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RESEARCH ARTICLE

Cohort fertility heterogeneity during the fertility decline period in Turkey

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Abstract
The decline in fertility, rapid urbanization and the increase in women's education levels in Turkey are simultaneous transformations. The coexistence and interaction of these transformations is the focal point for the interpretation of fertility trajectories in Turkey. This article explores Turkey's heterogeneous fertility structure by examining the fertility trajectories of women between 1949 and 1978 cohorts. It also examines changes in these trajectories in light of Turkey's fertility decline and interprets those changes through comparisons of women whose fertility behaviors are similar. Using three waves (1998, 2008 and 2018) of the Turkey Demographic and Health Survey data, we employed sequence analysis to calculate fertility trajectories and form clusters from these trajectories. The background similarities of women in the same fertility clusters were investigated with distance analysis, and we calculated predicted probabilities from multinomial logistic regression results and predicted cluster membership. The heterogeneous nature of fertility in Turkey during the demographic transition period shaped the transition process and it can be predicted that such heterogeneity will shape post-transition fertility. The behavior of having two children became the norm during this period, and greater spacing between births or even stopping after the first child became a preferred option among educated women who grew up in cities. For women who grew up in rural areas and uneducated women, we observed a transition from higher parities to three-norm.

Keywords: Fertility; Heterogeneity; Turkey; Birth History

Introduction

Understanding fertility patterns has been the primary focus of fertility studies for more than half a century. Most fertility literature has attempted to explain observed fertility levels with behavioral models and proximate determinants (Bongaarts 1978; Kohler et al. 2002; Goldstein et al. 2009), socioeconomic models (Becker 1960; Caldwell 1982; Van de Kaa 1987; McDonald 2000), or institutional approaches (McNicoll 1980; Szreter 1993; Rindfuss et al. 2003). The focus of these studies has mainly been on changes in the mean period and cohort fertility levels of the population, where mathematical modeling and fertility theories are widely used to analyze trends in average fertility levels of women with similar characteristics. However, women in the same cohort may have different fertility outcomes despite having similar characteristics, while women with dissimilar demographic backgrounds may display very similar fertility trajectories. In this study fertility trajectories refers to the total fertility structure of quantum (parity of women) and tempo (time spent in each parity) of women between ages 12 and 40. Employing fertility trajectories to understand the fertility structure of the population and its change over time is as functional and essential as using fertility outcomes such as total fertility rates. The interpretation of these trajectories allows us to get closer to reality when the criteria for detecting differences in fertility behavior are based on women's choices, rather than *a priori* distinctions made by the researcher (Blau and Schwartz 1984). This article reveals differences in fertility trajectories in Turkey to portray women with various fertility patterns and interprets those differences based on the women's various characteristics. To achieve this, we clustered the fertility trajectories of female cohorts and analyzed their pathways.

Changes in fertility are rarely uniform in a population and it is important to evaluate fertility in terms of differences in timing and size across reproductive ages, just as it is important to interpret fertility over its determinants. Heterogeneity in fertility can be defined as multiple fertility trajectories observed in a cohort of women which are significantly different from each other. Such an approach is an effective means understanding the composition of a population since childbearing is one of the most enduring demographic events, subject to the influence of individual decisions, and one that has important implications for a population in terms of structure and size. The demographic transition approach has often overlooked fertility heterogeneity and focused more on change in fertility size since intrinsic changes in fertility are of secondary importance. On the other hand, when examining the periods in which the fertility structure and accordingly fertility rates change, fertility differentiation such as postponing fertility, voluntary childlessness or the prevalence of births out of wedlock are frequently mentioned factors. For example, the second demographic transition (SDT) theorizes that cultural shifts and changes trigger individualization in demographic behavior. Lesthaeghe (2010) mentions that these changes can be observed heterogeneously in populations reflecting various cultural and historical paths. Indeed, social relationships and networks depend on the social environment, i.e. the composition of the community, as well as on the cultural and socio-psychological factors that govern individual tendencies and preferences (Blau and Schwartz 1984). The interpersonal channels are stronger among individuals with similar characteristics and the communication of ideas takes place through these channels. The preference of individuals to communicate with others who share like characteristics, called homophily, may result in the grouping of demographic behaviors within a society. For this reason, the course of change in fertility behavior over time becomes more important than the emergence of change, especially when focusing on the period where fertility has already started to decline.

Declining fertility, rapid urbanization and the increase in women's education levels in Turkey are simultaneous transformations that pave the way for an increase in interpersonal ties. The coexistence and interaction of these transformations is the focal point for the interpretation of fertility trajectories in Turkey. In this study, we examined the heterogeneous nature of fertility in Turkey in the second half of the 20th century, when both social structures and period level fertility in Turkey underwent rapid transformation. To this end, we analyzed the fertility course of women cohorts between 1949 and 1978 using the fertility history datasets of the three Turkey Demographic and Health Surveys (TDHS) 1998, 2008 and 2018. The TDHS is a nationally representative sample survey designed to provide information trends on fertility, infant mortality, family planning, and mother and child health (Hacettepe University Institute of Population Studies (HUIPS) 2019). In order to investigate fertility heterogeneity in Turkey, sequence analysis is used to reveal the fertility trajectories of ever-married women aged 40-49. Clusters of fertility trajectories are formed in order to group tempo and quantum-related fertility patterns. Unlike parity-based grouping, these clusters are based on the common experience of time spent with a certain number of children.

