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High-to-Low (Regional) Fertility Transitions in a Peripheral European Country: The Contribution of Exploratory Time Series Analysis

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Abstract: Diachronic variations in demographic rates have frequently reflected social transformations and a (more or less evident) impact of sequential economic downturns. By assessing changes over time in Total Fertility Rate (TFR) at the regional scale in Italy, our study investigates the long-term transition (1952–2019) characteristic of Mediterranean fertility, showing a continuous decline of births since the late 1970s and marked disparities between high- and low-fertility regions along the latitude gradient. Together with a rapid decline in the country TFR, the spatiotemporal evolution of regional fertility in Italy—illustrated through an exploratory time series statistical approach—outlines the marked divide between (wealthier) Northern regions and (economically disadvantaged) Southern regions. Non-linear fertility trends and increasing spatial heterogeneity in more recent times indicate the role of individual behaviors leveraging a generalized decline in marriage and childbearing propensity. Assuming differential responses of regional fertility to changing socioeconomic contexts, these trends are more evident in Southern Italy than in Northern Italy. Reasons at the base of such fertility patterns were extensively discussed focusing—among others—on the distinctive contribution of internal and international migrations to regional fertility rates. Based on these findings, Southern Italy, an economically disadvantaged, peripheral region in Mediterranean Europe, is taken as a paradigmatic case of demographic shrinkage—whose causes and consequences can be generalized to wider contexts in (and outside) Europe.

Keywords: regional disparities; total fertility rate; exploratory time-series approach; Italy

Citation: Rodrigo-Comino, J.; Egidi, G.; Salvati, L.; Quaranta, G.; Salvia, R.; Gimenez-Morera, A. High-to-Low (Regional) Fertility Transitions in a Peripheral European Country: The Contribution of Exploratory Time Series Analysis. *Data* **2021**, *6*, 19. https://doi.org/10.3390/data6020019

Academic Editor: Eric Vaz

Received: 28 December 2020
Accepted: 15 February 2021
Published: 16 February 2021

1. Introduction

Like other demographic processes, fertility decline intensified in advanced economies since the 1970s, with distinctive regional trends [1–9]. In Europe, the 'first demographic transition' has reflected—at least since the late 1960s—a fertility decrease together with (more or less evident) socioeconomic transformations [10–14]. Later on, the 'second demographic transition' has coincided with more heterogeneous and individualized demographic behaviors, leading to non-traditional family forms, cohabitation, marriage and childbearing postponement, resulting in an even more intense decline of birth rates. The role of exogenous drivers of change (e.g., the evolving labor and housing markets, institutional and

cultural transformations, strategic developmental policies and local governance) consolidated over time [15–18]. Economic stagnation has been regarded as a powerful cause of fertility decline [19–21]. This process was rather evident in peripheral Europe, and especially in Mediterranean countries, since the mid-1970s [12,22–26]. Such trends significantly differed from those observed in Central Europe—despite the structurally low birth rates typical of this region—and were also distinct from the high fertility of Western and Northern Countries [9,27–31], despite a temporary recovery associated with the 2000s economic expansion [32–36].

Based on these premises, a refined understanding of long-term population trends in advanced economies (i.e., encompassing both the first and the second demographic transitions) is especially meaningful to identify specific fertility trends and the underlying socioeconomic drivers in wealthy, peripheral countries, e.g., in Southern Europe [16]. Especially in such contexts, a better investigation of regional fertility contributes to reconcile basic knowledge from analysis of traditional (macro)indicators and approaches grounded on a refined comprehension of socio-demographic mechanisms at the base of individual choices [37–39]. Among Mediterranean countries, Italy is a particularly appropriate example of territorial divides in birth rates, with high-fertility districts located, for a long time, in Southern regions [39].

Our study illustrates the results of a time-series analysis exploring a sufficiently long period (1952–2019) and providing an overview of fertility trends in the Italian regions. These findings may inform a thorough discussion of mechanisms underlying formation and consolidation of spatial disparities in fertility, in Italy as well as in other peripheral countries of Europe [40]. An exploratory investigation of regional fertility is intended to highlight diversified demographic responses to economic downturns, possibly delineating the specific contribution of sequential expansion and recession waves. The empirical results of this investigation may contribute to rethinking long-term demographic trends in light of spatial complexity and local heterogeneity, outlining—especially with the second demographic transition—the increased role of individual behaviors toward marriage and childbearing.

2. Materials and Methods

2.1. Study Area

Displaying comparable population trends with other Southern European countries, such as Portugal, Spain, or Greece [19,20,32,41], Italy was regarded as a representative case in Mediterranean Europe of late and spatially heterogeneous fertility changes—in respect with earlier (and likely less intense) high-to-low fertility transitions typical of Western, Northern, and Central Europe [5,42,43]. While approaching the lowest fertility in the early-1990s after prolonged high fertility, a temporary recovery in gross birth rates was observed in the 2000s [43]. A regional divide in Northern and Southern Italy characterized regional fertility in the country up to the early 1990s, with the highest rates observed in economically disadvantaged Southern regions for a relatively long time. Even more intense within-regions differences in gross birth rates have been recorded in Italy depending on the local context [44,45].

