The Impact of Locational Nearness to Grandmothers(-in-Law) on the Transition to Second Births: Evidence from Andalusia, Spain

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Abstract

Geographical proximity to kin appears to have a pro-natal influence on women's fertility, although evidence from low-fertility settings with a familistic tradition is still scarce. In this paper, we exploit data from the Longitudinal Database of the Andalusian Population to investigate whether primiparous Spanish-born mothers in the low-fertility setting of Andalusia were more likely to have a second child if they lived in close proximity to maternal or paternal grandmothers (i.e. the mother's own mother or that of her partner). Following primiparous mothers with one child born in 2001, we model the occurrence of a second birth as a function of residential nearness to maternal and to paternal grandmothers after controlling for contextual and family background characteristics as well as individual and household characteristics. Our results show that living in close geographical proximity (<5km) to grandmothers(-in-law) had a positive influence on the occurrence of a second birth, although co-residence with maternal grandmothers indicates a negative association. Such associations vary as time progresses, with the strongest relationships at 3 and 4 years after first birth. These findings suggest that spatial proximity to maternal or paternal grandmothers might be a strategic response to the high opportunity costs of childbearing for women in the low-fertility context of Andalusia.

Key words: Fertility, geographical proximity, grandmothers(-in-law), intergenerational support, Andalusia, Spain.

1. Introduction

It is acknowledged that the availability of family support, particularly from grandparents, might reduce the cost of childcare and hence increase fertility (Blau and Robins 1989; Del Boca 2002; Hank and Kreyenfeld 2003; Heylen et al. 2012; Kaptijn et al. 2010; Lehrer and Kawasaki 1985; Mathews and Sear 2013; Waynforth 2011). Much less is known, however, about whether geographical proximity to maternal or paternal grandmothers is a salient factor in encouraging primiparous women to have second births, particularly in low- and late-fertility contexts. The aim of this study is to understand better whether, how and when the occurrence of second births is influenced by living close to maternal or paternal grandmothers (i.e. the primaparous mother's own mother or that of her partner) in Andalusia, Spain, a province where family networks are known to have a remarkable level of spatial concentration and formal childcare provision has traditionally been low (Tobío and Fernández Cordón 2013). We expect that, because grandmothers are often of major importance as the main providers of childcare support, living in geographical proximity to them will have a significant positive impact on fertility behaviour.

Prior research supports this expectation, particularly in societies where kin provide high levels of assistance that reduces the constraints on parents' childbearing and thus leads to higher fertility (Turke 1989). Crucially, some forms of kin assistance such as childcare and help with day-to-day activities can more easily be provided if significant kin live in close proximity. Various studies have shown that geographical distance to family members is strongly associated with frequency of face-to-face contact (Greenwell and Bengtson 1997; Grundy and Shelton 2001) and the exchange of support (Daatland and Lowenstein 2005; Kolk 2017; Litwak and Kulis 1987), even in the era of internet proliferation and communication technology (Michielin and Mulder 2007). It is thus plausible to assume that the likelihood of providing care decreases with increasing geographic distance between the older and the younger generations, particularly if regular grandchild care is considered (Hank and Buber 2009). Yet evidence from low- and late-fertility settings with a familistic tradition, such as Andalusia, is currently scarce and inconclusive (Aassve et al. 2012; Mendez 2015; Raymo et al. 2010). It is therefore important to investigate the impact of locational nearness to grandmothers(-in-law) on fertility behaviour, especially in relation to the transition to second births.

Our focus on second births is motivated by three factors. First, it is widely acknowledged that the difficulty of reconciling motherhood and careers is greater among those who have two children rather than only one (Brodmann et al. 2007). Second, the great majority of women, regardless of education, have at least one child. However, it is in relation to second and higher-order births that significant differences are found between socioeconomic groups and across countries (Andersson 2000; Kreyenfeld 2002; Sleebos 2003; Brodmann et al. 2007). Third, in low fertility contexts, second (and higher order) births make a critical contribution to population fertility levels and thus to the natural growth, or decline, of the population, "(b)ecause the fundamental driver for low fertility in advanced societies lies exactly in the lack of progression from the first to the second child" (Mencarini 2019: 3). Survival analysis is used to examine the association between proximity to grandmothers and the occurrence of second births at various intervals after first birth, whilst taking into account other contextual, family, individual and household characteristics. To our knowledge, this study is the first to investigate whether geographical proximity to both maternal and paternal grandmothers influenced the transition to second births during a period of temporary fertility recuperation in the 2000s in Andalusia.

