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Research Article

Partnership life courses and completed fertility in Spain

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Partnership life courses and completed fertility in Spain

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Abstract

BACKGROUND

Fertility in Spain has declined and shifted to later ages alongside diversification of family formation, raising questions about how partnership life courses shape completed fertility by late reproductive age.

OBJECTIVE

We aim to assess how key features of partnership trajectories – timing, duration, and sequencing – relate to motherhood and parity by age 41 among women in contemporary Spain, and whether associations differ by education.

METHODS

We analyze 7,656 women, born 1962–1977, in the Spanish Fertility Survey (2018). A feature-selection approach identifies salient aspects of union histories (e.g., postponement or absence of union, stability, cohabitation, higher-order unions) associated with (1) entry into motherhood and (2) progression to higher-order births by age 41, with results stratified by educational attainment.

RESULTS

Delayed or foregone union formation during the reproductive years is strongly associated with lower fertility, particularly a lower likelihood of entering motherhood. Stable marriage is consistently linked to higher probabilities of both becoming a mother and progressing to higher-order births. Cohabitation and post-separation trajectories show more nuanced and generally weaker associations with fertility in these cohorts. Associations between partnership status at later reproductive ages and fertility outcomes are more pronounced among highly educated women.

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CONCLUSIONS

Partnership life courses are central to understanding low and late fertility in Spain, and our results shed light on how traditional and emerging partnership dynamics jointly shape fertility outcomes by late reproductive ages.

CONTRIBUTION

We move beyond a narrow event-based focus to provide an integrated, trajectory-based account of how partnership timing, duration, and sequencing relate to motherhood and parity in a sustained low-fertility setting, documenting educational differences in these associations.

1. Introduction

Post-industrial societies have experienced a substantial decline in fertility, with total fertility rates falling below replacement levels since the last quarter of the 20th century. While period fertility is partly influenced by a generalized postponement of childbirth, cohort fertility or the final number of children – which accounts for the later recovery in fertility over women’s life courses – has substantively declined among women who ended their reproductive lives in recent decades. These trends have been paralleled by the end of the ‘golden age of marriage’ of the post-WWII period, characterized by high marriage rates, early marriages, low divorce rates, and marriage closely tied to childbearing. The social and economic conditions of post-war prosperity that supported this family model gradually eroded, and family norms evolved along with changes in gender roles, increasing acceptance of cohabitation, rising divorce rates, and the delay of marriage and childbearing. All in all, family life courses have become more diverse, with lower shares of women following the traditional early childbearing within a stable marriage. Relatedly, family life courses are increasingly complex, with women more often experiencing changes in their family situation.

Research on the links between the dynamics of partnership and fertility shows that the traditional role of marriage as the primary setting for childbearing has weakened, giving way to more diverse partnership forms that increasingly shape contemporary fertility behavior. Childbearing now occurs more often at later ages, in non-marital unions or stepfamilies, with multiple partners, or outside a partnership altogether (Beaujouan 2020; Thomson et al. 2014). Despite these changes, studies rarely integrate the multiple and heterogeneous partnership trajectories that unfold over the life course. In addition, literature on family demography has focused largely on births when they occur or at a point in time, using event-history methods to assess how partnership dynamics shape the likelihood and timing of these events. However, this approach overlooks the broader

picture of cumulative fertility, thus failing to capture the long-term fertility outcomes of partnership dynamics over the life course. Only a handful of studies have described the prototypical partnership trajectories that underlie fertility outcomes at later reproductive ages, and these have only focused on childlessness as the study outcome (Jalovaara and Fasang 2017; Chaloupková and Hašková 2020; Raab and Struffolino 2020).

In this study, we adopt a long-term life course perspective to examine the links between the aforementioned partnership trajectories – which are increasingly heterogeneous in terms of duration, timing, and sequencing of partnership episodes – and fertility outcomes by later reproductive ages. We argue that collectively studying the heterogeneous dynamics of partnerships across and within women’s trajectories supports a more comprehensive understanding of reproductive outcomes. To this end, we address the following question: How does the structure of partnership life courses matter for women’s outcomes in terms of reproductive behavior? We also acknowledge the importance of social gradients in fertility behavior, particularly the role of women’s education in shaping partnership and reproductive decisions. Prior research shows that educational trajectories influence both partnership transitions and motherhood pathways (Mikolai, Berrington, and Perelli-Harris 2018). To this end we address this additional question: How do the associations between partnership life courses and fertility outcomes vary by women’s level of education?

Using retrospective partnership and fertility histories of women born between 1962 and 1977 from the 2018 Spanish Fertility Survey, we examine motherhood and higher-order fertility by age 41. Applying a feature selection approach (Bolano and Studer 2020), we uncover which elements of partnership trajectories most strongly shape cumulative fertility. This integrated, life course framework provides new empirical insights for Spain by connecting partnership biographies with completed fertility in a demographic context characterized by lowest-low fertility and accelerating family change.

2. Research background

2.1 Evolving dynamics of partnership and fertility patterns

Partnership formation and stability remain a crucial part of the family formation process, with co-residential partnerships still seen as a social prerequisite for parenthood (Esteve et al. 2020). While marriage has traditionally been the primary setting for childbearing, the decline and delay in marriage over the last half-century in Europe and other Western countries has shifted the focus to the spread of cohabitation, union instability, and multiple partnerships over the life course, and their implications for fertility behavior,

often framed as the second demographic transition (Lesthaeghe and Surkyn 1988; Sobotka and Toulemon 2008; Hoem et al. 2009; Lesthaeghe 2014).

According to van de Kaa (2001), behavioral changes associated with the second demographic transition are driven by broader ideational shifts, starting with fertility declines and leading to the dissociation between marriage and fertility. Early research had already shown that cohabitation and marriage represent distinct contexts for the transition to parenthood (Manning 1995). More recent studies indicate that cohabitation has become a more stable form of partnership, often involving childbearing, and is increasingly seen as an alternative to marriage (Hiekel 2014; Sobotka and Berghammer 2021). However, the prevalence and stability of cohabitation differs notably across European regions (Di Giulio, Impicciatore, and Sironi 2019).⁴

Rising rates of union dissolution and repartnering during childbearing ages have also significantly altered traditional family structures and childbearing patterns. Concurrently, a body of literature has emerged that assesses trends in fertility in higher-order unions and with multiple partners. Research suggests that second or higher-rank partnerships increasingly contribute to childbearing, often compensating for childlessness in previous unions. Evidence indicates that women who experience separation or divorce and remain childless may expedite childbearing in new relationships (Beaujouan and Solaz 2013). Additionally, the increasing number of individuals that have children within step-families underscores the value placed on children in new unions (Heintz-Martin et al. 2014; Kreyenfeld et al. 2017). Despite that, fertility with multiple partners has remained relatively stable and only modestly contributes to birth rates across various European contexts (Thomson, Gray, and Carlson 2020).

While stable partnerships are crucial for fertility, in recent decades there has been a small but gradual increase in childbearing among unpartnered women (Harkness, Gregg, and Fernández-Salgado 2020), with higher contributions to first births (Perelli-Harris et al. 2012). This trend is associated with women attempting to conceive at later ages and experiencing first births while single, often through assisted reproduction technologies (ART), which provide opportunities for both different- and same-sex couples and singles dealing with infertility or desiring children independently. ART accounted for about 4%–7% of all births across European countries in 2015 (De Geyter et al. 2020).

⁴ For instance, cohabitation has only recently become more common in Southern Europe and remains less prevalent in parts of Eastern Europe. In these contexts, the rise in extra-marital births has not offset the long-term trends of low fertility that are largely influenced by economic uncertainty and the growing incompatibility between women's careers and family obligations (Alderotti et al. 2021). Conversely, in many Scandinavian countries where cohabitation is considered equivalent to marriage, non-marital childbearing rates have been rising since the 1970s (Kiernan 2004). These countries' higher levels of gender equality, family-friendly policies, and stable economic environments have helped maintain higher fertility rates compared to other regions, although recent declines in period fertility have been observed (Hellstrand, Nisén, and Myrskylä 2020).

2.2 Social stratification of family behavior: The role of women's education

Studies highlight a strong socioeconomic gradient in women's family behaviors, with education playing a key role in partnership and family dynamics (Corijn and Klijzing 2001). Educational enrollment typically delays first union formation for both genders due to societal expectations and time and financial constraints, often postponing marriage until after graduation (Blossfeld and Huinink 1991; Baizán, Aassve, and Billari 2003). Higher education is also linked to delayed motherhood beyond graduation, due to better job prospects and increased earning potential, particularly for men, and perceived career sacrifices particularly among women (Berrington, Stone, and Beaujoan 2015; Becker 1991; Oppenheimer 1994; Jalovaara 2012). Highly educated women thus delay motherhood until they are established in their careers, minimizing the impact of workforce interruptions (Kreyenfeld and Hank 2000). Cultural theories also suggest that higher education promotes individualistic lifestyles and non-traditional roles, leading women to postpone union formation and childbearing (Lappegård and Rønsen 2005). Conversely, another perspective suggests that economic disadvantage is linked to non-marital childbearing, with structural inequalities driving disparities in family behaviors across social statuses (McLanahan 2004; Perelli-Harris et al. 2010).