We argue that interpersonal communication, especially among women, increase alongside observed declines of fertility in Turkey during periods when social changes are experienced more acutely and immediately at the personal level. To reach this interpretation, we examined how women who exhibit similar fertility trajectories share other similar characteristics before their reproductive ages. In order to identify these similarities, we focused on the women's social background characteristics, their spouses, and their marriage formations with the help of distance analysis. To reflect the men's share of fertility decisions, we examined similarities between husbands for women with similar fertility trajectories. In addition, we inspected the marital background of spouses in order to evaluate cultural effects on fertility behaviors. In this context, this study discusses similarities in childhood place of residence for the woman and her husband, their education levels and other features underlying the establishment of their marriage. To complement these descriptive findings, we used multinomial logistic regression analysis to calculate the predicted probabilities of cluster membership in terms of women's childhood place of residence and education level, thereby linking fertility decline with increases in women's education and overall urbanization in Turkey.

Background

Some traces of fertility behavior differences in the population can be found early in the literature (Bongaarts and Potter 1983; Knodel 1987), and population and mortality heterogeneity can be found even earlier (Keyfitz and Littman 1979; Land and Rogers 1982), however less attention has been paid to assessing the variation and heterogeneity of fertility courses. Indeed, there are several notable examples of the shortcomings of the demographic transition framework wherein the non-homogeneous nature of fertility decline is rarely discussed (Coale 1969; Cleland and Wilson 1987; Kohler et al. 2002; Kreager and Bochow 2017). With second demographic transition (SDT) literature, attention has been drawn for the first time to the diversification of fertility outcomes. Lesthaeghe (2010) points out that the second demographic transition (SDT) results in non-stationary populations with a multitude of living arrangements, sometimes characterized by a "convergence to diversity", and further claims that fertility cannot be studied without a framework that reflects changing lifestyle preferences. Pesando (2019) refers to this heterogeneity as "persistent diversity with development". Indeed, it is possible to see a later upsurge in the literature on behavioral diversities among individuals. The rise of the life-course approach (Huinink and Kohli 2014), the literature on social interaction effects on fertility (Rossier and Bernardi 2009) and an emphasis on the decision-making process of individuals (Hakim 2003) show how fertility can be examined from a more integrated perspective. Pesando (2019) examines the persistent diversity of global family change, noting that divergent demographic trajectories of fertility have begun to characterize high-income societies. All these recent works focus on the fact that fertility has no monolithic and homogeneous structure, especially in populations where changes in fertility size and structure continue. In light of these studies, it is necessary to understand constituent and more homogeneous fertility trajectories and their transition, in order to correctly understand structural change in fertility.

Contrary to what was experienced at the beginning of the first demographic transition, variations in fertility structure are based on fragmented and more fluid behavioral changes. As suggested by the SDT, cultural shifts and changes trigger individualization in demographic behavior (Lesthaeghe 2010). Higher education is linked to a higher likelihood of accepting new family values and predicts new ideas and behaviors that originate among young, highly educated, and less traditional people in urban settings (Vitali et al. 2015). Accordingly, interpersonal connections and networks come to the fore in examining these changes.

In Turkey, changes in fertility have taken place alongside rapid societal transformations. The total fertility rate in Turkey declined steadily in the second half of the 20th century, from a total fertility rate of 5 children in the 1970s to around replacement level in the 2010s (HUIPS 2019). In parallel with the rest of the world, neoliberal economic policies have been adopted and Gross Domestic Product (GDP) per capita has more than doubled in 50 years (World Bank 2021a). Following the First Five-Year Development Plan in 1963 (State Planning Organization (SPO) 1963), anti-natalist policies such as the authorization of family-planning methods and the easing of laws banning abortion were adapted under the new population law in 1965 (Population Planning Law 1965). In 1983, with the legalization of abortion, a new population law was accepted and the family planning-oriented approach was continued (Population Planning Law 1983).

Despite these regulations, the population of Turkey, which was 40 million in 1975, doubled to 80 million in 2017. Accordingly, a similar increase was also seen in the analyzed female cohorts. While there were approximately 2.5 million women aged 40-49 in 1990 (TurkStat 2010), the number of women aged 40-49 is over 5.5 million according to the 2018 Address Based Population Registration System results (TurkStat 2019).

The most significant societal transformations in Turkey during the fertility decline period are urbanization and the increase in the education level of women. While the population living in the urban areas was around 40% in the 1970s, changing economic structures required more workers for the growing urban settlements. Beginning in the 1980s, the influx of migrants from rural to urban settlements has continued unabated and as a result, the urban population in Turkey went from 65% in 2000 to over 75% today (World Bank 2021c). In Turkey, where urban fertility levels are always lower than rural areas (HUIPS 2019), the findings of Kavas and Thornton (2019) confirmed that most of the urban population acknowledges the relationship between development and low fertility. Parallel to urbanization, the education level of women increased significantly in the second half of the 20th century. The percentage of ever-married women aged 15-49 with high school or higher education increased from 14 in 1998 to 32 in 2018 (HUIPS 1999; HUIPS 2019), and the literacy rate of women 15 years of age and over has increased from 45% in 1975 to 93% in 2017 (World Bank 2021b). In addition to the temporal contiguity of social changes, there have also been changes more directly related to fertility. Although the median age at first marriage increased from 19.5 in 1998 to 21.4 in 2018 for women in the 25-49 age group, the relatively early marriages and universality of marriage behavior among women means the pattern of having the first birth shortly after marriage in Turkey is retained, and the median age at first birth is calculated as 23.3 years (HUIPS 2019). In accordance with the age at first birth pattern, the currently childbearing group peaks with the 25-29-year-olds in Turkey, although that peak used to belong to the 20-24 age group. The change in the fertility of women aged 40-49, who have mostly passed their reproductive ages, has been in parallel to the overall decline of fertility. The mean number of children ever born to women aged 40-49 decreased from 4.3 children for the 1949-58 cohort to 2.7 children for 1969-78 cohort. (HUIPS 1999; HUIPS 2019). On the other hand, contraceptive prevalence has increased from 63% to 70% in 1993 to 2018 period (HUIPS 2019).

