirm that the regimes are not arbitrary partitions. Several provinces display high membership probabilities, especially for Classes 2 and 3, while other areas show more intermediate probabilities, indicating smoother transitions between regimes. This is consistent with the idea that the FMM identifies spatially structured territorial configurations rather than mechanically assigning provinces to fixed administrative groups. Overall, the maps reinforce the main result: the geography of the CCB–local economic activity relationship cuts across macro-regional boundaries, while still displaying local spatial clustering.

4 Discussion and concluding remarks

The evidence points to a latent geography of CCBs that is not captured by average estimates or by conventional macro-regional divisions. The benchmark OLS, IV, and Sys-GMM estimates show a positive average association between CCBs and local economic activity, but the FMM reveals that this relationship differs markedly across territorial regimes.

The three regimes suggest different configurations of local financial intermediation. In the first regime, CCBs are not significantly associated with local economic activity, whereas non-CCB bank branches, secondary employment, and trade openness are positively related to the outcome, pointing to territories where economic activity appears more connected to conventional banking channels and productive structures. In the second regime, on the other hand, both cooperative and non-cooperative banks are positively as-

sociated with local economic activity, suggesting a more balanced banking configuration. Finally, the third regime is the most distinctive: CCBs display a much stronger association with local economic activity, while the coefficient of non-CCB bank branches is statistically indistinguishable from zero. This suggests that, in this regime, the relationship with local economic activity is not simply driven by banking density in general, but by the cooperative component of the local banking system.

The spatial distribution of the regimes reinforces this interpretation. The posterior classifications do not simply reproduce the North–South divide or NUTS-1 macro-regions. Instead, they reveal territorial patterns that cut across standard administrative boundaries while still displaying local spatial clustering. This is the main contribution of the paper: the estimated role of cooperative credit banking depends on how spatial heterogeneity is modelled.

The policy implication is that CCBs should not be evaluated through a uniform territorial lens, as their relevance appears strongly dependent on the configuration of local banking systems and productive structures. More broadly, the paper suggests that conclusions about locally embedded financial institutions may change when territorial heterogeneity is modelled explicitly rather than imposed through pre-defined geographical partitions.

Declaration of Generative AI and AI-Assisted Technologies in the Manuscript Preparation Process

During the preparation of this work, the author used Grammarly for AI-assisted rewriting/paraphrasing and English language editing. The author reviewed and edited the output as needed and take full responsibility for the content of the published article.

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Appendix

Table 4: Descriptive statistics

Variable	Obs.	Mean	Std. dev.	Min	Max
Log value added per capita	2,060	10.003	0.276	9.370	10.998
CCB branches	2,060	0.080	0.086	0.000	0.684
Other bank branches	2,060	0.461	0.167	0.116	1.126
Primary employment	2,060	0.055	0.043	0.003	0.216
Secondary employment	2,060	0.256	0.077	0.101	0.457
Dependency ratio	2,060	54.656	4.566	37.600	67.600
Life expectancy	2,060	81.798	1.173	77.800	84.500
Log population density	2,060	5.153	0.763	3.438	7.869
Log trade openness	2,060	-1.253	0.999	-4.413	1.154
Historical rural/artisan bank branches	2,060	0.034	0.060	0.000	0.417

Table 5: Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) CCB branches	1.000							
(2) Other bank branches	0.138*	1.000						
(3) Primary employment	-0.117*	-0.574*	1.000					
(4) Secondary employment	0.177*	0.564*	-0.493*	1.000				
(5) Dependency ratio	0.060*	0.180*	-0.234*	-0.027	1.000			
(6) Life expectancy	0.244*	0.020	-0.195*	0.069*	0.473*	1.000		
(7) Log population density	-0.133*	-0.023	-0.427*	0.091*	-0.041	0.081*	1.000	
(8) Log trade openness	0.165*	0.495*	-0.665*	0.584*	0.228*	0.248*	0.281*	1.000

Notes: * denotes statistical significance at the 5% level.

Table 6: Variable definitions and sources

Variable	Definition and measurement	Source
Log value added per capita	Natural logarithm of per capita value added at the provincial level. Value added is taken from the regional economic accounts and divided by resident population. This is the main proxy for local economic activity.	Istat
CCB branches	Number of cooperative credit bank branches per 1,000 inhabitants in each province. Cooperative credit banks correspond to *Banche di Credito Cooperativo*. This is the key explanatory variable and captures the local presence of cooperative banking.	Bank of Italy
Other bank branches	Number of non-CCB bank branches per 1,000 inhabitants in each province. This variable controls for the overall availability of banking services and separates the role of CCBs from that of the broader local banking system.	Bank of Italy
Historical rural/artisan bank branches	Provincial density of rural and artisan banks in 1936, measured per 1,000 inhabitants. This variable is used as the external instrument for current CCB branch density and captures the historical roots of cooperative banking before the 1936 banking reform.	Bank of Italy
Log population density	Natural logarithm of population density, measured as resident population per square kilometre. It controls for agglomeration economies and the degree of urbanisation of each province.	Istat
Primary employment	Share of total employment in the primary sector. It controls for the weight of agriculture and other primary activities in the local productive structure.	Istat
Secondary employment	Share of total employment in the secondary sector. It controls for the degree of industrial and manufacturing specialisation of the local economy.	Istat
Dependency ratio	Structural dependency ratio, defined as the ratio between the population outside working age and the working-age population. It controls for demographic structure and potential dependency burdens.	Istat
Life expectancy	Life expectancy at birth at the provincial level. It is included as a proxy for broader socio-economic conditions and human capital-related local development.	Istat
Log trade openness	Natural logarithm of trade openness, measured as the ratio between total trade flows and local value added. It controls for the degree of integration of local economies with external markets.	Istat

Table 7: Finite mixture estimates: two latent classes

	Class 1	Class 2
CCB branches	0.588***	0.869
	(0.128)	(0.798)
Other bank branches	0.743***	0.040
	(0.104)	(0.423)
Secondary employment	0.278	-1.815***
	(0.321)	(0.598)
Primary employment	-1.415***	-3.936***
	(0.427)	(1.486)
Dependency ratio	0.001	-0.018*
	(0.005)	(0.011)
Life expectancy	0.062***	0.039
	(0.015)	(0.090)
Log population density	0.028	0.016
	(0.031)	(0.082)
Log trade openness	0.023*	0.110
	(0.013)	(0.075)
Time fixed effects	Yes	Yes
Class probability	0.806	0.194
Residual variance	0.008	0.013

Notes: The dependent variable is the natural logarithm of value added per capita. The model is estimated on 618 province-period observations obtained from non-overlapping three-year averages. Cluster-robust standard errors at the provincial level are reported in parentheses. Class probabilities are marginal posterior probabilities. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. The two-class specification should not be interpreted as providing classes directly comparable to those of the preferred three-class model. In finite mixture models, latent classes are model-dependent and may change when the number of components is varied. The two-class model therefore provides a more parsimonious partition of the data, separating a large regime in which both CCB and non-CCB bank branches are positively associated with local economic activity from a smaller regime in which banking coefficients are not statistically significant and productive-structure variables play a stronger role. This confirms that the average relationship masks latent heterogeneity, while the preferred three-class specification offers a more informative decomposition of such heterogeneity.