2.3 Study case

Spain's demographic landscape has experienced profound changes in recent decades. Greater access to education, increased female labor force participation, and rapid secularization have transformed family and partnership dynamics. Fertility declines began in the mid-1970s, with the total fertility rate (TFR) dropping from 2.9 children per woman in 1975 to below 1.3 by 1991, marking the onset of Spain's lowest-low fertility period, which persists today (Kohler, Billari, and Ortega 2002). Spain now has the highest average age at first childbirth in Europe and one of the world's highest levels of overall childlessness (Sobotka 2017).

These fertility trends were accompanied by shifts in family formation, such as delayed marriage, particularly among urban and highly educated women, and a weakening link between marriage and childbirth (Castro-Martín 1992, 1993). Despite this, marriage retained its role as a cornerstone of family life (Baizán, Aassve, and Billari 2003; García Pereiro, Pace, and Grazia Didonna 2014). This postponement and elongation of transitions to adulthood, termed the 'latest-late' pattern, characterizes Spanish and Southern European societies (Baizán, Aassve, and Billari 2003; Lozano et al. 2024).

Spain has been slower than other European countries to adopt new family dynamics such as non-marital cohabitation, childbearing outside marriage, and divorce, but these trends accelerated after the turn of the century. Non-marital cohabitation has become the primary pathway to union formation, with one-third of women born in the 1970s cohabiting by age 30, up from one-fifth for those born in the 1960s (Dominguez-Folgueras and Castro-Martín 2013). Non-marital births now account for 40% of all births, while unpartnered (late) motherhood is emerging as a trend (Castro-Martín and Cortina 2018). Childlessness has risen sharply, with 20% of women born in the early 1970s remaining childless, especially among never-married, highly educated women (Esteve, Devolder, and Domingo 2016; Reher and Requena 2019).

Two key aspects shape the link between partnership dynamics and fertility outcomes. First, women's educational advancement since the mid-1980s has reshaped family formation. Women now surpass men in tertiary education (OECD 2022), enhancing their autonomy and decision-making within households (Vitali and Mendola 2014). Although the male-breadwinner-model ideal persists, more women are equal or primary earners, and financial stability is now essential for starting families (Vitali and Mendola 2014; Brinton et al. 2018). Despite high fertility aspirations, regulatory labor market constraints challenge the ability of younger cohorts to balance careers and motherhood (Adserà and Lozano forthcoming). Second, rising divorce rates, which surged after a 2005 legal reform, have influenced family dynamics. This reform simplified divorce procedures, increasing accessibility and shifting norms toward more non-traditional attitudes to family formation and childbearing (Castro-Martín et al. 2008).

2.4 Research approach

From a life course perspective, individual life course trajectories are seen as sequences of actions and transitions that shape well-being over time (Bernardi, Huinink, and Settersten Jr 2019), with fertility viewed as a key life goal aimed at achieving successful parenthood or the desired family size (Mace 2014), or as an intermediate goal that enhances social well-being through the affection, stimulation, and social approval derived from close parent-child relationships (Huinink and Kohli 2014). Fostering a fulfilling partnership is also acknowledged as a lifetime goal and is considered an intermediate goal to fertility goals. Thus, fertility decisions are interlinked with partnership dynamics; e.g., unmet fertility goals can lead to union dissolution and new family structures, such as single motherhood or step-families (Buhr and Huinink 2014). Socioeconomic factors, such as education and employment, interact with partnership and fertility decisions, often delaying childbearing but improving conditions for raising children (Blossfeld and Huinink 1991; Baizán, Aassve, and Billari 2003).

Studies on the links between partnership dynamics and fertility outcomes from a life course perspective have used two main approaches: a transition approach and a trajectory approach. The transition approach focuses on discrete events, is widely used, and provides insight into the causal relationships between fertility and partnership dynamics. As it focuses on age-specific behaviors, this approach has offered little insight on the heterogeneous ways in which family lives evolve. The trajectory approach, on the other hand, analyzes entire life trajectories, highlighting diverse family pathways and complex dynamics over time (Aisenbrey and Fasang 2010). Sequence analysis, a key method in this approach, has been used to unpack the diversity in partnership trajectories that underlies fertility outcomes, such as childlessness at late reproductive stages (Jalovaara and Fasang 2017; Chaloupková and Hašková 2020; Raab and Struffolino 2020). This method clusters individual trajectories to identify patterns in family behaviors, though it sometimes oversimplifies variations within trajectories and often leads to an arbitrary interpretation of how the structure of partnership trajectories underlies fertility outcomes (Bolano and Studer 2020).

We combine these approaches by employing a methodology that integrates sequence analysis, feature selection algorithms, and regression models (Bolano and Studer 2020). Our approach identifies the key features structuring entire partnership trajectories and their association with fertility outcomes at a later point in time, providing a comprehensive analysis of how the timing, duration, and sequencing of partnership dynamics relate to women's completed fertility (see analytical strategy below). While descriptive in nature, this approach is methodologically sophisticated, allowing for a nuanced exploration of complex life course patterns without reducing them to a small number of typical trajectories or assuming specific parametric relationships. This makes it especially well-suited to uncovering subtle and multidimensional associations in diverse family formation processes.

2.5 Hypotheses

Drawing on previous literature and our research approach, we outline a set of expectations regarding the structure of partnership life courses, focusing on the timing, duration, and sequencing of partnership states among women born in the 1960s and 1970s that are plausibly associated with their fertility outcomes at later reproductive ages.

A first expectation addresses the extent to which a stable marriage remains the main site for (higher) fertility. Our study cohorts feature women for whom marriage was still important in the family life course, despite the context of changing family formation. Therefore, we expect that women in marital unions – particularly those who enter

marriage directly, marry early, and have long marital unions – display higher rates of completed fertility.

A second expectation addresses whether absence and postponement of stable unions are associated with lower levels of completed fertility. Compared to previous cohorts, our study cohorts feature women who spent less time in stable unions due to the delay and decline in partnership formation and the growing instability of unions. Therefore, we expect that union dissolutions, long non-partnered episodes, or being non-partnered at the average reproductive age are associated with lower levels of completed fertility.

A third expectation addresses emerging partnership dynamics as new sites for fertility. Cohabitation and non-marital childbearing were relevant among women in our study cohorts, and repartnering was emergent. Therefore, we expect cumulative fertility to be positively associated with (pre-marital) cohabitation and repartnering.

We expect differences in the associations between partnership dynamics and fertility outcomes by women's level of education, as socioeconomic gradients. In a context with high levels of unemployment and precarious work conditions, particularly among lower socioeconomic strata, women with lower levels of education might be less likely to become mothers outside the context of a stable union. By contrast, highly educated women face higher opportunity costs of having children due to little support for work–family balance and gendered expectations about childcare. Therefore, we expect that stable partnerships will be more strongly associated with motherhood and higher parities among lower-educated women, whereas being in a partnership at later reproductive ages will show a stronger association with childbearing among higher-educated women, particularly for higher parities.

3. Method

3.1 Data and sample

The data for the empirical analyses is extracted from the 2018 Spanish Fertility survey. This is a cross-sectional survey with retrospective questions on partnership trajectories, and is the most recent source for studying fertility dynamics in Spain. It consists of a probability sample of 2,619 men and 14,556 women aged 18–55 and legally resident in Spain in 2018.

This study focuses solely on women. Concentrating on women allows for a more nuanced understanding of gendered partnership and family dynamics. Women's evolving social and economic roles are widely regarded as key drivers of fertility declines (Phan 2013) and transformations in family structures (Stevenson and Wolfers 2007).

As we require information on fertility at later reproductive ages, to enable sufficient sample size we limit the study to women aged 41 or older at the time of interview. Our study sample thus comprises women born between 1962 and 1977 ($N = 7,656$). We note that women from these birth cohorts feature lower cohort fertility levels (below 1.75) than women from previous birth cohorts (before the 1960s), which is partly due to increasing rates of childlessness. We consider age 41 a rough proxy for completed fertility. The percentage of women in our sample who had their first child after the age of 40 is negligible (0.8%). While the number of women who have higher-order children after age 40 is growing, they are still a small number in our study cohorts. We acknowledge that pregnancies in women over 40 have increased due to ART. However, ART still adds little to total fertility levels, and for our study cohorts (particularly the oldest) it was less prevalent.

