

Future Patterns of Italian Fertility: Evaluation by Multistate Models¹

Tendenze della fecondità italiana: valutazione tramite modelli multistato

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Riassunto: Nel presente lavoro si definiscono le tendenze evolutive della fecondità italiana e si valutano e descrivono i percorsi plausibili nel futuro. Si è fatto ricorso ad un approccio di simulazione con un modello multistato il cui input è stato determinato tramite regressioni logistiche a partire da microdati, derivati dall'indagine nazionale di fecondità del 1995-1996, superando così le principali limitazioni delle stime usuali. I risultati mostrano il mantenimento degli attuali livelli della fecondità o un loro ulteriore declino, ed evidenziano come tale tendenza potrebbe interrompersi solo a seguito di modificazioni nei comportamenti individuali che non sembrano al momento plausibili.

Keywords: Fertility, Trends, Event history analysis, Multistate models

1. Introduction

During the last decades of the 20th century, Western countries underwent a sharp decrease in fertility accompanied, although only partially in Italy, by new models of behaviour among couples and new scales of values. The period fertility rate, which fell below the threshold for generation replacement of the population at the end of the 1970s, remained at around 1.15-1.25 children per woman in the 1990s, with a sharp rise in the average childbearing age observed in the various cohorts. This paper tries to define the future plausible trends in Italian fertility, as well as evaluating and formulating policies for fertility support. Starting from a theoretical basis, the so-called second transition, future scenarios have likewise been created on the basis of hypotheses linked to the diffusion of this behaviour. Trends have been obtained by macro-simulations on women residing in the various geographical areas (Northwest, Northeast, Central, South and the Islands), with a reinterpretation on a national level.

2. Data and Methods

Data on the micro level are from the second National Survey on Fertility in Italy (Inf-2), conducted between November 1995 and February 1996, with a sample formed by 4,824 women aged 20-49. The model used for the macro-simulations (LiPro - Lifestyle PROjections) is dynamic and multistate: it is based on the theory of the Multistate Life Tables commonly included in the Markov-chain time-continuous models with a finite

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state space. The process is described in terms of jumps, where each event corresponds to a jump between two distinct positions of the state space. The jumps are determined in LiPro on the basis of transition probabilities estimated starting from intensities, or instantaneous probabilities of transition. We assume $X \geq 0$ as the continuous non-negative parameter representing the time that passes since the occurrence of a particular event. The state space adopted consists of 6 positions deriving from the combinations of the status of the union (single or couple) with parity (0, 1, 2+ children). Thus any individual of the population under observation, who jumps from one position to another according to the variation of X , can be observed. This stochastic process is described by dummy random variables $I_i(x)$ ($i=1, \dots, 6; x \geq 0$) so that $I_i(x) = 1$ if the individual concerned occupies state i at time x , otherwise 0. Each jump is due to the occurrence of an event. There are 30, but some are logically impossible (reduction of the number of children already had) and others, like multiple instantaneous events, can be excluded by hypothesis. Once the state space has been defined, the model requires an initial population and a set of transition-probabilities, $\pi_{ij}(x,y)$, defined as the probability of $I_j(y)=1$ conditioned by $I_i(x)=1$, or a set of transition-intensities, $\mu_{ij}(x)$, defined as:

$$m_{ij}(x) = \lim_{h \rightarrow 0} \frac{p_{ij}(x, x+h)}{h} \quad i \neq j$$

In 1997 Willekens, in a discussion on multistate population-projection models, stressed the importance of the phase of estimating the intensities of transition, calling for the use of regression models on an individual basis, thus overcoming the difficulties in estimating the probabilities of transition on the macro level. This is the basis, in the context of links between the event-history analysis and the basic theory of the multistate life tables, for the use of logistic regression². For such a purpose, a closed population of women, with no mortality, were followed from birth up to the age of 50, using monthly intervals (Di Tanna, 2000). The covariates used (time-varying), are current age, the status of the union, parity and a cohort dummy (women born before or after 1960) included to take into account more recent models of behaviour. The inadequacy of the estimates of the occurrence/exposure rates at the macro level is thus overcome by using methods which follow the biography of the individuals. Once the instantaneous-risk matrix is obtained, the LiPro was used to calculate the transition-probability matrix and then the life and birth tables and experience tables, these being special tables limited to members of the population who have experienced a specific event at least once. To analyse the results on an aggregate level, a suitable weighting was carried out in the 5 geographical models obtained, with weights derived from the percentage composition of the women interviewed.