Fertility in Turkey has been largely studied as an extension of global fertility research trends and is mainly focused on language groups and regional differences that are indicators of ethnicity in that country. The study by Koç, Hancıoğlu and Çavlin (2008) shows the demographic differentials and integrational aspects of Turkish and Kurdish populations in Turkey. Their results indicate that strong demographic differentials exist between Turkish and Kurdish populations and the convergence of the two groups is not yet apparent. Yavuz (2006) also investigated the fertility decline in Turkey according to main language groups. His findings suggest that parity progression intensities of Turkish speaking mothers are lower than Kurdish speaking mothers, which implies that the fertility decline started much later for the latter group. Gore and Carlson (2010) stated in their study that besides ethnicity, education also influences marriage patterns and therefore fertility patterns. The results of their study showed that although low-educated Kurdish women married earlier than Turkish women, the difference was reversed among educated women. In addition, the study of Greulich et al. (2016) concludes that differences in female education are the driving force behind the regional heterogeneity of fertility in Turkey. As well, regional differentiation is apparent in other research in Turkey (Yüceşahin and Özgür 2008; Caarls and de Valk 2018). Although studies on Turkey's fertility refer to various rates and phases of the fertility transition in spatially distant population groups (Duben and Behar 2002), differences in fertility are usually related to predefined observed variables. These approaches only evaluated fertility by linking it to diversity in the demographic structure and did not go beyond this; however, the increase in the mean age at first birth in postponed marriages, together with the slowdown in fertility decline, gives clues that the change in Turkey may not be uniform.

Table 1. Number of unweighted observations of ever-married women aged 40-49

		Age Groups		
Surveys	Cohorts	40-44	45-49	40-49
1998 TDHS	1949-1958	874	698	1572
2008 TDHS	1959-1968	1170	1038	2208
2018 TDHS	1969-1978	1023	935	1958

Data and Methods

The data source of this study is the Turkey Demographic and Health Surveys (TDHS), which is part of the global DHS series. Turkey Demographic and Health Surveys are household-based nationally representative sample surveys designed to provide information on fertility, infant and child mortality, family planning, and maternal and child health. The surveys are carried out by Hacettepe University Institute of Population Studies (HUIPS). This study is based on three quinquennial TDHS datasets; 1998, 2008 and 2018, which contain the complete birth histories of women aged 15-49. For the purposes of the research, we limited the focus of the study to women aged 40-49, as near-complete fertility histories were needed to properly analyze women's fertility trajectories. Furthermore, since the 2008 study were conducted on ever-married women, all analyses were carried on ever-married women (Table 1). The vast majority of births in Turkey take place within marriage, so the exclusion of never-married women is negligible when analyzing fertility trajectories. However, since women who have never been married can be assumed as childless, overall childless women may have been underestimated. The proportion of women aged 40-49 who have never been married is 2, 1 and 4 percent for the 1949-58, 1959-68 and 1969-78 cohorts respectively. All ever-married women (currently married, divorced and widowed) were analyzed for their fertility structure with the sequence analysis. However, we excluded remarried women (5, 4 and 5 percent for the 1949-58, 1959-68 and 1969-78 ever-married cohorts respectively) from distance analysis and multinomial regression since there was more than one group of variables related to the husbands and marriage characteristics.

The analysis in this study was carried out in three steps. For the first part, we used the sequence analysis approach originally proposed by Abbott (1995) for ever-married women 40-49 separately in each dataset. The sequence analysis method can be used to describe the quantum and tempo of interrelated events and their sequencing (their order of happening) (Di Giulio et al. 2019). This strategy emphasizes the holistic nature of trajectories, and rather than handling them as a point in time, treats every observation as a life-course trajectory. By focusing on the analysis of entire trajectories rather than single events, sequence analysis considers the interrelation between multiple events (Barban and Sironi 2019). After separating the childless 40-49 women from the data, childbearing trajectories of women are constructed as sequences of 29 states from ages 12 to 40, where each age between 12 and 40 represents a parity-related state. Since the children ever born to women aged 40-49 in the cohort with the highest fertility was 4.8 (HUIPS 2019), the alphabet constructed for sequence analysis contained six mutually exclusive states according to children ever born, namely; "no birth", "one birth", "two births", "three births", "four births" and "five or more births". Then, women in each age can be represented with a state according to their number of children ever born in the corresponding age. After that, we employed the TraMineR package available in R to construct sequences in each dataset and used the optimal matching (OM) method (with insertion/deletion cost as 1, and the transition rates between states observed in the sequence data as substitution costs) to calculate distances between sequences and form the dissimilarity matrix for each dataset. We used the results of hierarchical clustering (calculated with Ward algorithm) as initial medoids (fertility trajectories in each cluster whose sum of dissimilarities to all the trajectories in the cluster is minimal) in a PAM (partitioning around medoid)

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algorithm. Since PAM algorithm assign each fertility trajectory to the closest medoid, in each cluster, women are closer to their cluster medoid than the medoids of the remaining clusters. Based on the clustering analysis and the weighted average silhouette width (ASWw) of the clusters, the optimal number of clusters were selected for each dataset. The ASWw value is a measure of coherence of assignments. High coherence indicates high between-group distances and strong within-group homogeneity. For this reason, the fact that a woman is in a particular cluster according to her fertility trajectory indicates that her fertility is more similar to the fertility behavior of this cluster than the others. Two women falling into the same cluster regardless of their last parity results from having similar fertility behaviors for ages 12-40 in terms of tempo and quantum. In other words, clustering by fertility trajectories allows us to consider the amount of the reproductive period spent at each parity. Although women in a certain final parity come to the fore in the resulting clusters, women in different final parities can coexist in the same clusters. Therefore, we interpreted clusters considering similar fertility behaviors rather than same final parities. While it seems to contradict orthodox categorization practices, this illustrates the importance of considering the timing of fertility. The clustering analysis resulted in five clusters in each data set and after combining the previously separated childless women, there were six clusters in total.