3.2 Measures

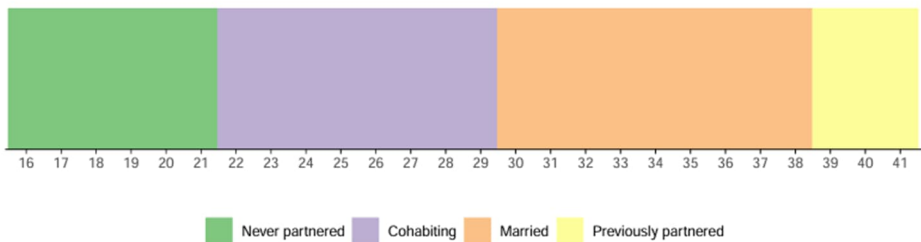
Our outcome of interest is based on the number of biological or adopted children by age 41. The information is extracted from retrospective accounts by respondents residing in the country in the survey year, and may differ from population register data based on birth certificates. While no studies examine the extent to which migration and mortality affect our fertility estimates, a study from the Swedish context reports little impact of selective migration and survival on fertility estimates (Andersson and Sobolev 2013). In our sample, by age 41, 26.2% of respondents were childless, 23.7% had 1 child, 40.4% had 2 children, and 9.6% had 3+ children. Our analysis includes predictions for becoming a mother and progression to higher order parities by age 41.

Information on partnership trajectories is extracted from retrospective accounts of up to five union episodes reported by respondents, including the month and year of the start and end of each union episode, and whether and when marriage, separation, divorce, and widowhood occurred in each union. In our sample, about 90% of respondents were ever in a union. Around 93% of partnered respondents married their first partner directly or after a previous period of cohabitation. About 1 in 5 partnered respondents dissolved the first union, and over 1 in 3 of them (about 7% of our overall sample) formed a second-order union. Second- and higher-order unions feature lower proportions of marriage and higher proportions of separation than first unions, at about 50% each.

As in a sequence analysis, a respondent's partnership trajectory is operationalized as a chronological sequence of partnership states, which contains structural features of

duration, timing, and sequencing of partnership episodes.⁵ Each sequence is formed of 26 elements corresponding to partnership states observed at the beginning of the year from age 16 to age 41 (see Figure A-1 in the Appendix for the distributions of partnership states at each age). In each sequence, four possible partnership states can be observed: never partnered (NP), cohabiting (C), married (M), and previously partnered (PP). Information on unmarried, non-coresident partners is not available in all surveys, and thus respondents in such situations are categorized as unpartnered. The ‘previously partnered’ status includes both separation and divorce because a disaggregated analysis was not feasible.

Figure 1: Fictional sequence of a partnership trajectory between ages 16 and 41



As an illustration, Figure 1 shows a sequence representing the partnership trajectory of a fictional individual between ages 16 and 41. The sequence is composed of a ‘Never partnered’ episode until age 21, a ‘Cohabiting’ episode until age 29, a ‘Married’ episode with the first partner until age 38, and a ‘Previously partnered’ episode until age 41. This fictional sequence displays features of an emerging trajectory in our study cohorts, with early union formation, the experience of pre-marital cohabitation, and an overall long union duration only truncated at a late reproductive age. The extraction of structural features of the trajectories for the analysis is explained in the subsequent section.

Women’s education is a measure of the highest level of education achieved at the time of interview, based on the 1997 International Standard Classification of Education (ISCED). We discretize the measure to take value 1 if the respondent reported a tertiary educational degree (i.e., ISCED levels 5 and 6), and 0 otherwise. Approximately 30% of respondents reported having a tertiary education degree at the time of interview.

⁵ We use yearly rather than monthly states because multiple within-year transitions are rare and often reflect short-lived or administrative changes rather than substantive partnership dynamics, and modeling such month-level shifts would introduce substantial analytical complexity with limited analytical gain.

3.3 Analytical strategy

We deploy Bolano and Studer's (2020) feature selection approach to identify the most relevant features of a previous trajectory that predict a later-life outcome. This strategy follows three steps: feature extraction, selection, and prediction. This approach has been used in recent studies in demography, sociology, and life course studies (e.g., Kapelle and Rowold 2025; Rowold 2025; Vendula et al. 2025; Unterlerchner, Studer, and Gomensoro 2023)

First, it is necessary to build a set of indicators measuring the different aspects of the partnership trajectories to be considered in the analysis. Often, a data-driven definition and automatic extraction of trajectory features is deployed, which entails some degree of arbitrariness. We limit this issue by making theoretically informed decisions regarding the features to be further analyzed, based on the hypotheses that we previously set. We thus consider the following features:

- Duration of (un)partnered states: We extract a three-category variable for each of the four possible states (NP, C, M, PP) in a sequence that indicates whether the duration in years is (1) zero, (2) below the average duration (excluding zero durations), and (3) above the average duration.⁶
- Timing of (un)partnered states: We extract five binary variables for each of the four possible states in a sequence that indicates whether the respondent is observed in a given state at ages (1) 16–19, (2) 20–24, (3) 25–29, (4) 30–34, and (5) 35–41. We end up then with 20 features (5x4) representing the timing of events.
- Order or sequencing of (un)partnered states: We extract several binary variables that capture the chronological order across different contiguous states in a sequence to indicate entering into a cohabiting relationship (NP > C), direct marriage (NP > M), marriage after pre-marital cohabitation (C > M), union dissolution (C > PP, M > PP), and repartnering (PP > C, PP > M, M > C).

Table 1 displays the distributions of the extracted partnership-trajectory features for the overall sample and for the subsample of mothers. Marriage is common in both groups. Only 22% of women in the overall sample never married, compared with 12% among

⁶ The discretization reflects the distinction between zero duration and any positive duration, which represent qualitatively different experiences. However, we acknowledge that the cutoff separating below- and above-average durations is somewhat arbitrary and serves primarily as a pragmatic way to operationalize the theoretical expectation that a longer time spent in specific partnership states is associated with childbearing. As a robustness check, we re-estimate the models by treating the duration in each state as a continuous variable, rather than using its discretized form. The results (available from the authors upon request) remain substantively unchanged, both with respect to the relative importance of the other features and the direction and strength of their associations with the outcomes.

mothers. Mothers are more likely to have spent longer periods married (48% above-average marital duration, versus 41% in the overall sample). Marriage is also concentrated at later ages, with relatively few women married as teenagers (6%–7%), and the share married rises sharply from ages 25–29 onward, reaching 73% in the overall sample and 83% among mothers at ages 35–41. Cohabitation is less prevalent and typically shorter. Around 69% of women never cohabited, while roughly 31% experienced some cohabitation, with little difference between the overall and mother samples. Consistent with these patterns, the most common partnership sequence is a transition from never partnered to marriage (NP→M), observed for 59% of women overall and 67% of mothers, followed by NP→C (about 28%) and C→M (about 19–21%). We note that the NP→M category should be interpreted as ‘direct marriage’ at the yearly level, and may include women who cohabited briefly before marrying in the same calendar year (i.e., short pre-marital cohabitations). Union dissolution and repartnering are comparatively uncommon in these cohorts. Only about 12% had experienced a previous partnership by ages 35–41, and longer durations spent previously partnered are rare (around 5%–6%). Overall, differences between the full sample and the mother subsample are modest for separation-related features and repartnering sequences.

Table 1: Sample distribution of extracted features of partnership trajectories (overall and mother samples)

	Overall sample (%)	Mother sample (%)
Duration		
Married (M)		
Never	22.2	11.9
Below avg.	36.8	40.0
Above avg.	41.0	48.2
Cohabiting (C)		
Never	68.7	68.7
Below avg.	19.1	19.5
Above avg.	12.1	11.8
Previously partnered (PP)		
Never	86.2	86.4
Below avg.	8.3	7.5
Above avg.	5.4	6.1
Timing		
Never partnered (NP)		
Age 16–19	98.5	98.3
Age 20–24	87.4	85.6
Age 25–29	58.5	52.2
Age 30–34	27.0	17.3
Age 35–41	14.9	5.5

Table 1: (Continued)

	Overall sample (%)	Mother sample (%)
Timing		
Married (M)		
Age 16–19	6.2	7.0
Age 20–24	27.9	23.6
Age 25–29	55.7	64.5
Age 30–34	68.5	78.9
Age 35–41	73.3	83.2
Cohabiting (C)		
Age 16–19	2.4	2.8
Age 20–24	8.3	9.2
Age 25–29	15.4	16.4
Age 30–34	17.6	17.3
Age 35–41	15.2	13.7
Previously partnered (PP)		
Age 16–19	0.2	0.2
Age 20–24	1.3	1.5
Age 25–29	4.1	4.3
Age 30–34	7.0	6.8
Age 35–41	11.8	11.3
Order or sequencing		
NP > M	58.7	67.0
NP > C	28.4	28.1
C > M	19.0	21.0
C > PP	4.6	3.7
M > C	0.5	0.5
M > PP	9.5	10.4
PP > C	3.9	4.0
PP > M	0.6	0.7

Note: Samples of women born between 1963 and 1978. The overall sample includes all women in the study and is used to analyze the probability of becoming a mother. The mothers sample includes only women with at least one child and is used to analyze the probability of having more than one child.