The remainder of the paper is organised as follows: Section 2 provides a literature review and outlines the regional and country contexts of the study; Section 3 describes the data and methods used in the empirical analyses; Section 4 presents the results from a series of Cox regression

models for the main relationships between geographical proximity of maternal and paternal grandmothers and the likelihood of a second birth, at different times since first birth; Section 5 discusses the main findings and directions for future research; and finally, Section 6 concludes by considering the study's contribution to the literature on kin support and fertility, and by commenting briefly on the wider implications of the study.

2. Literature Review

State and Kin Support

Much recent demographic research has focused on whether state welfare support for working mothers in the form of formal childcare both reduces the difficulties of work-family balance and determines fertility behaviour (Fagnani 2012; Rindfuss and Brewster 1996). Evidence suggests that good welfare state support is one of the most important structural requirements for solving the compatibility problem between work and child-rearing. This is demonstrated by the positive relationship between women's employment and childbearing in Northern Europe (Andersson 2000; Wood and Neels 2019), in contrast to the negative relationship in Southern European countries (González and Jurado-Guerrero 2006). Hence, it has become evident that parental fertility decisions are likely to be different if childcare is available, with most studies highlighting childcare availability as fundamental for fertility recuperation (Esping-Andersen and Billari 2015; McDonald 2000, 2006).

While the provision of childcare facilities may be of structural importance, it should also be noted that childcare costs can be a considerable extra burden for parents. Therefore, unless childcare facilities are subsidised by the government and geographically accessible to (potential) parents, they may not mitigate the postponement of childbearing among parents who face economic hardship or labour market uncertainties (Adsera 2004; Hofmann and Hohmeyer, 2013). In such an economic and institutional context, the availability of family support may be a crucial component of the local opportunity structure, especially in settings where grandparents are heavily involved in childcare (Di Gessa et al. 2016). Thus, all else being equal, family support may be more important in those countries where state support is weak and intergenerational ties strong (Raymo et al. 2010). In Southern Europe, including Andalusia and a significant part of Spain, families have traditionally been characterised by strong ties and familism is seen as a normative framework for social interactions (Reher 1998). Thus, unsurprisingly, the role of grandparenting in individuals' family formation decisions appears to be stronger in southern Europe, where public childcare provision for young children is less prevalent (Aassve et al. 2012). For instance, Danish women are more likely to have a second child than Spanish women, in general because welfare state support makes reconciliation of motherhood and careers easier (Brodmann et al. 2007). In the case of Spain, the difficulties of combining work and family have only recently been mitigated by state involvement in childcare provision (Baizán 2009), thus access and support from geographically proximate kin, especially grandparents, is likely to play an important role in response to the difficulties of balancing work and family, especially for women. Recent rises in women's labour force participation have increased the opportunity cost of childbearing in most advanced economies (Morgan and Taylor 2006), and the compatibility between motherhood and paid employment has become central in individual fertility decision-making (Harknett and Hartnett 2014).

It has also been pointed out, from an evolutionary perspective, that humans are 'cooperative breeders' (Sear 2016), with a reproductive strategy adapted to conditions where mothers receive substantial assistance in childbearing. In this sense, although greater mobility of individuals has

become the norm, family support is seen as crucial to spreading the costs of childrearing (Turke 1989; Newson et al. 2005). Although some families are likely to be more supportive than others, it is increasingly recognised that general and specific forms of support from families can reduce the costs of reproduction and, thus, influence fertility behaviour (Schaffnit and Sear 2017). Nevertheless, it can also be argued that contexts in which family ties are strong may have opposing effects on fertility. On the one hand, strong ties may have a pro-natal effect in those cases where support from grandparents subsidises the costs of rearing of grandchildren and strengthens intergenerational bonds (Dalla Zuanna and Micheli 2004). Prior research from the Italian context provides some evidence of a positive relationship between grandparental support and fertility (Del Boca 2002). On the other hand, support given to grandparents may have the opposite (negative) effect on fertility, particularly for women who face simultaneous obligations to support elderly parents and dependent children (Grundy and Henretta 2006).

