

Clustering Italian Families across Population Censuses: A space-time exploration

Marcantonio Caltabiano, Emanuela Dreassi, Emilia Rocco, Daniele Vignoli

Abstract Since the second half of the twentieth century, family forms have become more diverse everywhere in Europe. At the end of the Seventies, traces of family changes began to emerge also in Italy. These changes intensified in the Nineties, and accelerated in the first decade of the twenty-first century. The aim of this paper consists in drawing a general, comprehensive background picture of the diffusion of new family patterns in Italy. We analyze the data of the Italian Population Censuses (1971–to–2011) - considered at municipality level - by applying spatial statistical methods, in order to establish the spatial distribution of family typologies, and their development over time. Our first results suggest that the structure of Italian families is changing deeply, following a pattern similar to that characterizing demographic transition in this country (from north-west to south-east, from urban areas to small villages).

Key words: Space-time models, family structures, population census

1 Introduction and aim

Since the second half of the twentieth century, family forms have become more diverse everywhere in Europe. Increasing levels of life-expectancy, together with the decreasing propensity to marry and have children, the increasing tendency to postpone marriage and childbearing, and the general decline in the centrality of marriage in many societies, have led to the formation of very different types of living arrangements (Vignoli *et al.* 2014). The traditional family model-i.e., a household consisting of a couple and their children-has been replaced by a range of family constella-

Marcantonio Caltabiano
Università di Messina, Italia, e-mail: caltabiano@unime.it

Emanuela Dreassi, Emilia Rocco and Daniele Vignoli
Università di Firenze, Italia, e-mail: {dreassi,rocco,vignoli}@disia.unifi.it

tions. Living as a family in Europe today means living longer in smaller (with fewer siblings), often more deinstitutionalized (non-marital) and non-co-resident families (Hantrais 2006), in which the kinship networks have become “tall and lean.” Despite these pronounced changes in family structures, most studies on family life conducted over the past few decades have focused on the traditional family, and have not considered alternative family structures (Uhlendorff *et al.* 2011).

At the end of the Seventies, with some delay in comparison with other countries, traces of family changes began to emerge also in Italy, also as a consequence of new laws introducing divorce and changing gender equality in family relationships. These changes intensified in the Nineties, and accelerated in the first decade of the twenty-first century (Castiglioni and Dalla Zuanna 2008). Although the incidence of new family behaviors is still less evident in Italy than in other Western European countries, marriage dissolution is now a pervasive phenomenon and informal unions have reached unexpected levels. At the same time, Italian fertility is blocked at very low levels since decades.

The aim of this paper consists in drawing a general, comprehensive background picture of the diffusion of new family patterns in Italy. We will make use of the Italian Population Censuses (1971-to-2011) to establish the spatial distribution of family typologies across the Italian territory and its development over time. Through spatial statistical methods - applied with municipality precision - we will assess patterns of temporal and geographic clustering beside the traditional, and possibly simplistic, North-to-South divide.

2 Data

Italian population censuses are held by Istat (Italian National Institute of Statistics) every ten years, and the corresponding population data are available at the municipality level for most variables. This gives us the opportunity to explore the changes in Italian families at the municipality level (about 8,000 administrative units), a territorial level so far rarely considered for the country. We select the censuses held from 1971 to 2011 (the last one is not yet fully available), whose data quality is generally very good (census coverage was 96.5% in 1981, 99.1% in 1991, 98.6% in 2001 and 2011; Istat 2009 and Mazziotta *et al.* 2015). Moreover, among the information available for each municipality, in our study we chose to focus on two specific characteristics of the families: the percentage of families with one component and the percentage of families with five or more components.

3 Method

Acknowledging the spatial correlation structure of the data, we will perform ecological regressions to assess the main factors associated with the diffusion of family

behaviors across the Italian territory over the last decades. In this preliminary analysis, our variables of interest (dependent variables) are the percentage of families with one component and the percentage of families with five or more components. In particular, in order to study the time-space variation of clustering of these kinds of Italian family, we rely on generalized linear mixed models which allow including in the linear predictor both covariates treated as fixed effects and spatial and time structured or unstructured heterogeneity terms. These models could be extended to consider also time-space interaction terms (see Knorr-Held 2000). In fact, space and time are clearly non-additive dimensions. Here the models are implemented into a Bayesian approach.

To give more detail, each model consists in a Poisson (rate parametrized) likelihood

$$y_{it} \sim \text{Poisson}(N_{it}\theta_{it})$$

where N_{it} is the number of families and θ_{it} the rate of families with one/five components for municipality $i = 1, \dots, I$ at time $t = 1, \dots, T$. By using the logarithmic scale to model the rate θ_{it} , the more general formulation of the model that includes a fixed part (with covariates x_{itj}) and a convolution of structured and unstructured gaussian random effects, is:

$$\log(\theta_{it}) = \mu + \sum_j \beta_j x_{itj} + u_i + v_i + \alpha_t + \delta_t + \psi_{it}$$

where μ represents the intercept random effect (constant over the space-time dimensions); β_j is the linear coefficients; x_{itj} are the covariates; u_i is the unstructured spatial random effect; v_i is structured the spatial random effect; α_t is the unstructured temporal random effect; δ_t is the structured temporal random effect; and finally ψ_{it} is the unstructured interaction term.