More specifically, the traditional division into Northern and Southern regions highlights the intense territorial disparities characteristic of Italy, similarly to other large European countries such as Germany, Spain, or the United Kingdom. Since World War II, the Northern regions in Italy have represented an affluent area, with a consolidated economic structure based on industry and advanced services. Industrial (and infrastructural) development has long been facilitated by the great accessibility of the Po Valley, a central location with respect to the European countries with which Italy has the most intense commercial and institutional relations (e.g., France, Germany). For a long, Central Italy has represented a developed and moderately rich area, with a strong agricultural and tourism vocation, a widespread industrial structure and concentration of advanced services in specific districts, especially in Tuscany and Marche. However, marked disparities

between urban areas (e.g., Rome and Florence) and rural areas have been observed in this region [46]. Southern Italy, a peripheral and economically backward area, has benefited from an intense flow of economic subsidies granted by the development policies of the European Union. Agricultural specialization, lack of industrial concentration except in a few poles (e.g., Naples), settlement dispersion and spatially fragmented urbanization along the sea coast—together with the peripheral position of internal areas, in many cases still socially backward—make this context similar to the most marginal regions of Southern Spain and Greece [47–49].

2.2. Demographic Data

Total Fertility Rate (TFR) was adopted in this study as a honest indicator of fertility spatial patterns and trends over time. TFR represents the average number of children per woman over a certain year, cumulating the specific fertility quotients calculated dividing, for each fertile age (15–49 years), the number of live births to the (average) female population at the same year. TFR was derived from vital statistics released annually by the Italian National Institute of Statistics (ISTAT) covering a time period encompassing 68 years (1952–2019), a sufficiently long time series including significant socioeconomic dynamics since World War II. TFR was calculated separately for 20 administrative regions, a geographical domain corresponding with the NUTS-2 level of Eurostat hierarchical classification of the European space. Administrative regions in Italy (Figure 1) were classified in three macro-domains: (i) Northern Italy (Aosta Valley, Piedmont, Lombardy, Liguria, Trentino Alto Adige, Veneto, Friuli Venezia Giulia, and Emilia Romagna), (ii) Central Italy (Tuscany, Umbria, Marche, and Latium), and (iii) Southern Italy (Abruzzo, Molise, Campania, Apulia, Basilicata, Calabria, Sicily, and Sardinia).

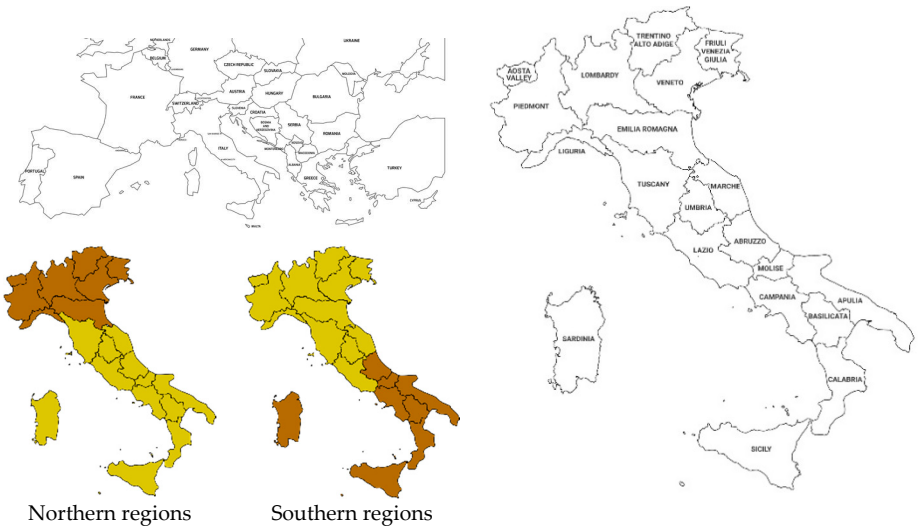

Figure 1. The position of Italy in Europe and the Northern Mediterranean basin (upper left); the geography of administrative regions in Italy (right); classification of administrative regions in two macro-partitions (lower left).

2.3. Data Analysis

Our study evaluates TFR time series separately for each of the Italian regions between 1952 and 2019. An integrated, exploratory analysis based on multivariate and time-series approaches was proposed here to investigate latent patterns in long-term regional fertility along the post-war Italian development. A refined knowledge of such patterns may reveal interesting elements for a refined comprehension of present demographic conditions and a more precise (short-term) prediction of population dynamics, of interest for both socioeconomic disciplines and environmental studies [50]. A hierarchical clustering was carried out on a data matrix constituted of TFR values at 20 regions (from Aosta Valley to Sardinia)

and 68 years (from 1952 to 2019). Hierarchical clustering is a multivariate exploratory technique analyzing complex data matrices [51] and assumes that cases (years) and variables (administrative regions) contribute to delineate apparent (and latent) patterns in regional fertility. Based on Euclidean metric and Ward's agglomeration rule [52], a dendrogram was constructed illustrating similarities (or differences) in long-term fertility regimes across administrative regions in Italy [53,54].