Decisions to have a(nother) child also depend on the structure of interactions between individuals, including the spatial kin-related social structure. There is often a strong "implicit assumption that in individualistic and secularised post-industrial societies, social norms and constraints are not effective; and that parenthood and childbearing is an intimate couple-based choice that is free of any social considerations" (Bernardi and Klärner 2014: 643). However, the intention to have a child, the value attributed to children, the norms regulating appropriate parenthood, and the support available to parents are created, diffused, and transformed by social interaction (Rossier and Bernardi 2009). The notion of social interaction, or linked lives, is at the core of existing arguments supporting a re-theorisation of family demography in which individuals are seen as embedded in structural environments that do not fully determine their actions but rather provide a framework of opportunities for action (Bernardi and Klärner 2014). Thus, in order to complement the individual-level focus of many recent studies of fertility, various scholars have provided evidence that social support may facilitate the decision to have a child and encourage an earlier transition to second and higher order births (Arránz Becker et al. 2010; Balbo and Mills 2011a, 2011b; Bühler and Fratczak 2007). Further, the characteristics of kin ties may also be significant for fertility outcomes, with research indicating that increases in the proportion of possible exchanges among kin are positively associated with completed fertility (Bernardi and White 2010). In so far as geographical proximity increases the chances of kin exchanges, this suggests that living close to grandmothers may also have a positive impact on fertility.

The Role of Geographical Proximity to Kin

Although greater mobility of individuals has become the norm and internet proliferation and communication technology is widespread in high-income countries (Michielin and Mulder 2007), living close to other family members remains strongly associated with the frequency of face-to-face contact and the exchange of support (Lawton et al. 1994; Silverstein and Bengtson 1997; Hank 2007; Mulder and Van der Meer 2009). Importantly, the proximity of parents to their adult children has been shown to be positively related to cooperative behaviour (Hank and Buber 2009) and to positively affect women's fertility through exchanges of resources and services, although the effect appears to depend on social as well as geographical closeness. After comparing frequently and infrequently contacted relatives who lived within 50 miles of the respondent in Britain, Mathews and Sear (2013) found that only the frequently contacted relatives significantly increased the risk of first birth. This suggests not only that relatives may influence fertility behaviour even in a resource-rich population but also that some kin ties are more dominant within family networks. We know too that geographical distance is a strong predictor of contact and support between family members and that ties with parents and siblings are likely to dominate (Agree and Glaser 2009; Hank 2007). Thus, examining the influence of geographical proximity

to close kin such as grandmothers(-in-law) can be considered an important proxy for the availability of grandparent support for childcare, shedding light on the interplay between family dynamics and fertility behaviour.

To date only a few studies have directly considered the impact of geographical proximity to grandparents on fertility behaviour. Estimating the transition risk to first and second births for western German women, Hank and Kreyenfeld (2003) found that living in the same town as grandparents increased the probability of having a first birth by around 20%, although no such effect was found for second births. Interestingly, in the same study the availability of formal childcare had no effect, a finding which led to subsequent analyses by Hank et al. (2004) to test whether the "grandmother effect" was also significant in the former East Germany where the greater availability of formal care arrangements appeared to be relevant for first births. They concluded that the impact of grandparents' care is subject to the institutional context, and that the mechanisms are likely to be linked to parents' need for childcare or the reduction of parental costs associated with having children. In a similar vein, García-Morán and Kuehn (2017) have recently shown that women in West Germany residing close to both grandparents and grandparents-in-law are more likely to have children. More specifically, they found that living close to grandparents(-in-law) is associated with a 6% fertility increase among married women, and with a 5% fertility increase among employed women. They concluded that, if more women had access to proximate grandparent-provided childcare, both fertility and mothers' labour force participation would increase in West Germany, albeit geographical mobility would be reduced. In contrast, Rindfuss et al. (2007) found a negative effect from having grandmothers living nearby (within the same municipality) and first birth timing in Norway. According to Rindfuss and colleagues, this negative effect could have various explanations such as the fact that their models did not account for grandmother's work status, or that living within the same municipality as grandmothers is not a sufficient measure to capture potential help with childcare. It is also possible, as Rindfuss et al. (2007) note, that in a society with near full coverage of public childcare, grandparenting does not have the expected effect.