This procedure was then applied to each simulation. Various future scenarios were then obtained on the basis of two categories of hypotheses: the first type involves modifications of the functional pattern of the transition-intensity sets and the second

⁽²⁾ In particular, defining the hazard function $h(t)$ as the limit for $dt \rightarrow 0$ of $\Pr[t \leq T < t+dt | T \geq t]/dt$ or also as the ratio between $f(t)$ and $S(t)$ where $f(t)$ is the density of the cumulative distribution function $F(t) = \Pr[T \leq t]$ and $S(t) = 1-F(t) = \Pr[T > t]$, or the *survivor function*, and considering a series of random variables T_n , we can interpret $h(t)$ as the instantaneous rate at which the n -th event occurs in $[t, t+dt)$, with $h(t)dt = \Pr[t \leq T_n < t+dt | T_n \geq t]$.

type has the aim of studying how *imitative* behaviour (limited to the transition-intensities between states of parity) between geographical areas can modify the fertility trend on a national level.

3. Main Results and Discussion

The picture emerging from the benchmark models shows Italy to be characterised by definitely varied types of behaviour, with the north-central areas associated with very low fertility rates, only partially balanced by higher values in the South and the Islands which are in any case far below the generation-replacement threshold (Table 1). Aggregating the results by geographical area, the overall fertility rate reached in our country is 1,276 and corresponds with some extent to the real level. Besides confirming the scenarios, this enables us to validate the methodological process undertaken. A total of 95.6% of births occur within unions (either marriage or cohabitation).

Table 1: Benchmark Models. Main fertility characteristics.

	TFR	Women with at least one child (%)	Average age at first child	Women with at least two children (%)	Average age at second child
Northwest	0.939	57.33	30.9	24.67	33.4
Northeast	1.087	55.40	29.6	31.50	32.8
Centre	1.075	58.81	30.2	30.49	33.2
South	1.759	66.44	28.7	49.23	31.7
Islands	1.672	59.73	29.1	46.15	32.4

The different scenarios created by simulation (Table 2) indicate that:

- The timing of starting cohabitation strongly influences the fertility rate and a further delay in leaving the parental home would have significant consequences.
- The break-up of unions has a minimal effect on the aggregate reproductive behaviour.
- A further lowering of the propensity to have the first child could only be balanced by an earlier starting of cohabitation.
- If the current trend were to continue, with the Centre adopting reproductive behaviour commons to the North and the South those of the Centre, a further decrease in fertility rate, to 1.02 children per woman, would be expected.

Table 2: Total Fertility Rate according to different hypothesis and variations from Benchmark Models.

Model	Hypothesis	TFR	Variation %
1	Lowering the age of start of union	1.692	+32.57
2	Raising the age of start of union	1.005	-21.26
3	Elimination of the dissolving of unions	1.315	+3.00
4	Reduction of transitions to first child	0.967	-24.23
5	Combination of models 1 and 4	1.297	+1.61
6	The Northwest adopts the behaviour of Central Italy	1.330	+4.19
7	Central Italy and the Northeast adopt the behaviour of the Northwest	1.210	-5.17
8	Central Italy and the Northeast adopt the behaviour of the South	1.474	+15.47
9	The South and the Islands adopt the behaviour of Central Italy	1.083	-15.18
10	Combination of models 7 and 9	1.017	-20.35
Benchmark	No modifications	1.276	-

The results have confirmed what we expected, i.e. the definite trend to postpone and decrease fertility and a strong geographical characterisation.

The analysis conducted has enabled us to evaluate current trends in Italian fertility, and their plausible future changes. On the basis of the results presented, which are only summarised here, our country could experience a further decrease in the fertility rate ranging between 5% and 20%. This negative trend could be stopped only with decisive changes which currently seem unlikely. Even the extreme hypothesis of anticipating cohabitation of five years, while producing a recovery of about one third in the fertility rate, would leave us well below the generation-replacement rate.

Our aim was to evaluate the future trends in Italian fertility. The theoretical approach of the second transition was used as a background for processing our scenarios. A consolidated methodological tool, i.e. the multistate modelling, was applied. In this context, we went beyond some classical limitations, by using direct estimates of transition probabilities, starting with individual data. Thus also provided an indication of the reliability of the estimates which is not available in traditional approaches. Furthermore, problems concerning interpretation can easily be overcome by the use of a state space that considers factors such as education, employment status and alternative forms of union. Finally, this procedure enabled us to obtain solid, satisfactory estimates for the phase of formulating the simulation hypotheses which painted a worrying picture for future trends in Italian fertility. It should be said that we are still at an early stage, and although highly interesting and detailed results were obtained, further endeavour is warranted to forge a valid tool for the evaluation of policy interventions to sustain fertility.

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