In the second part, we performed distance analysis in order to interpret the fertility behaviors in the light of the differences regarding the basic characteristics before the fertility period. We measured the similarity of women in each cluster to calculate the heterogeneity of background characteristics on three dimensions; background characteristics of women, their husbands and their marriages. In order to measure dissimilarities, we calculated the heterogeneity scores $\phi(P)$ using Hamming distances between observations, for six clusters of three surveys. On the axis of urbanization and increase in educational levels, the background characteristics of women and men consist of the place of residence where they spent their childhood, their educational status and their mother tongue (Table 2). In addition to these, since it contains cultural codes, the marriage characteristics dimension was created from the variables of age at first marriage of women, kinship with her husband, arrangement of marriage and marriage ceremony. The background characteristics used in this study to understand heterogeneity are the features that women and men acquire mainly in the pre-fertility period. Therefore, background characteristics are not only related to the heterogeneity of fertility trajectories, but also constitute the foundation of this heterogeneity. Even though other aspects such as religiosity contain invaluable insights to the fertility, the available data are insufficient to provide these variables to make retrospective comparable analyses. We used the selected variables with binary categories to give equal weights to each variable in a dimension and so as to preserve the difference in the categories of the variable for all 3 cohorts in distance analysis.

The Hamming distance $d_H(x_1, x_2)$ is defined as the number of variables at which the two observations x_1 and x_2 are different. The variables are recoded with binary categories and the Hamming distance between two observation according to these variables is hypothesized as the theoretical distance between women in that dimension. Since the Hamming distance between two observations can be measured, it is also possible to calculate the pairwise distance of a group of observations. The pairwise Hamming distance H between n observation would then be,

$$H = \sum_{k=1}^{k=n-1} \sum_{k'=k+1}^{k'=n} d_H(x_k, x_{k'})$$

The sum of all possible pairwise distances gives the pairwise distance of observations. When the pairwise distance is divided to number of distances, the average pairwise distance in a group of observation is calculated. The average pairwise distance is,

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Table 2. Variables for distance analysis and multinomial logistic regression

	Categories for multinomial regression	Categories for distance analysis
Background Characteristics of Women		
Mother tongue	Turkish	1 Turkish
	Kurdish	0 Other
	Other	
Education	Education in single years	1 Complete primary or higher
		0 No education or prim. Incomp.
Childhood Place of Residence	Urban	1 Urban
	Rural	0 Rural
Background Characteristics of Husbands		
Mother tongue	Turkish	1 Turkish
	Kurdish	0 Other
	Other	
Education	Complete secondary or higher	1 Complete secondary or higher
	Primary complete	0 Less than secondary
	No education or primary education incomplete	
Childhood Place of Residence	Urban	1 Urban
	Rural	0 Rural
Background Characteristics of Marriages		
Women's age at first marriage	18 and above	1 18 and above
	Before 18	0 Before 18
Relationship to husband	No relation	1 No relation
	Relative	0 Relative
Marriage arrangement	Themselves	1 Themselves
	Families	0 Families/ Escaped/Abducted/Other
	Escaped/Abducted/Other	
Marriage ceremony	Only civil	1 Only civil or civil first
	Both, civil first	
	Both, religious first	0 Only religious, religious first or no ceremony
	Only religious	
	No ceremony	

$$H_{avg} = \frac{2 * H}{n * (n - 1)}$$

In order to calculate average Hamming distances, the algorithm introduced by Morrison (2004) were used. His algorithm first calculates the centroid (moment of inertia) of the observations. The i-th coordinate of the centroid of equally weighted points is,

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$$c_i = \frac{\sum_{j=1}^{j=n} x_{ij}}{n}$$

where x_{ij} are the values of observations (in this case x_{25} indicates the 5^{th} observation in second variable). Then, total pairwise Hamming distance becomes the sum of the moments of inertia about their centroid (Morrison, 2004),

$$H = n * \sum_{i=1}^{i=m} \sum_{j=1}^{j=n} (x_{ij} - c_i)^2$$

where m is the number of variables and n is the number of observations. However, this calculation of the distance does not take case weights into consideration. When the case weights are introduced to the above equations, the weighted total pairwise Hamming distance becomes,

$$H^w = \sum_{j=1}^{n} w_j * \sum_{i=1}^{i=m} \sum_{j=1}^{j=n} w_j * (x_{ij} - c_i)^2$$

where w_j is the case weight of observation j. Since the weights are introduced, the weighted total pairwise Hamming distance can be divided by the sum of pairwise products of weights to calculate the average of the total distance. The average weighted pairwise Hamming distance becomes,

$$H^w_{avg} = \frac{H^w}{\sum_{i=1}^{i=n-1} \sum_{j=i+1}^{j=n} (w_i * w_j)}$$

H^w_{avg} takes values between 0 (minimum heterogeneity) and $\frac{m}{2}$ (maximum heterogeneity) where m is the number of variables and n is sufficiently large. For example, for the TDHS, if all observations have the same value at every background characteristic of women, which means the population is extremely homogenous, the indicator will take a value of 0. On the other hand, for a sufficiently large n, if the observations are distributed evenly to all possible categories, which means the population is at maximum heterogeneity, the indicator will take a value of 3/2 (since m=3 for the background of women). In order to normalize the indicator and generate heterogeneity scores ϕ,