An exploratory approach based on a multivariate time-series analysis was run on regional fertility rates by calculating multiple autocorrelation coefficients by lag (from 1 to 33 over 68 years). Autocorrelation is a statistical technique implemented in time series analysis with the aim at measuring the degree of correlation of two values in the same data set at different times [55]. We adopted four autocorrelation coefficients (namely, Bray-Curtis, Pearson, Spearman, and Morisita metrics) that range between 1 (the highest positive autocorrelation over time) and -1, representing the highest negative autocorrelation over time [56]. Being appropriate for analysis of time series with different statistical characteristics, these metrics allow a joint exploration of data (i) with both normal and non-normal statistical distribution and (ii) with both linear and non-linear structure over time. A comparative analysis of these metrics provides an enhanced overview of a given time series structure, irrespective of the length over time (i.e., the number of observation) and the intrinsic statistical features of the data [55]. Finally, results' stability using various metrics was considered an indirect proof of statistical robustness and conceptual representativeness of the analysis.

Global and local analysis have been performed respectively considering (i) all regions together and (ii) each region separately. A Mantel scalogram—a multivariate extension to autocorrelation quantifying similarity (or distance) between the multivariate time series and a time-lagged copy, for different lags [57]—was carried out at both analysis' levels. The scalogram plots similarities between all pairs of points along with the time series, with the apex representing the degree of similarity between the first and last point and the base illustrating similarities between pairs of consecutive time points [58]. The global analysis was complemented with the Mantel periodogram representing a power spectrum of the multivariate time series [59]. This spectrum was derived from the Mantel correlogram, assessing the temporal structure of the TFR series (i.e., estimating the relative frequency of recurrent fertility levels at varying lags).

The exploratory approach was complemented with results of a Continuous Wavelet Transform (CWT) adopting a Morlet function and running on the complete TFR time series separately for each Italian region [56]. The CWT is a procedure exploring latent structures of data sets at small, intermediate and large scales simultaneously, with the final objective at identifying (i) data periodicities at multiple wavelengths, (ii) self-similarity and (iii) other (intrinsic) features of the studied time series [59]. CWT provides a graphical outcome called biplot, with the vertical axis (logarithmic size scale) representing the signal recorded at a scale of only two consecutive data points at the bottom, and a scale of one-fourth of the whole sequence at the top [58]. CWT algorithm is based on fast convolution of the signal with the wavelet at different time scales, using the fast Fourier transform. Assuming that one unit on this axis corresponds to a doubling of the size scale, the bottom of the CWT biplot provides a fine-grained representation of short-term time trends, and the top depicts a smoothed overview of trends at broader time scales. Taken together, results of temporal autocorrelation analysis, Mantel scalograms and Continuous Wavelet Transform, give further insight in the intrinsic complexity of fertility transitions in Italy. Regional specificities are discussed in line with literature information on the socioeconomic development path characteristic of each spatial domain.

3. Results

Between 1952 and 2019, fertility in Italy decreased from 2.4 to 1.3 children per woman (Supplementary Materials, Table S1). A continuous increase was observed between 1952 and 1964–1965 (from 2.4 to 2.7 children per woman), preceding an intense decrease between

1965 and 1998 (from 2.65 to 1.18 children per woman). A temporary fertility recovery was observed between 1999 and 2010 (ranging from 1.19 to 1.42 children per woman), and a new decline manifested between 2011 and 2019 (shifting from 1.40 to 1.29 children per woman). Changes over time in the North-South fertility gap were reported in Table 1 and summarized in Figure 2.

Table 1. Total Fertility Rate in the Italian Regions at selected years between 1952 and 2019.

Region	1952	1960	1970	1980	1990	2000	2010	2019
Piedmont	1.49	1.65	2.09	1.34	1.10	1.17	1.44	1.30
Valle d'Aosta	1.82	1.73	2.21	1.37	1.18	1.28	1.63	1.31
Liguria	1.39	1.56	1.88	1.11	1.01	1.03	1.37	1.21
Lombardy	1.90	1.98	2.15	1.40	1.15	1.21	1.57	1.36
Trentino-Alto Adige	2.52	2.67	2.55	1.67	1.40	1.46	1.65	1.57
Veneto	2.37	2.43	2.39	1.45	1.16	1.22	1.50	1.32
Friuli-Venezia Giulia	1.75	1.91	2.03	1.25	1.03	1.10	1.40	1.23
Emilia-Romagna	1.69	1.79	1.96	1.18	1.01	1.17	1.54	1.35
Tuscany	1.64	1.79	1.95	1.32	1.08	1.12	1.42	1.25
Umbria	1.85	1.96	1.92	1.49	1.17	1.17	1.42	1.23
Marche	2.01	2.03	2.11	1.52	1.23	1.18	1.42	1.20
Latium	2.21	2.25	2.35	1.59	1.28	1.20	1.46	1.27
Abruzzo	2.46	2.35	2.35	1.74	1.39	1.16	1.37	1.18
Molise	2.46	2.35	2.41	1.82	1.42	1.15	1.24	1.15
Campania	3.18	3.27	3.20	2.34	1.81	1.48	1.45	1.31
Apulia	3.38	3.26	3.03	2.24	1.65	1.35	1.35	1.22
Basilicata	3.49	3.19	2.91	2.04	1.66	1.25	1.20	1.15
Calabria	3.39	3.46	2.99	2.25	1.74	1.26	1.32	1.26
Sicily	2.96	3.15	2.90	2.22	1.85	1.41	1.44	1.32
Sardinia	3.80	3.45	2.92	1.99	1.37	1.06	1.19	1.03

Figure 2. Total fertility rate between 1952 and 2019 in three macro-regions (North, Centre, South) of Italy.