Source: Spanish Fertility Survey 2018.

The second step involves selecting the features of the partnership trajectory that are substantive predictors of (1) becoming a mother by age 41 and (2) having more than one child (conditional on being a mother) by age 41, using data mining techniques.

While various feature selection methods are available, we rely on the Boruta algorithm as it has been shown to perform robustly compared to alternative approaches (e.g., Degenhardt, Seifert, and Szymczak 2019), especially in relatively low-dimensional settings such as ours. Feature selection refers to the process of identifying the most relevant variables – or features – from a larger set of candidate predictors to improve model interpretability and performance. In our case, features correspond to indicators

derived from women's partnership trajectories, such as the timing, duration, and sequencing of different partnership states. In addition to the features extracted in the first step, we include a set of control variables (i.e., migration background, birth cohort, basic education, number of siblings, parental divorce by age 15) to account for potential (childhood background) confounders of the association between partnership trajectories and fertility outcomes.

The Boruta algorithm builds on the random forest method, a machine learning technique that constructs an ensemble of decision trees using random subsets of the data and predictor variables to estimate the outcome. Random forest models are well-suited for capturing non-linear relationships and interactions – that is, how the effect of one feature may depend on the value of another – without requiring these to be explicitly specified in advance, as would be the case in traditional regression models.

A key advantage of Boruta is its ability to handle multicollinearity among features, which refers to high correlations between variables that can distort results in conventional regression models. Since many aspects of partnership trajectories (e.g., being married at age 30 and having a long marriage) are naturally correlated, this property is particularly relevant for our analysis.⁷

Boruta determines the importance of each feature by comparing it to a set of 'shadow features,' which are created by randomly shuffling the values of the original features. These serve as a benchmark representing uninformative noise. A feature is considered important only if it consistently contributes more to the predictive accuracy of the model than the best-performing shadow feature – effectively 'outperforming' random noise. This makes the selection process more objective and less prone to overfitting.⁸

In the last step, we estimate the direction and magnitude of the associations between partnership features and our two outcomes, becoming a mother and having additional children (conditional on being a mother). Following Bolano and Studer (2020) and Arpino, Le Moglie, and Mencarini (2022), we employ a random forest regression model to examine how partnership features are associated with the predicted outcome(s), and visualize these associations in terms of predicted probabilities using partial dependence plots (PDPs; Friedman 2001). An alternative approach would have been to run a

⁷ We detected some relevant correlations across extracted features that indeed justify our approach (see Figure A-2 in the Appendix for correlations across extracted features for the overall sample). As expected, there are positive correlations between the different temporal features of duration, timing, and order for each of the states, and there are negative correlations between the temporal features of marriage and those of cohabitation and never-partnered states.

⁸ Bolano and Studer (2020) recommend pre-filtering the extracted features before applying Boruta or other feature selection algorithms to enhance interpretability. For example, they suggest removing sub-sequences that occur only rarely in the data. In our case, however, since the feature extraction process was guided by theoretical considerations rather than being purely heuristic, such pre-filtering is unnecessary. Moreover, the distribution of the extracted features reported in Table 1 supports this decision, as only a small number of features are relatively infrequently observed in our sample.

conventional regression model on a selected subset of features.⁹ We rely on the PDPs derived from the random forest approach instead, since it allows us to account for potential structural dependencies between features (e.g., multicollinearity issues) and avoids the need for an arbitrary additional feature selection.

To address the social stratification of the study associations, we repeat the steps outlined above stratifying the sample by women's education, comparing results for women who achieved higher education and those who did not.

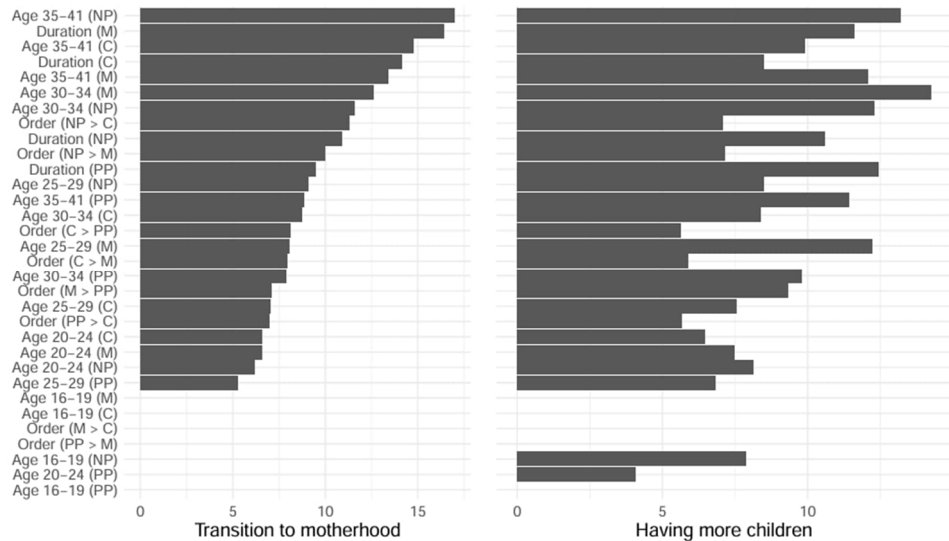
4. Results

Figure 2 presents Boruta's importance values for the partnership trajectory features, with the left panel showing predictors of becoming a mother and the right panel showing predictors of having more than one child. The bars indicate the importance of each feature, where a higher value indicates higher relevance relative to other features. Because the two fertility outcomes we analyze differ in prevalence and underlying processes, the feature-selection importance scores are specific to each outcome. We therefore interpret them qualitatively and avoid direct comparisons across outcomes, as differences in rankings do not necessarily imply distinct behavioral mechanisms.

For the transition to motherhood, Figure 2 (left panel) shows that the most important features capture women's partnership status at higher ages. The single most relevant predictor is being never partnered (NP) at ages 35–41 (importance = 16.99), followed by longer durations in marriage (16.39) and indicators of cohabitation at ages 35–41 (14.74) and longer cohabitation duration (14.10). Being married at ages 35–41 (13.40) and at ages 30–34 (12.59) also ranks among the most important predictors. Features related to younger ages, previous partnerships (except duration in PP and PP at ages 35–41, with importance values around 9), and most partnership transitions (except NP>C and NP>M, with importance values around 11 and 10) generally appear lower in the ranking.

⁹ In additional robustness checks, we estimated series of logistic regression models increasing the temporal granularity of the age brackets to test the sensitivity of results to time specification, and treating duration-related features as continuous rather than categorical variables (see Tables A-3 and A-4 in the Appendix). Results remained consistent with the original random forest specification.

Figure 2: Importance of variables (partnership trajectory features) for fertility outcomes at age 41



Note: Women born between 1963 and 1978. The X axes show importance values of features selected by the Boruta algorithm. Importance is measured as the average decrease in model accuracy when the values of a given feature are randomly permuted across decision trees in a random forest. Features that consistently reduce accuracy more than any randomized 'shadow feature' are considered important. For readability, we exclude from the figure the variable importance of the covariates. Full results are available as Supplementary Material in Table A-1. Results based on 10,000 maximal number of importance source runs. Hyper-parameters set after tuning as suggested by Probst, Wright, and Boulesteix 2019. Trajectory features: Age – indicator for a partnership state observed within the age range; Duration – categorical variable with never, below average duration, and above average duration in a partnership state; Order – indicator of a subsequence of two different partnership states. Partnership states: NP – Never partnered, M – Married, C – Cohabiting, PP – Previously partnered.
 Source: Spanish Fertility Survey 2018.