Since the rigidity and limitations of the supply of publicly-provided child care are somewhat compensated for by a substantial family support system, it has been argued that it is important to test whether co-residence and residential proximity to parents(-in-law) play an important role in offsetting the relatively high costs of parenthood, especially for women (Raymo et al. 2010). However, findings on the relationship between residential proximity to kin and fertility outcomes in Mediterranean countries where family ties are conventionally seen as stronger than in Northern Europe remain mixed. Whereas research by Mendez (2015) suggested that couples in Southern Europe live close to their parents in order to reconcile work and family by taking advantage of their own mothers' low labour force participation rate, Raymo et al. (2010) found no clear evidence that intergenerational residential proximity is associated with higher fertility intentions among Italian (and Japanese) women, although the results are consistent with a scenario in which 'family-centred women' (Hakim 2000) tend to live close to their parents(-in-law). Further, Aassve et al. (2012) found no significant effect of geographical proximity to grandparents on the likelihood of having another child, although the availability of grandparents appeared to play an important role in individuals' childbearing decisions in Southern Europe with effects varying across different extended family scenarios. It is likely that this inconsistent empirical support for an association between living close to grandparents and fertility outcomes reflects both data limitations and methodological differences. One major issue is how 'geographical proximity' is defined. In some cases, it is considered that living up to a reasonable threshold distance (e.g. within 25km) allows contact and exchange of care within the extended family (Aassve et al. 2012), whereas in other cases co-residing with parents, living in the same city (proximate residence) and

non-proximate residence are used as the main categories to classify intergenerational proximity (Raymo et al. 2010).

This study takes as its primary focus the relationship between proximity to grandparents and the likelihood of a second birth, and addresses two key research questions. It extends previous research in several ways. Most importantly, our starting point is a large sample of Spanish-born primiparous mothers aged 20-49 who all gave birth to their first child in the same year (2001). This provides a control for exogenous factors, such as the state of the wider economy, associated with temporal context. Unlike those past studies that used data from the Survey of Health, Aging and Retirement in Europe (SHARE), for all primiparous mothers in our sample we are able to distinguish between maternal and paternal grandmothers. We model these separately as we posit that the former may be more important than the latter in providing childcare support. We also use detailed geo-referenced data linking the residential locations of primiparous mothers and both grandmothers and grandmothers-in-law, including information on co-residence, which allows us to explore different definitions of geographical proximity. Our first research question is therefore:

> (RQ1) Is geographical proximity to (a) maternal grandmothers, and (b) paternal grandmothers associated with an increased likelihood of having a second birth?

Further, we recognise that any association between living close to grandparents and transition to second birth may vary over time since first birth, either as a reflection of birth spacing planning, fecundity or different experiences of coping with one child. Thus, in a methodological advance over previous studies, we employ data from a 10-year follow-up of mothers with one child born in 2001 who were continually resident in Andalusia during the study period (2001-2011). The longitudinal nature of these data allows us to test the associations between the residential proximity of grandparents and the relative risks of transition to second birth at various times after first birth over a long follow-up period. Our second key research question is therefore:

> (RQ2) Does the relationship between geographical proximity to grandmothers(-in-law) and the likelihood of having a second birth vary depending on time since first birth?

A particular strength of the data used in this study is the size and representativeness of the analytical sample, which includes all Spanish-born mothers aged 20-49 living in Andalusia who had their first child in 2001 and can be tracked over the following decade to determine if/when they had a second child. Andalusia is one of 17 autonomous communities in Spain and, while childbearing experiences of women there may differ from those of women in the large cities such as Madrid or Barcelona, our findings will be relevant to other areas both in Spain and across Southern Europe where formal childcare provision is relatively low.