Fertility levels in Southern Italy (especially in Campania, Apulia and Sicily) were rather stable between the 1950s and the 1960s, decreasing during the 1970s. Mild and relatively more stable birth rates were observed in Sardinia, Calabria, and Basilicata. While being classified as peripheral regions in Italy, Abruzzo and Molise were in some ways more similar to Central Italian regions such as Latium, Umbria or Marche. Fertility levels in more dynamic regions were less marked and the decline was less intense over time during the first demographic transition, between the 1970s and the 1990s. Interestingly, fertility

recovery in the 2000s was more intense than in Southern regions. A particularly accelerated recovery was observed in correspondence with less peripheral, advanced regions such as Lombardy, Veneto, Emilia Romagna, Trentino Alto Adige and, in part, Tuscany and Piedmont. High-fertility regions such as Campania (Southern Italy), showed the reverse pattern, demonstrating the most rapid response of dynamic and central areas to the intrinsic changes typical of the second demographic transition. Such dynamics progressively reduced the fertility gap between Northern and Southern Italy (1.5 children per woman more in Southern Italy during the 1950s), being substantially neutral at the beginning of the 2000s. Ten years later (2010), fertility rates were higher in Northern Italy than in Southern Italy for the first time in the modern history (Figure 2). A hierarchical clustering run on long-term TFRs with Euclidean distances and Ward agglomeration rule indicates a traditional division of Italy in dynamic and disadvantaged regions (Figure 3), reflecting the North-South gradient. Similarities in long-term fertility trends were particularly evident for Northern and Central Italy; Southern regions clustered together.

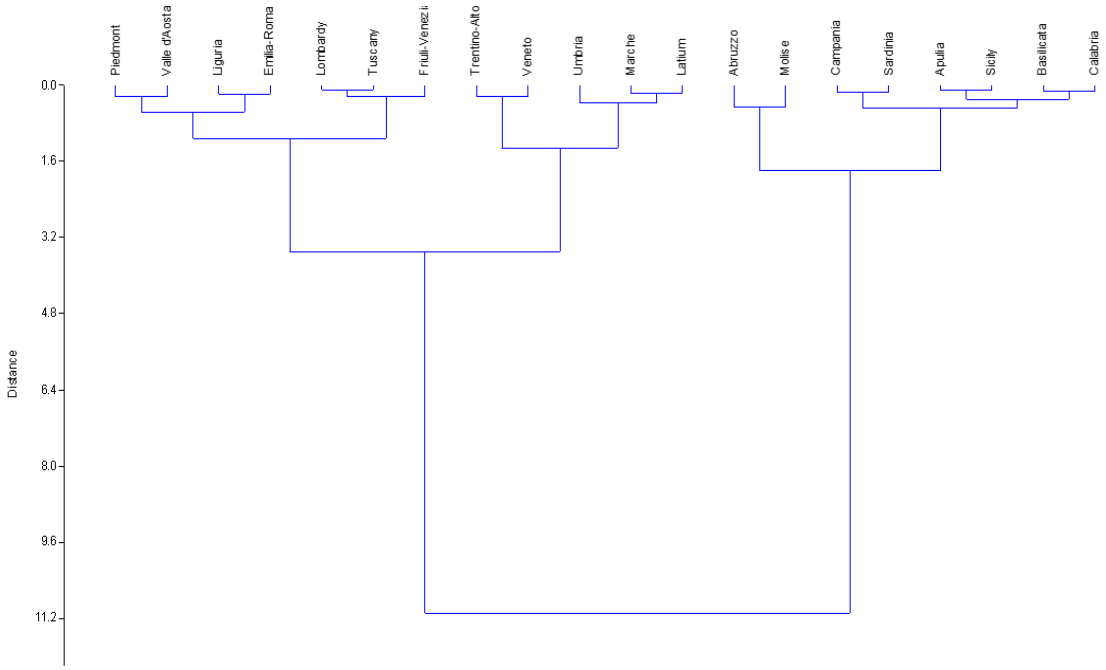

Figure 3. A dendrogram of hierarchical cluster analysis (Euclidean distances, Ward's agglomeration rule) representing similarities and differences of regional fertility rates in Italy, 1952–2019.

An exploratory time series analysis of regional fertility in Italy showed simplified latent structures at the global scale. Partial auto-correlation coefficients over time for TFRs were positive and significant only at lag 1 for all regions in Italy (with values ranging between 0.95 and 0.99). This result suggests a linear, short-term dependence structure over the whole time series. Considering together all regional time-series based on a multivariate approach, results of four different metrics (Bray-Curtis, Pearson, Spearman, Morisita) outline a progressive decline of temporal autocorrelation with increasing lags. Mantel periodogram confirms the importance of lag-1 autocorrelation structure in regional fertility time-series. The scalogram plot finally delineates the polarization between (i) short-term fertility regimes, reflecting a rather simplified and linear autocorrelation structure, and (ii) long-term trends showing a regime shift toward a more complex structure with smaller similarities (Figure 4).