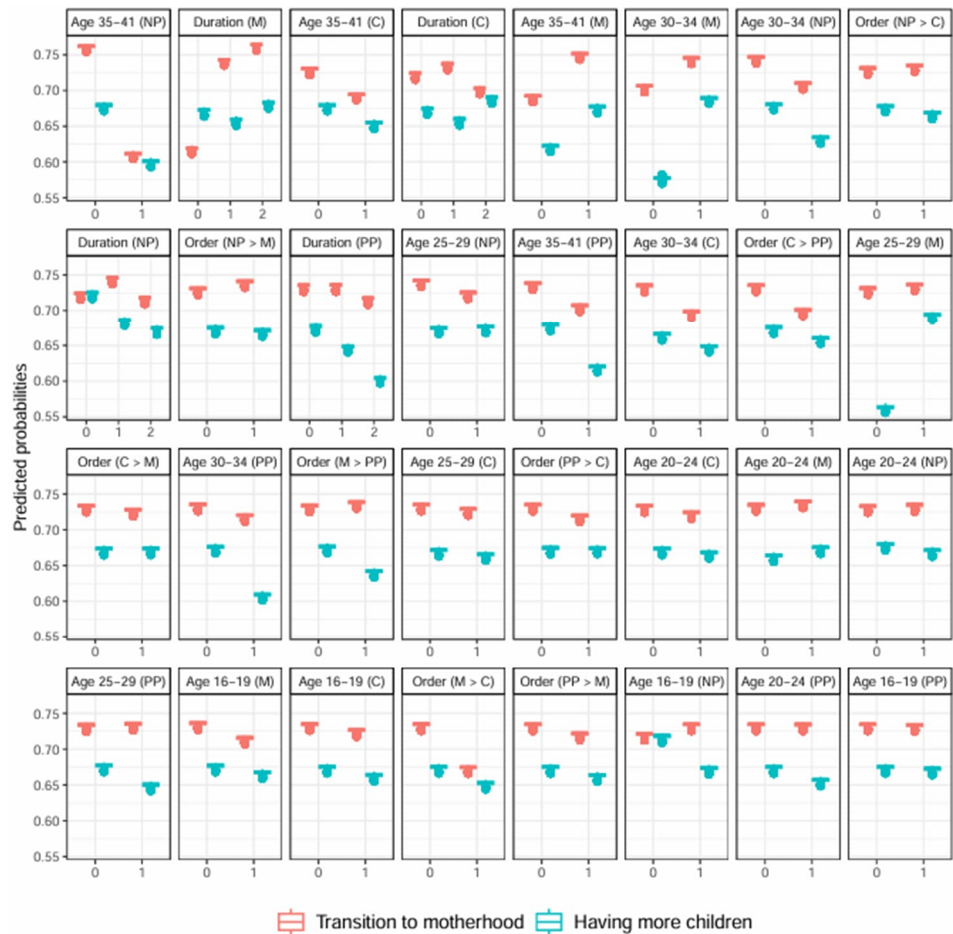
For higher-order births, Figure 2 (right panel) reveals a similar but not identical ordering. The highest importance values correspond to being married at ages 30–34 (14.23), 25–29 (12.22), and 35–41 (12.07), being never partnered at ages 35–41 (13.21) and 30–34 (12.29), and longer durations in marriage (11.59). Several PP-related features also rank relatively high, particularly longer durations spent previously partnered (12.44) and being previously partnered at ages 35–41 (11.41). Cohabitation indicators, such as cohabiting at ages 35–41 (9.92) or having a longer cohabitation duration (8.50), occupy a mid-range position, while features tied to younger ages and most transition sequences tend to show lower importance scores. In sum, partnership dynamics at older ages, capturing the postponement or absence of union formation and the type of union, emerge as the strongest predictors for both outcomes, whereas features observed at younger ages play a comparatively minor role. Differences across outcomes are also apparent. Marriage- and previous-partnership indicators rank higher for higher-order births, while

cohabitation-related features appear somewhat more salient for the transition to motherhood.

To assess the direction and magnitude of the effects of the different features on the outcomes, Figure 3 presents partial dependence plots showing the predicted probability of each outcome evaluated at different values of a given feature, averaged over the distribution of all other features (Friedman 2001). In other words, PDPs illustrate the isolated effect of a feature on the predicted outcome, holding all other variables constant on average, similar to post-estimation predicted probabilities commonly reported in conventional regression models. In Figure 3, the red box plots correspond to models predicting becoming a mother by age 41, while the blue box plots correspond to models predicting having more than one child (conditional on being a mother). The y-axis of the plots represents the predicted probability of the outcome associated with each value of the respective predictor. The red box plots are, on average, higher than the blue ones, reflecting the higher overall probability of having at least one child compared to having multiple children by age 41 in our sample.

For the most important features associated with becoming a mother (red boxplots in Figure 3), the PDPs show clear differences across partnership states at older ages. Being never partnered (NP) at ages 30–34 and especially at ages 35–41 is associated with markedly lower predicted probabilities of motherhood (around 0.6 when NP at ages 35–41, compared to roughly 0.76 when partnered). Differences in the direction of the associations emerge across type of partnership at older ages. While being married at these ages corresponds to higher predicted probabilities of motherhood (approximately 0.75 when married at ages 30–34 and 35–41, compared to 0.70 when unmarried), cohabitation at older ages is associated with lower predicted probabilities (roughly 0.70 when cohabiting at ages 30–34 and 35–41, compared to 0.75 when not cohabiting). Differences across categories are smaller at younger ages (16–24), when predicted probabilities cluster more closely. For duration-based features, longer durations in marriage are associated with higher predicted probabilities (rising from about 0.6 for no marriage exposure to around 0.73 and 0.77 for short and long marital exposures, respectively), while longer durations in cohabitation are associated with somewhat lower predicted probabilities (0.7) than shorter or zero durations (roughly 0.74 and 0.72, respectively). Post-separation features and partnership transitions display comparatively flat PDPs, indicating only modest variation across categories. However, longer durations in PP, being previously partnered at ages 35–41, and repartnering sequences (PP>M, PP>C, M>C) are generally associated with lower predicted probabilities of becoming a mother.

Figure 3: Partial dependency plots for partnership predictors of fertility outcomes at age 41



Note: Women born between 1963 and 1978. Predicted fertility outcomes at age 41. Partial dependency plots derive from random forest models including the covariates. They represent the predicted probabilities of each outcome evaluated at different values of each feature and averaged over the distribution of all other features and covariates. The x-axis shows the different values taken by the features, while the y-axis shows the predicted probability of the outcomes associated with each value of the predictor. For readability the predicted probabilities of each outcome evaluated at different values of the covariates are not shown. Features are ordered according to their relative importance as in Figure 2. Trajectory features: Age – indicator for a partnership state observed within the age range (0 – yes, 1 – no), Duration – categorical variable of duration in a partnership state (0 – never, 1 – below average duration, 2 – above average duration), Order – indicator for a subsequence of two different partnership states (0 – yes, 1 – no). Partnership states: NP – Never partnered, M – Married, C – Cohabiting, PP – Previously partnered.
 Source: Spanish Fertility Survey 2018.

For higher-order births (blue boxplots in Figure 3), the PDPs highlight a similar pattern but with greater contrast across marital categories. Predicted probabilities are highest when women are married at ages 25–29, 30–34, and 35–41 (typically around 0.67–0.70), and lowest when they have not yet been in a partnership (NP) at ages 30–34 and 35–41 (around 0.60–0.64). Previously partnered features show more variation for higher-order births than for motherhood. Longer durations in PP are associated with lower predicted probabilities (0.61) than shorter or no PP exposure (0.65 and 0.67, respectively), and being previously partnered at ages 35–41 shows a similarly negative association. By contrast, marriage duration, cohabitation-related features, and transition sequences display relatively small differences across categories, with predicted probabilities remaining close together across the PDP values. In contrast to the results for becoming a mother, longer durations in cohabitation correspond to slightly higher predicted probabilities of having more than one child (rising from about 0.67 for zero or short cohabitations to 0.7 for longer cohabitations).

Additional analyses address the stratification of the study associations by women's education. Results from Boruta show that similar partnership features are important across highly and less-educated women (see importance values of selected features stratified by level of education in Table A-2 in the Appendix). In both groups, the highest-ranked features predicting motherhood and higher-order births are in line with our main results presented above. However, the relative importance of specific features differs across education groups. Among highly educated women, indicators capturing being never partnered and being married at ages 30–34 and 35–41, as well as longer marital durations, dominate the rankings for both outcomes. Among low-educated women, cohabitation-related features are more prominent, and partnership status at younger ages, such as being never partnered (NP) at ages 16–19, 20–24, or 25–29, has comparatively higher importance values.

Partial dependence plots further show variation in the strength and, in some cases, the direction of associations by education (Figures A-3 and A-4 in the Appendix). Marriage duration and being married at older ages are positively associated with both motherhood and additional childbearing in both groups, but the gradients tend to be stronger among highly educated women. Remaining never partnered across the life course – and especially at older reproductive ages – is associated with lower predicted fertility outcomes in both groups, with a more pronounced decline among highly educated women. By contrast, being never partnered at younger ages is linked to lower predicted probabilities of having additional children among low-educated women, whereas among highly educated women it is associated with slightly higher predicted probabilities. Cohabitation also shows educational heterogeneity, where cohabiting at ages 20–34 predicts slightly higher probabilities of additional childbearing among highly educated women, while the association is weaker or negative among low-educated women. Finally,

differences by education in the predictive role of union dissolution and post-separation states are limited.