$$\phi(P) = \left(\frac{H^w_{avg}(P)}{H_{max}(P)}\right) * 100$$

is used where H_{max} is the maximum heterogeneous distribution of the population P. For these scores, higher values indicate a more heterogeneous distribution of women. The relative heterogeneity scores were calculated as $\Delta\phi_c = \phi_c(P) - \phi_t(P)$, the difference between the heterogeneity score of a cluster and the score of the whole cohort. Relative heterogeneity scores are used to understand the similarities of background characteristics of the clusters with the overall cohort. Positive values represent more heterogeneous nature of the cluster related to the cohort overall and negative values show less heterogeneity.

In the last part, we further analyzed the fertility trajectories of cohorts using multinomial logistic regression using the same variables as the distance analysis but using more detailed categories (Table 2). The predicted cluster membership probabilities of "ideal types", i.e. an average educated/uneducated woman where other independent variables were kept in their group means, are calculated with the help of two variables: women's education and childhood place of residence. The probability distribution of educated and uneducated average women in clusters and the change of these probabilities through cohorts not only help to understand past experiences, but also contain clues about future changes. Distance measures are calculated with R and regression analyses and marginal effects were calculated with SPost13 package in Stata (Long and Freese 2014).

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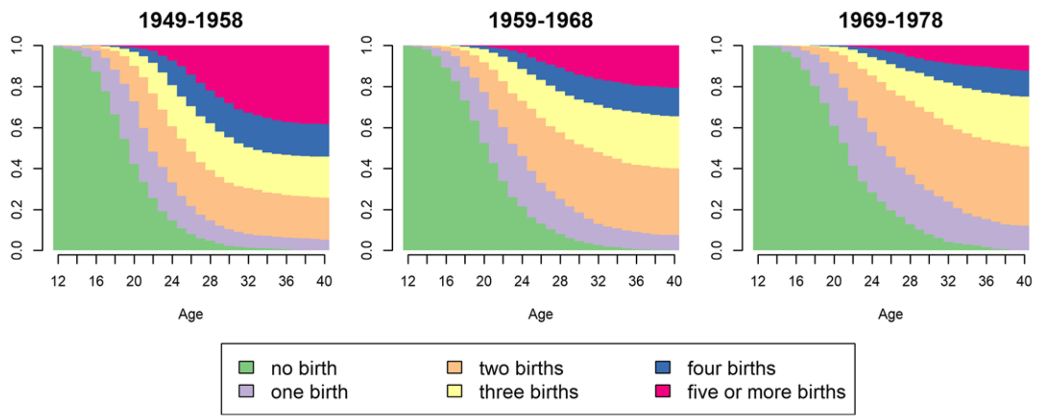

Figure 1. Children ever born state distribution plots of women aged 40-49 with children according to cohorts.

Results

The cumulative state sequences up to age 40 of women aged 40-49 years who have had at least one birth are shown in Figure 1 by their childbearing trajectories between the ages of 12 and 40, where areas of different colors show the time spent in each parity. The results of the sequence analysis revealed that the total time spent with 5 or more children decreased significantly in younger cohorts and the time spent childless in the reproductive zone is extended. Furthermore, cluster analysis revealed that the fertility trajectories of ever-married women aged 40-49 with at least one birth can be grouped into 5 clusters according to the ASWw values of clusters. For each year, the same parity-related categories emerged from the cluster analysis. Although women with different final parities may co-exist in the clusters, we have named the clusters as follows: "one-norm", "two-norm", "three-norm", "four-norm" and "five or more-norm" based on the fact that a certain parity stands out as the norm.

The results of cluster analysis showed that the types of clusters remained unvaried over the years, but the size of these clusters has changed. Figure 2 shows the change of cluster sizes through the women's cohorts. The changes in cluster sizes show those associated with higher fertility have declined over time. Most notably, the share of five or more-norm cluster decreased from 35% to 9% over 20 years, while the size of lower parity clusters increased. Furthermore, the percentage of women in the two-norm cluster increased one and a half times in 20 years, causing this cluster to stand out among fertility trajectories. The most outstanding increase was observed in the one-norm category. The share of women in the one-norm cluster increased from 8% to 26%, while the share of women in the childless cluster remained relatively stable in size. We examined the cohort trend of mean years spent in each parity state with sequence analysis to provide more insight into the tempo structure of the clusters (Figure 3). For one-norm cluster, we observed a decrease followed by an increase in time spent in parity one. For the remaining clusters, main trend can be specified as the increased spacing of births. Especially the time spent in second parity increased for three-norm, four-norm and five or more-norm clusters.