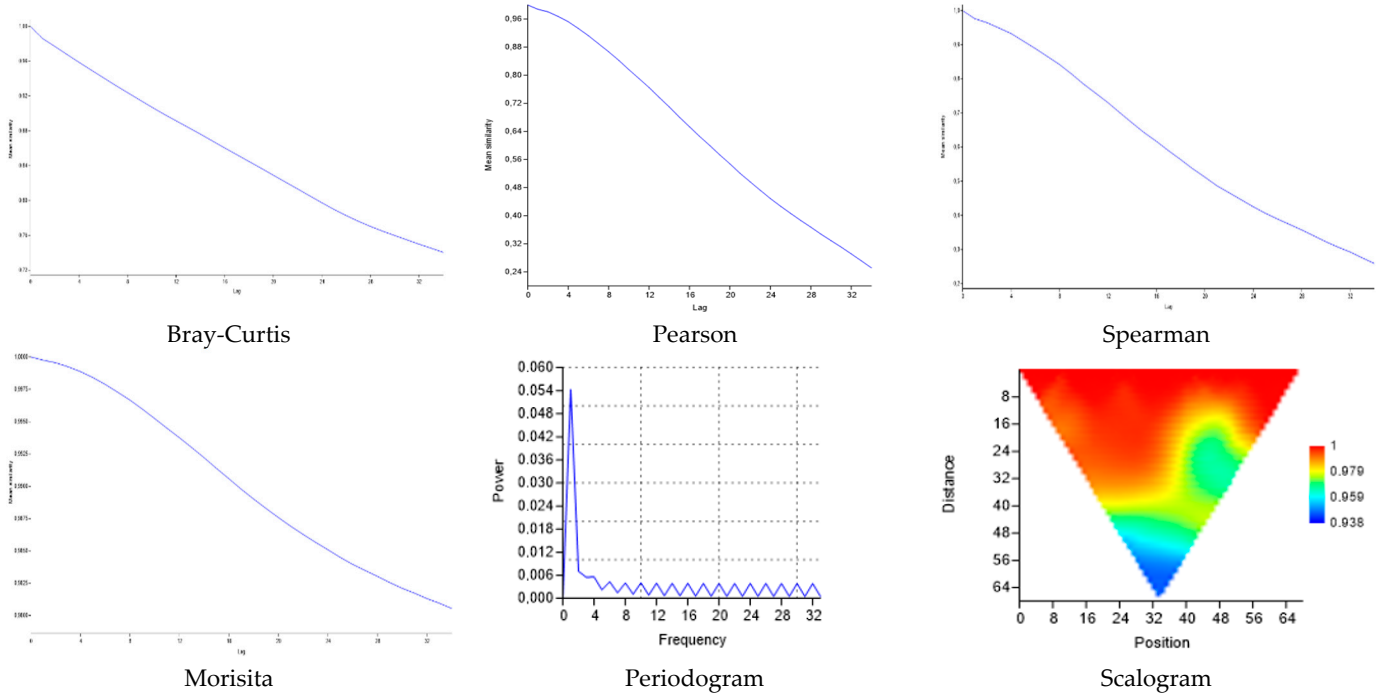

Figure 4. A global (exploratory, multivariate) time-series analysis of regional fertility in Italy, 1952–2019; four autocorrelation coefficients by lag (Bray-Curtis, Pearson, Spearman, Morisita) were illustrated together with a general periodogram and scalogram plots.

A time-series analysis was run separately for each Italian region (Figure 5) evidencing a substantial similarity in the regional TFR across the country, although the scalogram was highly comparable only for Southern Italian regions. Mantel's scalogram based on similarity coefficients showed a characteristic structure of long-term birth rates. This structure was demonstrated to 'loose memory' more rapidly in Southern Italian regions (Campania, Apulia, Basilicata), in turn displaying a more intense shift from high-to-low fertility. Long-term fertility trends in Northern Italy demonstrated to 'loose memory' less rapidly, indicating a more balanced transition from high fertility to low fertility. However, Mantel's scalogram in both contexts outlined the intrinsic similarity of demographic behaviors at the beginning (1950s and 1960s) and the end (2000s and 2010s) of the time series, in turn classifying the intermediate decades (1970s, 1980s, 1990s) as a transitional period.

Empirical results of a Wavelet analysis were presented in Figure 6 using biplots that report spectrums illustrating short-term and long-term fertility trends respectively at the bottom and the upper part of each plot. The lowest part of the Continuous Wavelength Transform (CWT) biplot indicates a (more or less intense) fertility decline in Italy with a rather stable structure reflecting the inherent transition from high to low fertility. Two homogeneous transitional patterns have been observed in regions of Northern and Central Italy, around time 16 and 48 (corresponding with the mid-late 1960s and late 2000s). Less similar dynamics were evident in Southern Italy: two particularly intense transitions were observed in Campania, with a similar timing of that found in Northern/Central Italy. A more complex transitional pattern was recorded in Abruzzo, Molise and Apulia. Sardinian and, in part, Calabria fertility displayed less intense transitions. Multiple shifts at various wavelengths were recorded in Sicily and Abruzzo, documenting how fertility transitions were less balanced over time in peripheral regions likely as a result of abrupt population changes all over the study period (e.g., internal migration toward the north, international emigration toward Americas and more advanced economies in Europe).