5. Discussion and concluding remarks

Spain's transition to persistently low fertility unfolded alongside major changes in partnership formation, including later union entry, rising cohabitation, and increasing union instability. This paper examines how traditional and emerging patterns in partnership biographies are associated with women's completed fertility outcomes by late reproductive ages. Using retrospective partnership and fertility histories from the 2018 Spanish Fertility Survey for women born 1962–1977, we employed a feature selection approach to examine the links between the previous partnership trajectories and two cohort-based fertility outcomes: entry into motherhood and progression to higher-order-birth fertility outcomes by age 41.

Our findings align clearly with the expectation that delayed or foregone union formation is closely associated with low fertility. Rather than early-life partnership experiences, what matters most is whether women spend substantial time in a coresidential union during their thirties, when many in these cohorts concentrated their fertility. This pattern fits the Spanish 'latest-late' transition to adulthood, in which leaving the parental home, forming a union, and becoming a parent have increasingly been postponed and de-synchronized. Although we cannot test cohort change directly, the findings are consistent with a broader literature pointing to the role of extended education, women's rising labour-market attachment, and economic constraints (e.g., precarious employment and housing barriers) in delaying partnership and family formation (Baizán, Aassve, and Billari 2003; Kohler, Billari, and Ortega 2002; Vitali and Mendola 2014; Lozano et al. 2024), thereby contributing to low and late fertility in Spain.

Our findings also support the expectation that marriage remained a central institution for childbearing in these cohorts, particularly for progression to higher-order births. This aligns with Spain's comparatively late and gradual shift away from marriage as the dominant framework for family formation. Even as cohabitation spread, marriage continued to structure the conditions under which larger family sizes were achieved.

Evidence for emerging partnership dynamics as new 'sites' of fertility is more nuanced. Cohabitation is clearly part of family formation, but it does not operate as a straightforward substitute for marriage for these cohorts. Stable and long-term cohabiting unions – still limited but growing due to evolving cultural norms, secularization, and economic conditions, particularly among highly educated women – appear compatible with childbearing, especially for additional births, whereas cohabitation at later reproductive ages is more weakly associated with entry into motherhood than marriage.

Similarly, union dissolution and repartnering play a limited role in these cohorts, consistent with the still modest prevalence of complex partnership biographies during much of their reproductive life course and with the fact that the sharp rise in divorce in Spain followed the 2005 reform. Taken together, these patterns point to continuity alongside change. Partnership diversification is evident, but marriage remained a key structuring context for fertility among women who completed their reproductive years during this period of transition.

Finally, the stratified analyses show that partnership trajectories intersect with social stratification in meaningful ways. While similar dimensions of partnership biographies matter across education groups, their relative salience differs, reflecting divergence in the timing of union formation and parenthood and in the role of cohabitation in family-building. This pattern is consistent with broader evidence that rising female educational attainment and changing gender and labour-market roles have reshaped family formation in Spain, with highly educated women more often postponing partnership and motherhood and showing lower fertility by age 41. In this context, being in a stable union – particularly at later reproductive ages – appears especially consequential for fertility among highly educated women.

Taken together, our findings have important implications for family policies. The diversity of partnership trajectories observed – particularly the prevalence of delayed or foregone unions, and the persistence of marriage as a key context for fertility – suggests that policies narrowly targeting traditional couples may fail to address the needs of a growing share of the population. Supporting reproductive choices across a broader range of partnership contexts, including cohabiting and unpartnered individuals, is crucial in addressing fertility challenges in low-fertility settings like Spain. Moreover, given the relevance of partnership status at later reproductive ages, especially among highly educated women, policies that facilitate family formation beyond the early reproductive years (e.g., through flexible parental leave, childcare, and housing support) may be particularly effective. By recognizing the interplay between life course trajectories and fertility, policy frameworks can better respond to the realities of contemporary family formation.

Our study also extends the existing literature in several ways. First, while previous studies have often focused on single events such as the timing of first births or transitions into specific union types, our results underscore the value of examining full partnership trajectories over the reproductive life course. In line with studies by Jalovaara and Fasang (2017) and Raab and Struffolino (2020), we confirm the importance of long-term partnership dynamics for fertility outcomes. However, by going beyond childlessness and assessing higher-order births, we offer a more comprehensive view of completed fertility. Second, the nuanced educational differences we identify – particularly the relevance of late partnering for highly educated women – add to ongoing discussions about social

stratification in family formation (e.g., McLanahan 2004; Schnor and Jalovaara 2020), and point to new forms of educational divergence in fertility patterns. Third, by applying a feature selection approach, we identify which specific aspects of partnership biographies are most strongly associated with fertility outcomes, refining prior sequence-based or event-history studies that often treat trajectories in aggregate or focus narrowly on timing. While our analysis is descriptive and does not identify causal effects, this strategy enables a nuanced examination of complex life course trajectories without reducing them to a small set of typical types or relying on restrictive model assumptions, making it well suited to detect subtle and multidimensional associations in contemporary family formation processes.

Among other limitations, the survey provides limited information on employment instability and quality and partners' characteristics, which likely condition both partnership stability and fertility progression. Future work combining richer longitudinal information on employment and partners with partnership histories would help clarify how economic resources and the dynamics within couples interact with union dynamics to shape completed fertility. Extending the approach to younger cohorts whose partnership biographies include more widespread cohabitation, higher union instability, and greater repartnering will also be crucial for assessing whether the patterns observed here persist or intensify in later cohorts.

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Appendix

Figure A-1: Distribution of partnership states at each age (proportions)

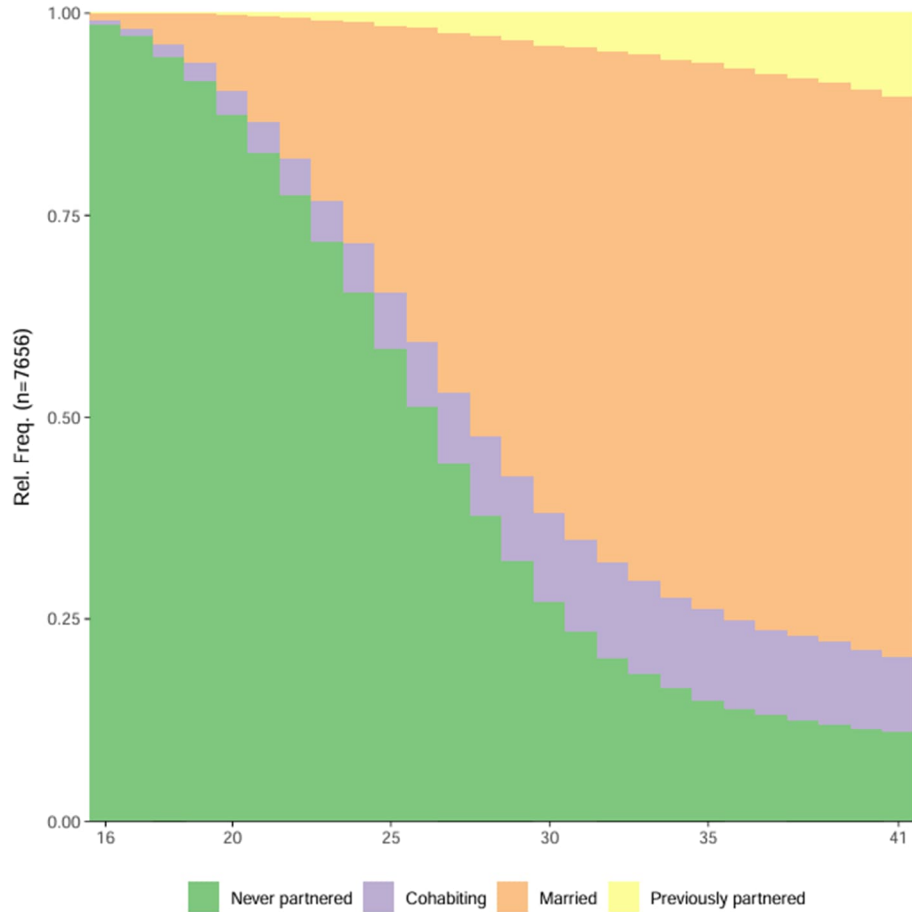
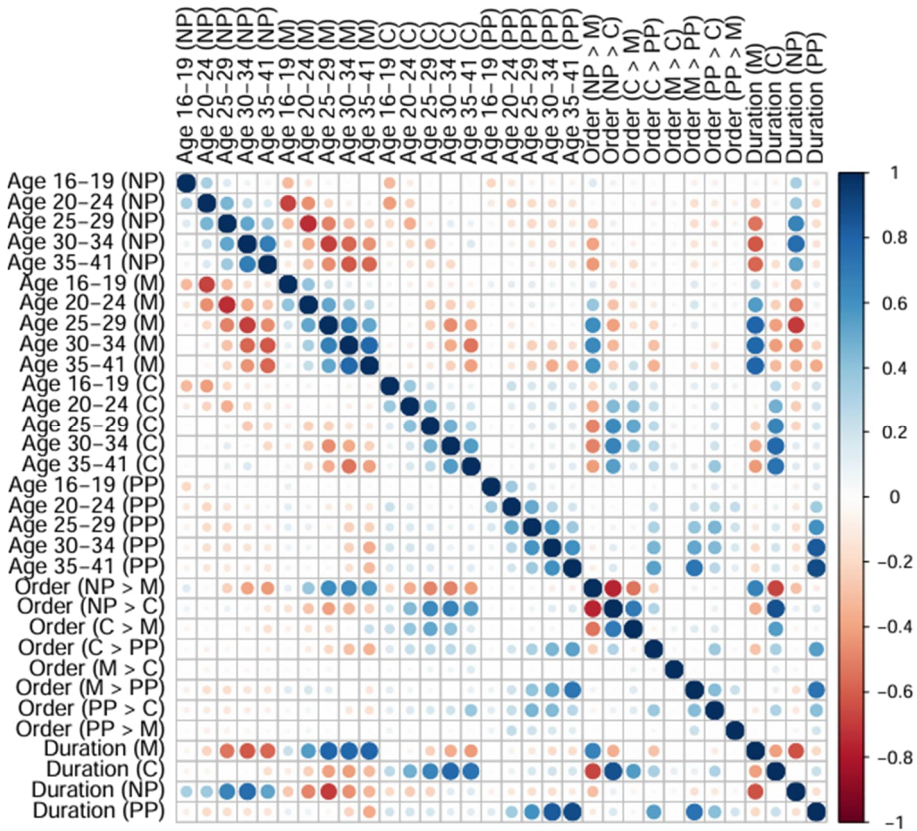