Following the sequence analysis, we calculated the heterogeneity scores, $\phi(P)$, for six clusters in each cohort according to three categories of background properties, namely women's, husband's and marriage characteristics (Table 3). Figure 4 shows the relative heterogeneity scores $\Delta\phi_c$, the difference between heterogeneity score of a cluster and the score of the whole cohort for each year by dimensions. Positive values of $\Delta\phi_c$ indicate relatively more heterogeneous structure. The most striking finding is that women in the two-norm cluster are much more homogeneous according to their background characteristics compared to the cohort overall. A similar finding for women in the one-norm cluster can be observed; however, for higher parity clusters, relative heterogeneity

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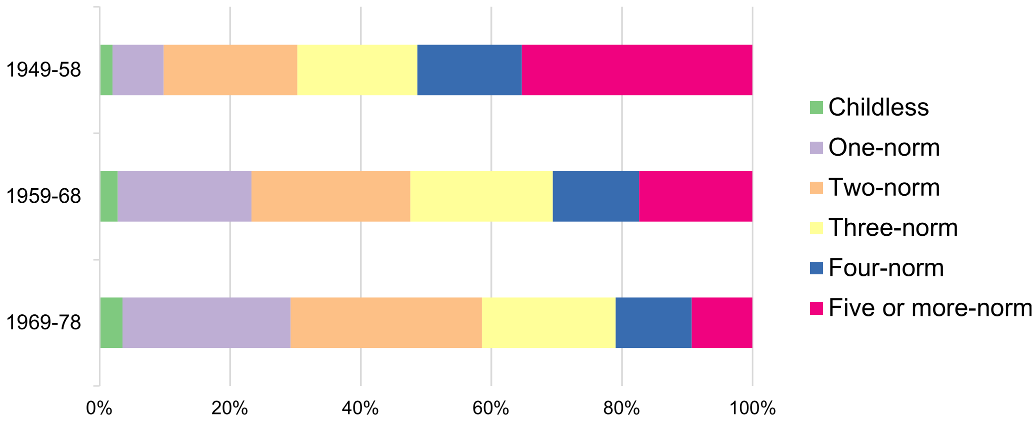

Figure 2. Fertility trajectory cluster size change among cohorts.

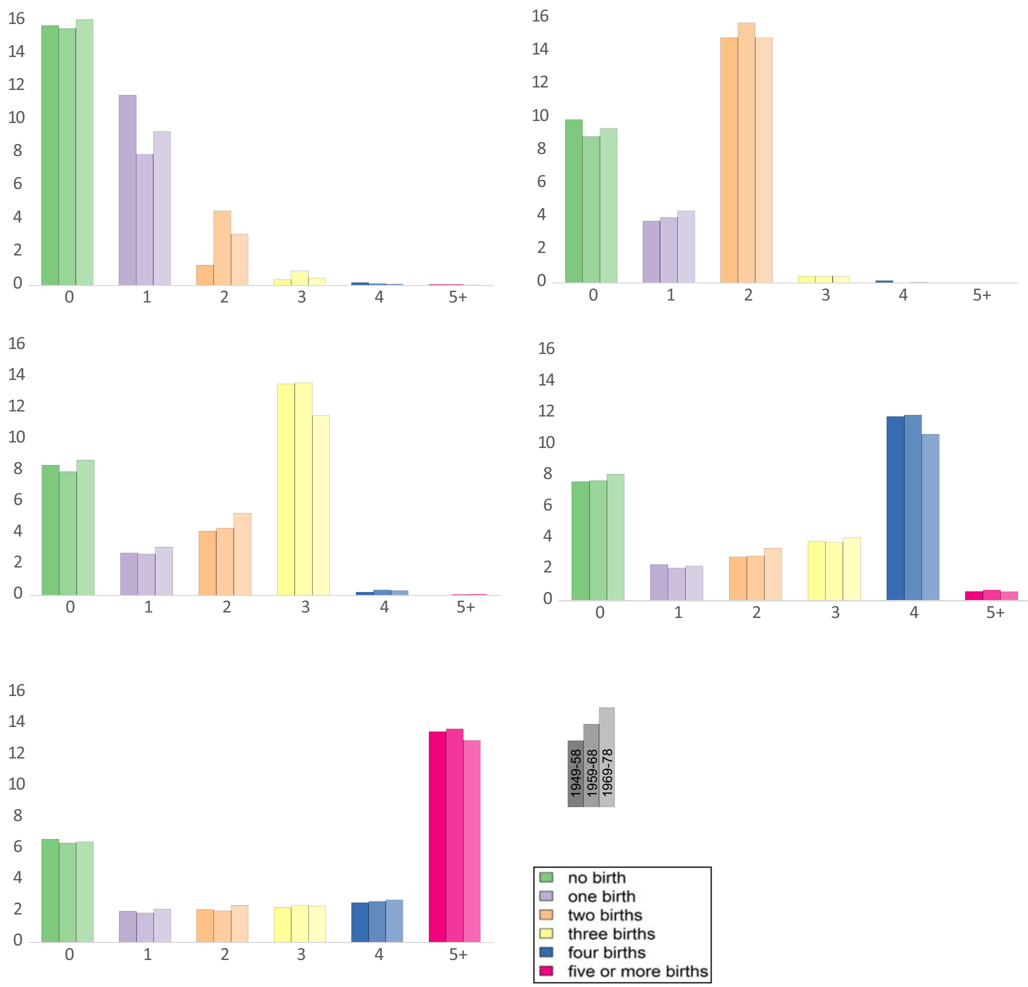

Figure 3. Mean years spent in each state among cohorts.

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Table 3. Heterogeneity Scores of Clusters in TDHS

		Cohorts		
	Clusters	1949-58	1959-68	1969-78
Background of women	Childless	73.3	81.8	63.0
	One-norm	65.7	57.7	47.4
	Two-norm	52.7	46.9	46.2
	Three-norm	63.3	60.9	57.7
	Four-norm	72.8	77.4	85.5
	Five or more-norm	77.4	90.5	87.1
	Total*	81.7	74.7	67.3
Background of husband	Childless	67.2	89.7	79.4
	One-norm	80.5	75.6	75.4
	Two-norm	66.1	71.0	72.3
	Three-norm	65.1	77.0	73.8
	Four-norm	60.5	72.7	85.1
	Five or more-norm	67.6	75.7	84.8
	Total*	72.6	82.1	83.7
Background of marriage	Childless	84.8	74.8	63.0
	One-norm	75.8	63.5	65.5
	Two-norm	74.8	78.2	80.6
	Three-norm	77.4	87.3	89.9
	Four-norm	89.7	89.0	92.4
	Five or more-norm	82.7	77.6	75.7
	Total*	88.3	87.8	87.4

*The total row shows the heterogeneity score for women aged 40-49 in the cohort before clustering.