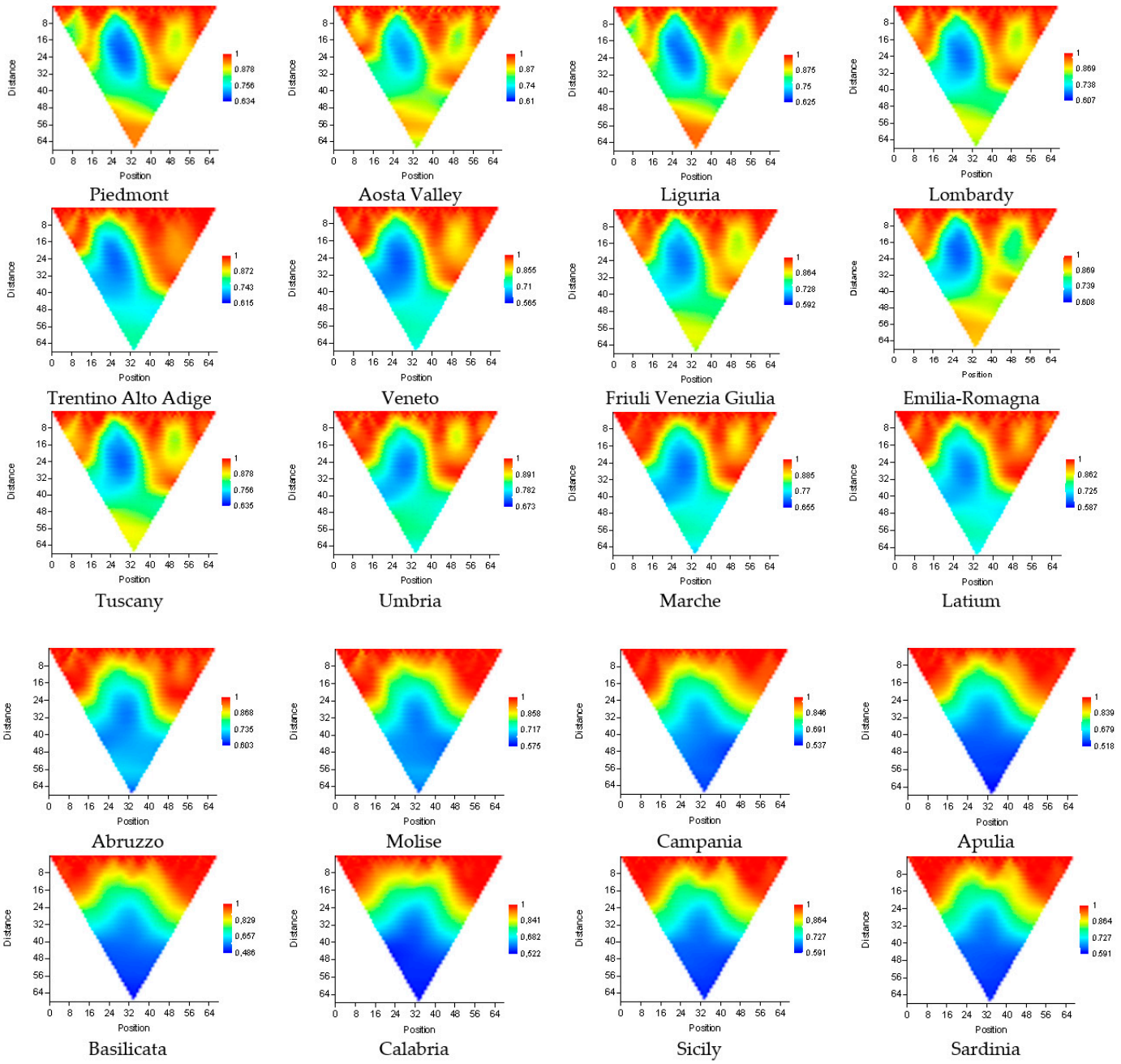

Figure 5. Scalogram illustrating the temporal auto-correlation structure (rho similarity coefficient) of regional fertility rates in Italy, 1952–2019.