The following prior distribution are given: for μ and β_j (for each j) a flat distribution (normal with low precision); for the spatial structured vector \mathbf{v} a Gaussian intrinsic conditional autoregressive (ICAR)

$$p(\mathbf{v} | \lambda_v) \propto \exp\left(-\frac{\lambda_v}{2} \sum_{i \sim j} (v_i - v_j)^2\right)$$

for the time structured vector δ (temporal structured) a random walk with Gaussian step, i.e.

$$p(\delta | \lambda_\delta) \propto \exp\left(-\frac{\lambda_\delta}{2} \sum_{t=2}^T (\delta_t - \delta_{t-1})^2\right)$$

for the spatial unstructured vector \mathbf{u} , the temporal unstructured vector α a gaussian exchangeable model, i.e.

$$p(\mathbf{u} | \lambda_u) \propto \exp\left(-\frac{\lambda_u}{2} \sum_{i=1}^I u_i^2\right) \quad \text{and} \quad p(\alpha | \lambda_\alpha) \propto \exp\left(-\frac{\lambda_\alpha}{2} \sum_{t=1}^T \alpha_t^2\right)$$

Finally, for the unstructured space-time interaction vector ψ again a gaussian exchangeable model

$$p(\psi | \lambda_\psi) \propto \exp\left(-\frac{\lambda_\psi}{2} \sum_{i=1}^I \sum_{t=1}^T \psi_{it}^2\right)$$

The hyperprior for λ parameters are not informative Inverse Gamma.

To estimate the model we have used MCMC methods (Gibbs Sampler) because posterior distributions are not in closed form.

4 Preliminary findings and future work

For the sake of simplicity we show the results just for the North-West section of the country and for families with five or more components. In Figure 1 we illustrate rates from the additive space-time model while in Figure 2 those from the space-time interaction model. For both models covariates are not included. Our first results suggest that the structure of Italian families is changing profoundly, following a pattern similar to that characterizing demographic transition in this country (from north-west to south-east, from urban areas to small villages).

Interestingly, families start to become smaller in mountainous areas and villages far from main communication routes (see Golini *et al.* 2000). Overall, our preliminary results point to a temporal and geographic clustering of Italian families that goes beyond the traditional North-to-South divide.

We will continue by performing ecological regressions to assess the main factors associated with the diffusion of family behaviors over the last decades (role of demographic and socio-economic covariates). In addition, we will go beyond the indicators used in the preliminary work and, we focus on changes in family typologies across space and time (1971-2011).

References

1. Castiglioni, M., Dalla Zuanna, G. Marital and Reproductive Behavior in Italy After 1995: Bridging the Gap with Western Europe? *European Journal of Population*, **25**, 1–26 (2008).
2. Golini, A., Mussino, A., Savioli, M. Il malessere demografico in Italia. Una ricerca sui comuni italiani. Bologna: Il Mulino (2000)
3. Hantrais, L. Living as a family in Europe. In L. Hantrais, D. Philipov and F. C. Billari (Eds.), Policy implications of changing family formation, *Population Studies*, 49, 117–181. Strasbourg: Council of Europe Publishing (2006)
4. Istat. La qualità dei dati. 14° Censimento generale della popolazione e delle abitazioni - 21 ottobre 2001. Rome: Istat (2009)
5. Knorr-Held, L. Bayesian modelling of inseparable space-time variation in disease risk. *Statistics in Medicine*, **19**, 2555–2568 (2000)
6. Mazziotta, M., Bernardini, A., Russo, M. The Post Enumeration Survey of 15th Italian Population Census: Methods and Results. In *Proceedings of the 2015 POPDAYS Conference*. Palermo: Universit di Palermo (2015)

7. Uhlenborff, U., Rupp, M. and Euteneuer, M. (eds.) Wellbeing of families in future Europe- Challenges for research and policy, family platform-Families in Europe, Vol. 1 (2011)
8. Vignoli, D., Pirani, E., Salvini, S. Family Constellations and Life Satisfaction in Europe. Social Indicators Research, **117**, 967–986 (2014)

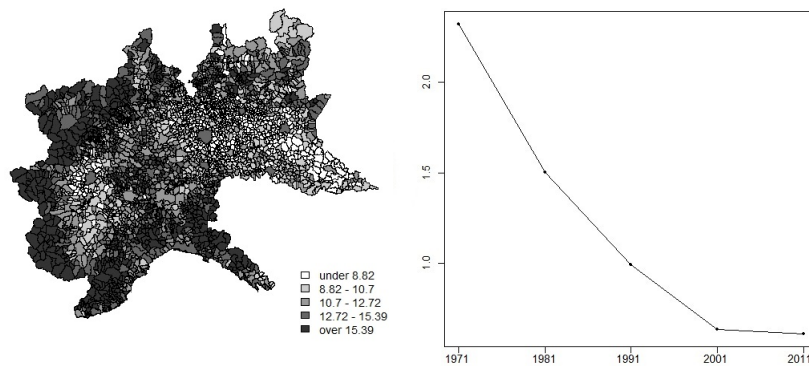


Fig. 1 Results from the model without the interaction term ψ_{it} for families with five or more components on the North-West part of Italy: the model is space-time additive. On the left the spatial component $\exp(u_i + v_i)$, on the right the time component $\exp(\alpha_t + \delta_t)$ for time $t = 1971, 1981, 1991, 2001, 2011$.



Fig. 2 Results from the model with the interaction term ψ_{it} for the family with five r more components on the North-West part of Italy θ_{it} .