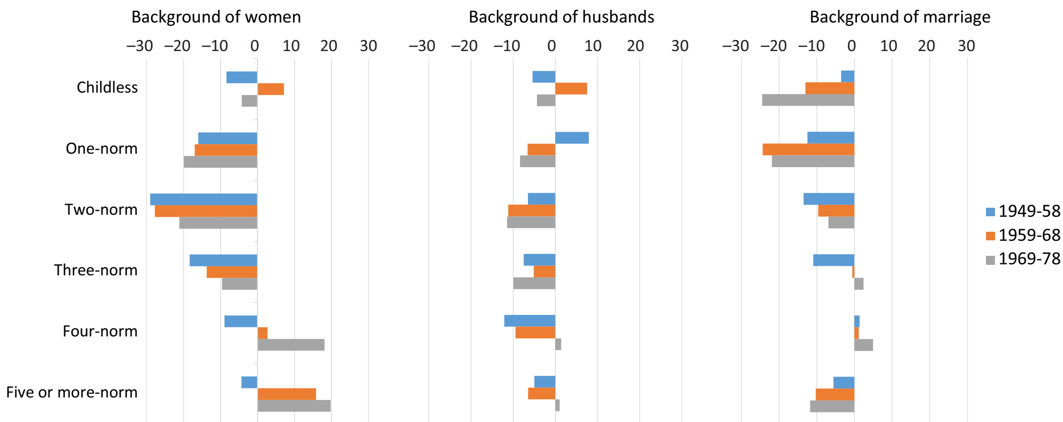

Figure 4. Relative heterogeneity scores of clusters according to background characteristics.

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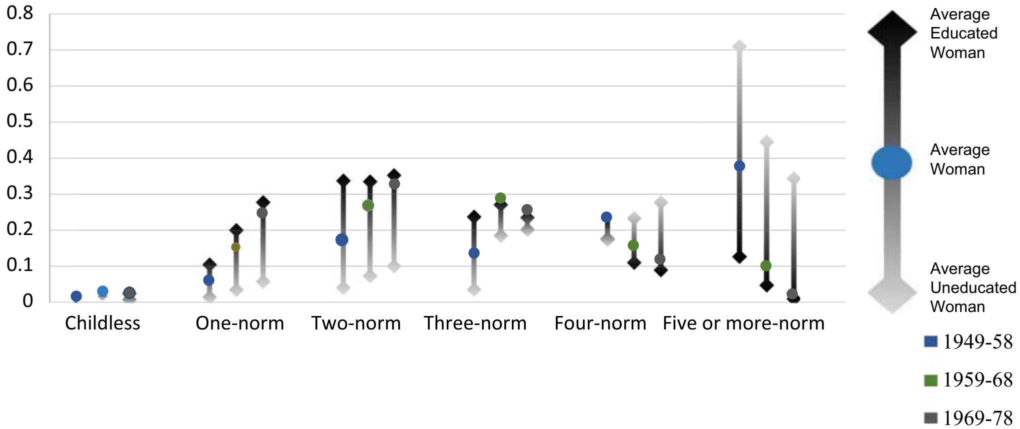

Figure 5. Predicted probabilities from multinomial logistic regression for women.

increased over time. This result shows that the women with higher parities who were much more alike according to their selected background characteristics in the past now are more diverse. The second part shows the relative heterogeneity scores of women according to the background characteristics of their husbands. The most remarkable change can be observed for husbands in the one-norm cluster who become less diverse over time. On the other hand, the relative heterogeneity of the husbands of higher parity clusters increased especially for the last cohort. In the third and last part, the heterogeneity of the clusters can be seen over the years according to the background of marriage characteristics. These results show that for childless women and women in one-norm cluster, marriage constructions become less diverse with time and for two-norm and three-norm clusters, homogeneity increased.

In the last part, we employed multinomial logistic regression to determine cluster membership with the same variables used in distance analysis. Separate analyses were made for women's education and childhood place of residence in order to see the variation in fertility associated with education and urbanization, which are the most important social changes in the period under review. Supplementary Table 1 shows the predicted probabilities calculated from the multinomial logistic regression model and marginal effects at group-specific means for education and childhood place of residence, as well as the interaction between those elements. The predictions show the probability of being in each cluster for ideal types, e.g., the probability of an average-educated woman raised in an urban area. Figure 5 summarizes the predicted probabilities of clusters for the cohort overall (colored dots), as well as two ideal types; average women with at least primary education (dark diamonds) and average women with less than primary education (light diamonds). It is evident that for ever-married women, childlessness remained quite rare in Turkey throughout the years. Childlessness also does not differ with the educational background of women, while the remaining clusters show clear patterns. The share of one-norm increased in Turkey among the cohorts and educated women who grew up in urban areas increasingly prefer one child or longer spacing of births after the first child. For educated women, having only one child, or longer spacing after the first birth is becoming an alternative to the two-norm. The predicted probability of two-norm cluster has also increased in years, especially among women who grew up in rural areas. Although the two-norm was already a settled behavior among educated women from urban areas, it has become more commonplace among women from rural backgrounds in recent cohorts.