Figure A-2: Correlation matrix for all extracted features



Note: Women born between 1963 and 1978. The size and color of the circles indicate the strength and direction of the correlation across each two features. Trajectory features: Age – indicator for a partnership state observed within the age range; Duration – categorical variable with never, below average duration, and above average duration in a partnership state; Order – indicator of a subsequence of two different partnership states. Partnership states: NP – Never partnered, M – Married, C – Cohabiting, PP – Previously partnered.

Source: Spanish Fertility Survey 2018.

Table A-1: Mean importance of features for fertility outcomes (Motherhood and Additional Children) at age 41, by women's education

	Motherhood	Additional Children
Age 35–41 (NP)	16.99	13.21
Duration (M)	16.39	11.59
Education (High educated)	15.02	9.18
Age 35–41 (C)	14.74	9.92
Duration (C)	14.10	8.50
Age 35–41 (M)	13.40	12.07
Native	13.35	7.06
Age 30–34 (M)	12.59	14.23
Number of siblings	12.48	5.33
Age 30–34 (NP)	11.59	12.29
Order (NP > C)	11.30	7.09
Duration (NP)	10.89	10.58
Order (NP > M)	9.98	7.15
Duration (PP)	9.46	12.44
Age 25–29 (NP)	9.05	8.48
Age 35–41 (PP)	8.83	11.41
Age 30–34 (C)	8.70	8.38
Cohort 1972_1977	8.42	
Order (C > PP)	8.09	5.64
Age 25–29 (M)	8.05	12.22
Order (C > M)	7.93	5.87
Age 30–34 (PP)	7.90	9.80
Order (M > PP)	7.06	9.32
Age 25–29 (C)	7.03	7.53
Order (PP > C)	6.99	5.66
Cohort 1926–1967	6.73	4.98
Age 20–24 (c)	6.57	6.45
Age 20–24 (M)	6.54	7.48
Age 20–24 (NP)	6.19	8.13
Age 25–29 (PP)	5.27	6.83
Cohort 1967–1972	4.36	
Separated parent		4.04
Age 16–19 (M)		
Age. 16–19 (C)		
Order (M > C)		
Order (PP > M)		
Age 16–19 (NP)		7.89
Age 20–24 (PP)		4.08
Age 16–19 (PP)		

Note: Women born between 1963 and 1978. Trajectory features: Age – indicator for a partnership state observed within the age range; Duration – categorical variable with never, below average duration, and above average duration in a partnership state; Order – indicator for a subsequence of two different partnership states. Partnership states: NP – Never partnered, M – Married, C – Cohabiting, PP – Previously partnered

Source: Spanish Fertility Survey 2018.

Table A-2: Importance of variables (partnership trajectory features) for fertility outcomes (Motherhood and Additional Children) at age 41, by women's education

	Highly educated		Low-educated	
	Motherhood	Additional Children	Motherhood	Additional Children
Age 35–41 (NP)	15.87	14.17	15.50	10.62
Duration (M)	14.87	7.95	14.11	12.00
Age 35–41 (M)	14.05	10.35	13.10	10.15
Age 30–34 (M)	13.81	12.03	12.81	11.79
Duration (C)	11.33	5.58	12.96	8.61
Age 35–41 (C)	10.61	6.55	12.33	9.03
Age 30–34 (NP)	10.50	10.10	12.97	12.08
Duration (NP)	9.96	5.57	11.50	11.06
Order (NP > M)	9.73		10.75	7.97
Age 25–29 (M)	8.96	14.04	9.13	10.78
Order (NP > C)	8.47		11.38	8.14
Order (C > PP)	8.11	4.65	6.48	4.76
Age 30–34 (C)	7.69	6.27	7.70	7.10
Order (C > M)	7.56		7.61	6.09
Duration (PP)	7.55	10.94	8.99	10.96
Age 35–41 (PP)	7.41	10.02	6.58	9.24
Order (M > PP)	6.12	7.65	6.95	8.35
Age 25–29 (NP)	5.87	4.54	9.66	9.70
Age 20–24 (M)	5.10		6.50	8.42
Age 30–34 (PP)	4.71	5.85	8.28	8.61
Age 25–29 (C)	4.16	4.69	8.85	6.95
Age 16–19 (NP)	3.39			10.56
Order (PP > C)			6.74	5.03
Age 20–24 (C)			7.39	7.65
Age 25–29 (PP)			6.62	6.89
Age 20–24 (NP)			7.85	7.43
Order (PP > M)				
Age 20–24 (PP)				
Age 16–19 (PP)				
Order (M > C)				
Age 16–19 (M)			4.37	
Age 16–19 (C)				

Note: Women born between 1963 and 1978. For readability we report the mean importance of the partnership trajectory features only, and if selected as 'important' by the algorithm. Features ordered by most important for the highly educated motherhood model. Trajectory features: Age – indicator for a partnership state observed within the age range; Duration – categorical variable with never, below average duration, and above average duration in a partnership state; Order – indicator of a subsequence of two different partnership states. Partnership states: NP – Never partnered, M – Married, C – Cohabiting, PP – Previously partnered. Source: Spanish Fertility Survey 2018.

Table A-3: Likelihood of motherhood (model 1). Logit model, Odds ratio reported

VARIABLE	(1)	(2)	(3)
Duration continuous			
M	1.107*** (0.010)		
C	1.046*** (0.012)		
NP	0.944*** (0.008)		
PP [linear combination of the others]			
Duration categorical			
Duration M (ref. never married)			
Below average		7.346*** (0.594)	2.618*** (0.496)
Above average		9.726*** (1.243)	2.698*** (0.634)
Duration C (ref. never C)			
Below average		1.275*** (0.105)	1.012 (0.098)
Above average		2.505*** (0.272)	0.864 (0.149)
Duration NP (ref. never NP)			
Below average		1.239 (0.344)	1.055 (0.287)
Above average		0.739 (0.216)	0.829 (0.246)
Duration PP (ref. never PP)			
Below average		0.888 (0.098)	0.742*** (0.084)
Above average		0.831 (0.118)	0.618** (0.122)
Most relevant features			
Age 35–41 NP			0.293*** (0.046)
Age 35–41 C			1.423** (0.197)
Age 35–41 M			1.033 (0.203)
Age 30–34 M			1.351** (0.194)
Age 30–34 NP			0.735** (0.088)
Constant	1.512 (0.403)	0.448** (0.155)	1.568 (0.594)
Observations	7,656	7,656	7,656