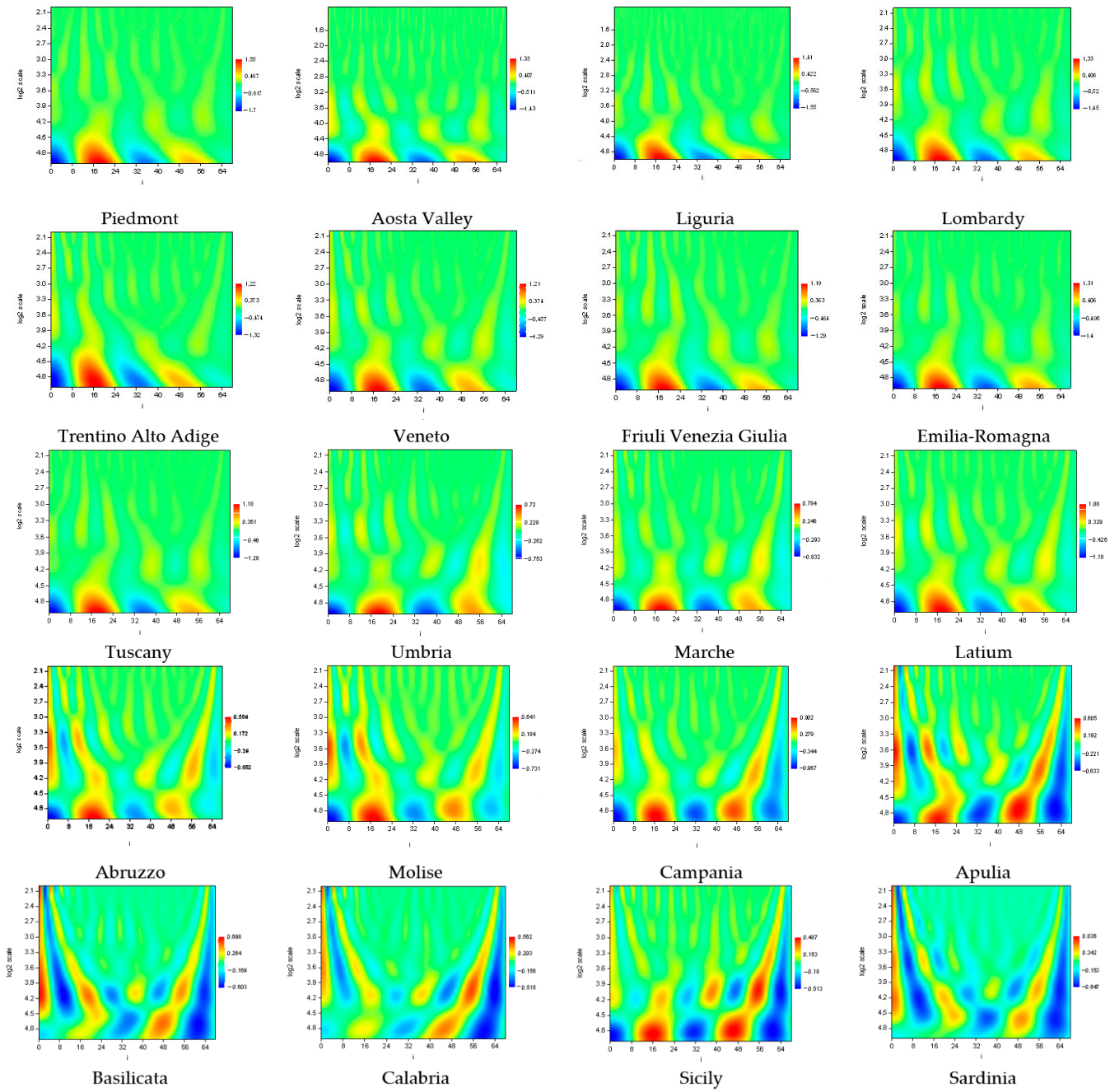

Figure 6. Continuous Wavelength Transform (CWT) plots for fertility trends in Italian regions, 1952–2019.

4. Discussion

Economic downturns, urbanization, internal and international migration, changes in individual attitudes towards family social institution (e.g., marriage and childbearing postponement), were (more or less relevant) socioeconomic dimensions affecting regional fertility levels [21,24,60]. These dimensions have influenced long-term demographic dynamics anticipating, at least in some cases, short-term fertility patterns [26,35,43]. Results of our work delineate, likely better than other—more traditional—approaches, a fertility trend typical of the late stages of the first demographic transition (fertility decline in both Northern and Southern Italy, possibly with high between-region differences and a relatively low within-region heterogeneity). A less intense fertility decline, and a low between-region heterogeneity in reproductive behaviors, were characteristic of the early phase of the second demographic transition [16,52,61]. This new pattern, however, was not

associated with homogeneous fertility levels at the local scale, varying with the socioeconomic context [62–64]. As a matter of fact, the new regime seems to reflect more individual (demographic) behaviors, in parallel with a moderate decline in the role of traditional (e.g., economic) factors of population change [24,65–67].

Considering time intervals long enough to represent different components of an economic cycle impacting fertility trends and shaping population structures at large, a comparative analysis of changes in regional fertility regimes provides relevant knowledge to a refined understanding of the intrinsic linkage between demographic dynamics and socioeconomic contexts [18,68,69]. Assuming expansions and recessions as important factors influencing individual decisions towards marriage (and childbearing) postponement [10,70–72], our study compared fertility trends over more than 60 years of the recent demographic history in Italy, considering separately 20 administrative regions that reflect a developmental gradient from advanced northern contexts to peripheral and disadvantaged areas in Southern Italy [73]. The exploratory, multivariate time-series approach adopted here contributes to identifying significant changes in regional fertility, confirming the relevance of integrated exploratory and predictive techniques to identification and comprehension of complex demographic transitions [35,70,74].