Contrary to the previous two clusters, the three-norm category remained relatively stable among the cohorts, but the educational difference in the three-norm category diminished over time. Education has no significant effect on the three-norm category for women from urban areas

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and the effect of education remained stable for the women who grew up in rural areas. The decreasing share of higher parities seem to coincide with an increase in the share of the three-norm category, especially for rural women. Although there was only a small decrease in the share of the four-norm category, educational difference became more significant throughout the years and shares of the four-norm category increased for urban-raised women with less than primary education. Contrary to the three-norm category, the educational background of women became more determinant of the four-norm category over time. There were two striking results in the five or more-norm category, including the difference in fertility between uneducated and educated women, and the decrease in size of the category as a whole, which decreased by 30% with a stable difference between women according to educational background. Although the change of size in the five or more-norm cluster for educated women was relatively small, the decrease in rural uneducated women can be related to an increase in the three and four-norm categories, and the decrease of share of five or more-norm cluster in educated rural women can be related to an increase in the two-norm.

Conclusion and Discussion

In Turkey, changes in fertility patterns go hand-in-hand with other significant social changes. Examining the heterogeneity of fertility pathways reveals trends that, when considered together with current levels of fertility and mortality, indicate Turkey is in the final stages of demographic transition. Growing urbanization and an increase in education levels for women in Turkey have led to a shift in the cultural structure of the population and as cities become more and more cosmopolitan spaces, women's participation in the public sphere has also increased. Both of these changes have increased women's opportunities to communicate with each other, however, the increase is greater for educated and urban-raised women. Based on this perspective, we examined the fertility trajectories of women cohorts in Turkey between 1949 and 1978 and the change in these trajectories in light of Turkey's changing societal structures and fertility decline.

This study has some data-based limitations, the first of which is that we only analyzed the experience of ever-married women. Although, it does not affect the results significantly because the survey included various types of legal and non-legal cohabitations, such as religious marriages, and the percentage of never-married women in the 40-49 age group is between 1 and 4% (HUIPS 2019). Furthermore, births for never-married women are very rare in Turkey. For instance, there are no births reported by never-married women age 40-49 in the last two waves of the TDHS. Therefore, there may be only a small underestimation of childless women in the analysis. The second limitation of the study is that women aged 40-49 were used as a proxy of completed fertility. Although in 2019, births to mothers over the age of 40 accounted for only 3% of all births (TurkStat 2020), and the age specific fertility rate of the 40-44 age group was less than 0.015 in surveys (HUIPS 2019), with the spread of assisted reproductive techniques and the overall postponement of fertility, the higher parity clusters may be underestimated. We excluded women married more than once (4% to 5% in the respective cohorts) from the distance and multinomial logistic regression analysis since we need husband characteristics for these two analyses. Another limitation of this study was the chosen framework to interpret fertility trajectories. In order to make a consistent comparison for the three surveys covering a 20-year period, we used only certain variables to interpret the background similarities of women. The study also focused on the properties of women before their childbearing period as determinant factors and overlooked some valuable perspectives like occupational status of women and economic status of the couple during or before the childbearing period. However, the employment status of women did not change significantly in Turkey over the period in question, and there is no available data on wealth status of women before their reproductive periods. Since the study focused on pre-fertility similarities and differences of women, ignoring these dimensions did not create major deficiencies.

Interpreting the results of combined analyses is essential to understanding changes in fertility structure. When the cohort fertility of the demographic transition period in Turkey is considered, it can be seen that childlessness has never been a preferred choice for ever-married women. The absence of a distinctive structure for childless women and their spouses in terms of mother tongue, childhood place of residence and education shows that childlessness is mainly caused by infertility. As seen with the two-child ideal in Europe, having two children in Turkey has always been the highest preference for educated women who grew up in the city. The increase in overall urban populations and increasing education levels for women in Turkey have subsequently led to a numerical growth of women with two-norm fertility behavior. Although the impact of growing up in the city was evident for the earlier cohorts, the main determinant for all cohorts was education level. These results indicate that the effect of urbanization in the heterogeneous structure of fertility has been replaced by the effect of education. The decline of share in the five or more-norm cluster has caused the four-norm cluster to become a transitional phase of fertility decline, especially for uneducated women.

Among all fertility trajectory changes, the change that gave the most clues about future fertility can be found in the one-norm cluster. In particular, when the increase of educated women's preference in having a single child, or in extending the time between the first and the second child is considered together with the high and increasing homogeneity in background characteristics, it is evident that this fertility behavior is willingly chosen. It can also be stated that women whose fertility is not very high at the beginning of the transition period prefer one-norm trajectory as a new fertility behavior. The similarity of women in king-child and two-norm clusters shows that lower parity fertility trajectories started to be preferred more by group of women with certain characteristics. The higher fertility behaviors in Turkey became less dependent on ethnic-based, educational or residential properties. In the meantime, the decline of share in the higher parity fertility trajectories when following the cohorts over time led to various changes in clusters characterized by lower fertility. The choice of three children comes to the fore especially among educated women who grew up in rural areas. This group is the best candidate to become the preferred behavior among women with reduced fertility since it is the highest parity cluster level where background of women and spouses are relatively homogeneous.

In conclusion, the heterogeneous nature of fertility in Turkey during the demographic transition shaped the transition process and it can be predicted that such heterogeneity will also shape the post-transition fertility. The changes occurred not only in final parity of women but also in timing of the births and clusters analysis provided insight to the tempo changes of the clustered fertility behaviors. The increase in urban population has led to the behavior of having two children became a norm, spacing or even stopping after the first child is an increasingly preferred choice among educated women who grew up in the city. By contrast, for women who grew up in rural areas and uneducated women, a soft transition was observed from higher parities to three-norm. In future cohorts, one-norm can be expected to replace the current two-norm, voluntary childlessness in urban and educated women will increase to significant levels.

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