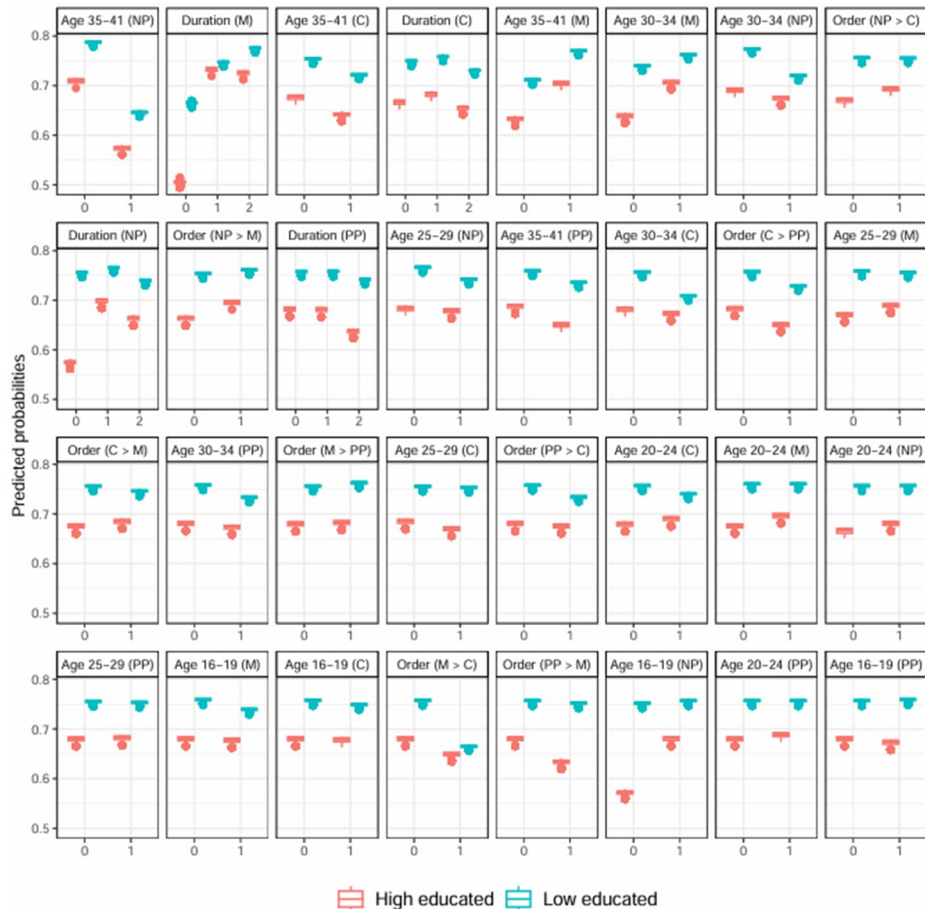
Note: Standard error in parentheses. OR reported *** p<0.01, ** p<0.05, * p<0.1 Models include the following set of controls: being born in Spain, parental separation, birth cohort, parental separation.

Table A-4: Likelihood of having more than one child (model 2). Logit model, Odds ratio reported

	(1)	(2)	(3)
Duration continuous			
M	1.107*** (0.010)		
C	1.061*** (0.012)		
NP	0.999 (0.010)		
PP [linear combination of the others]			
Duration categorical			
Duration M (ref. never married)			
Below average		2.212*** (0.230)	1.171 (0.237)
Above average		3.438*** (0.488)	1.416 (0.343)
Duration C (ref. never C)			
Below average		0.840** (0.068)	0.896 (0.080)
Above average		1.245* (0.150)	1.108 (0.193)
Duration NP (ref. never NP)			
Below average		0.205*** (0.078)	0.190*** (0.073)
Above average		0.152*** (0.059)	0.155*** (0.061)
Duration PP (ref. never PP)			
Below average		0.742*** (0.084)	0.726*** (0.085)
Above average		0.535*** (0.073)	0.373*** (0.079)
Most relevant features			
Age 35–41.NP			0.449*** (0.087)
Age 35–41.C			0.655*** (0.100)
Age 35–41.M			0.845 (0.175)
Age 30–34.M			1.231 (0.174)
Age 30–34.NP			0.607*** (0.063)
Constant	0.483*** (0.135)	4.544*** (1.993)	12.396*** (5.884)
Observations	5,649	5,649	5,649

Note: Standard error in parentheses. OR reported. *** p<0.01, ** p<0.05, * p<0.1.
Models include the following set of controls: being born in Spain, parental separation, birth cohort, parental separation.

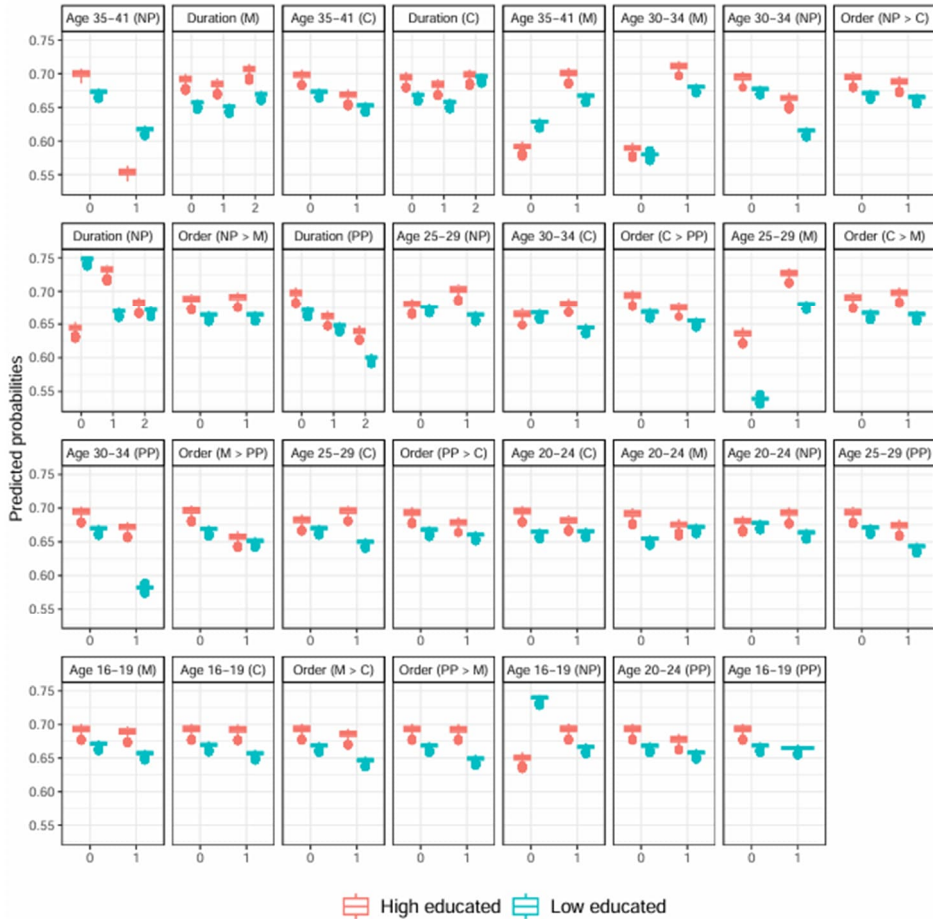
Figure A-3: Partial dependency plots for partnership predictors of becoming a mother at age 41, by women’s education. Left hand side the predicted probability of becoming a mother, right hand side the predicted probability of having more than one child (conditional on being a mother)



Note: Women born between 1963 and 1978. Predicted fertility outcomes at age 41. Partial dependency plots derive from random forest models including the covariates. They represent the predicted probabilities evaluated at different values of each feature and averaged over the distribution of all other features and covariates. The x-axis shows the different values taken by the features, while the y-axis is the predicted probability of the outcomes associated with each value of the predictor. For readability the predicted probabilities for the covariates are not shown. Features are ordered as in Figure 3, left panel. Trajectory features: Age – indicator for a partnership state observed within the age range (0 – yes, 1 – no); Duration – categorical variable of duration in a partnership state (0 – never, 1 – below average duration, 2 – above average duration); Order – indicator of a subsequence of two different partnership states (0 – yes, 1 – no). Partnership states: NP – Never partnered, M – Married, C – Cohabiting, PP – Previously partnered.

Source: Spanish Fertility Survey 2018.

Figure A-4: Partial dependency plots for partnership predictors of having more than one child (conditional on being a mother) at age 41, by women’s education



Note: Women born between 1963 and 1978. Predicted fertility outcomes at age 41. Partial dependency plots derive from random forest models including the covariates. They represent the predicted probabilities evaluated at different values of each feature and averaged over the distribution of all other features and covariates. The x-axis shows the different values taken by the features, while the y-axis is the predicted probability of the outcomes associated with each value of the predictor. For readability the predicted probabilities for the covariates are not shown. Features are ordered as in Figure 3 left panel. Trajectory features: Age – indicator for a partnership state observed within the age range (0 – yes, 1 – no); Duration – categorical variable of duration in a partnership state (0 – never, 1 – below average duration, 2 – above average duration); Order – indicator for a subsequence of two different partnership states (0 – yes, 1 – no). Partnership states: NP – Never partnered, M – Married, C – Cohabiting, PP – Previously partnered.

Source: Spanish Fertility Survey 2018.