For decades, the demographic gap between Southern and Northern regions has represented one of the most relevant dimensions of the territorial gap in Italy. Until the 1980s, the low fertility of the northern regions was associated with an intense level of economic development, similar to that recorded in other regions of Western and Central Europe. Peripheral regions in Southern Italy have represented the permanence of traditional family models associated with the pervasiveness of the Catholic religion, superior marital stability, the role of housewives, the perfect division of labor and childcare tasks between men and women [75,76]. In a peripheral, secular society closed to innovation, characterized by a young population age structure, as well as high emigration and negligible immigration, a high-fertility regime maintained for a long time [38]. However, this regime did not resist the stimuli of social modernization inherent in the last phase of the first demographic transition [19,32,41]. In fact, fertility levels in the 1980s fell more rapidly in Southern Italy than in the rest of the country, showing the progressive spread of more innovative social practices and family models [5,26,42]. The second transition, albeit oriented towards greater heterogeneity and individualism in reproductive behaviors, offered an opportunity to recover fertility levels in Southern Italy through e.g., the contribution of immigration [72]. It has been demonstrated widely that since the early 1990s, in parallel with the slowdown of both internal migrations and emigration to the Americas and Northern Europe, international migration has played a basic role in population dynamics of marginal regions in the Mediterranean [77].

The higher birth rate characteristic of immigrant families significantly contributed to the demographic recovery of the 2000s. However, the peripheral location of Southern Italy, a progressive decoupling from the economic dynamics of Northern Italy, a substantial social retreat, an economic base still traditional and backward, also in terms of infrastructures, together with a cogent marginalization in north-south relations at the European level, have led to population shrinkage. Despite the impact of economic subsidies for local development in the target regions, the progressive reduction of foreign immigrants, moving to central and dynamic regions, in Italy as in the European Union, fueled population ageing. This has caused internal migrations of the foreign population towards Northern Italy, attracted by greater job opportunities and better conditions of life, e.g., through the reunification of pre-existing families. These dynamics, in the last twenty years, have inverted the traditional fertility gap between Southern and Northern Italy, consolidating a sort of 'demographic marginality' of the South [78,79]. While these dynamics confirm the role of economic performances and geographical centrality in regional demography [20], they also indicate how a substantial rethinking of territorial gaps is necessary for economic development policies, which should impact 'demographic dividends' more effectively [80],

trying to reverse the downward spiral toward population shrinkage, which is threatening the most peripheral regions of Mediterranean Europe.

5. Conclusions

Like other exploratory statistical techniques, our study showed the potential of multivariate time series analysis for regional demography. This analysis has highlighted the (latent) temporal structure of regional fertility rates in Italy, outlining the main shifts typical of the later stages of the first demographic transition and the greater volatility associated with the second demographic transition. With this perspective in mind, the recovery of gross birth rates in the 2000s is re-interpreted as a distinctive regional process of change, confirming the importance of spatial analysis in demographic transitions. The traditional gap in fertility levels between northern and southern regions represents a characteristic element of the Italian demographic system, which faithfully reflects the wider regional disparities in economic development, similarly with what has been observed in other European countries—Spain and the United Kingdom, among others. With the second demographic transition, the inversion of fertility levels between Northern and Southern Italy delineated a new course of population dynamics in the Northern Mediterranean arc. A progressive, further marginalization of peripheral regions and a modest strengthening of central regions (better connected with the economic dynamics typical of the most advanced European countries), were observed. As demonstrated in this work, fertility dynamics remain a key dimension of territorial divides and represent, better than other indicators, the complex socio-demographic evolution of wealthier economies.

In this sense, future studies on territorial disparities in Europe from an eminently demographic perspective should integrate exploratory multivariate techniques and inferential approaches based on hypothesis testing. Such studies could also perform a spatially explicit analysis of the relationship between fertility levels and socioeconomic contexts. However, substantial lacks in relevant social and economic time series at such geographical scales should be overcome, especially for the earlier decades of study (e.g., 1950s and 1960s at least). A more appropriate analysis in this direction could be run on disaggregated spatial domains (e.g., provinces, homogeneous local districts, municipalities), but the actual lack in sufficiently long time series prevents historically sound investigations. Official statistics in Europe should consider the importance of spatially detailed, long time series in economic modeling and social analysis.

Supplementary Materials: The following are available online at https://www.mdpi.com/2306-5729/6/2/19/s1, Table S1: Total Fertility Rates of Italian regions by year, 1952–2019.

Author Contributions: Conceptualization, J.R.-C. and L.S.; methodology, L.S.; software, A.G.-M.; validation, R.S. and G.E.; formal analysis, L.S.; investigation, G.E.; resources, G.E.; data curation, G.E.; writing—original draft preparation, L.S. and G.Q.; writing—review and editing, J.R.-C. and R.S.; visualization, R.S.; supervision, G.E.; project administration, A.G.-M.; funding acquisition, G.Q. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data used in the present study were derived from official statistics released by Italian National Statistical Institute (ISTAT) at www.istat.it (accessed on 28 December 2020).

Conflicts of Interest: The authors declare no conflict of interest.

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