The Fertility Context in Andalusia

Andalusia is the largest region of Spain and makes up most of the southern part of the Iberian Peninsula, with over 8 million inhabitants (around 18% of the total population of Spain). Since 1975 Andalusia has undergone a prolonged and intense fertility decline until the late 1990s when a period of slight recovery emerged until the onset of the 2008 economic crisis (see Figure 1). During the 2000s, period total fertility rates rose steadily, reaching 1.56 children per woman by 2008 compared to 1.44 for Spain as a whole. Although Andalusian fertility shares some common features with national fertility, particularly the lowest-low levels at the end of the 1990s, it has traditionally exhibited higher total fertility rates. An important aspect of the difference between Andalusian and national fertility rates relates to the differential weight of second birth. For

instance, at the beginning of our study period in 2001 the total fertility rate in Andalusia was 1.35 children per woman, of which 0.66 (49%) were first births and 0.51 (38%) were second births. During the same year, the total fertility rate in Spain was 1.24 children per women, of which 0.66 (53%) were first births and 0.44 (35%) were second births. As can be seen in Figure 1, these differences endured over the following decade. Thus, at the end of our study period in 2011, the total fertility rate in Andalusia was 1.42 children per woman, of which 0.74 (52%) were first births and 0.54 (38%) were second births, while the total fertility in Spain was 1.34, of which 0.73 (54%) were first births and 0.48 (36%) were second births. Thus, total fertility rates remain higher in Andalusia compared to national fertility, partly because second birth rates contribute more in the region than they do nationally. This preliminary evidence suggests that transition to second births is more likely in Andalusia and this is partly explained by the fact that women tend to have their first child at an earlier age in Andalusia than in Spain as a whole. In 2001, for example, the average age of women having their first child in Andalusia was 28.2 years, whereas in Spain the average age of women having their first child was 29.1 years. Such differences still remained in 2011, when the average age of women having their first child in Andalusia was 29.4 years compared to 30.1 years nationally.

[Insert Figure 1 about here]

Although postponement need not result in fewer births if circumstances allow for catch-up, delaying first births in Spain tends to limit subsequent fertility. While various factors, such as welfare state support and access to secure jobs that may facilitate fertility catch up, are associated with transitioning from first to second births in other European contexts, in this paper we focus on the influence of geographical proximity to grandmothers(-in-law) on the likelihood of a second birth. Given the underdeveloped mother-friendly policies in Spain, the number of grandparents caring for grandchildren has experienced remarkable growth over the past decade (Ortega and Fernández 2018), suggesting the availability of grandparent childcare has become increasingly important. As living close to grandparents is likely to facilitate interaction and availability, this suggests that residential proximity to grandmothers – who are frequently the main providers of intensive childcare (Hank, 2009) - could encourage second births. This may be especially so in Andalusia where there are stronger family dependencies and positive attitudes towards grandparenting than in Spain as a whole (Ortega and Fernández Alonso 2018; Tobío and Fernández Cordón 2013). Further, family networks are known to have a remarkable level of spatial concentration in Andalusia, with almost 60% of the members of family networks living in the same municipality, including some who live in the same building or neighbourhood and very few who live in a different Spanish region or abroad (Tobío and Fernández Cordón 2013). This level of residential proximity may itself be related to the relative lack of formal childcare provision, which has expanded only slowly in Andalusia with a coverage rate for children under 3 of around 1% in 2001 and 6% in 2006 compared to a national average of 9% and 20% respectively for the same years. Low levels of formal childcare provision in Andalusia suggest a general expectation that (potential) parents will rely instead on a pool of informal caregivers (mostly grandparents). Andalusia provides a context in which the influence of intergenerational residential proximity on fertility is most likely to be apparent and is, therefore, a highly appropriate test case for investigating our two research questions.

3. Data and Methods

Data

Our study employs high quality data from the Longitudinal Database of the Andalusian Population (LDAP) to develop a follow-up study of Spanish-born primiparous mothers with one child born in 2001 and continued residence in Andalusia until 2011. The LDAP uses information from multiple data sources, which are linked, combined, and then reviewed by trained statisticians from the Andalusian Statistical Office (for a detailed description, see https://www.juntadeandalucia.es/institutodeestadisticaycartografia/fecundidad/index.htm).

Two analytical samples are systematically derived to analyse the association under consideration for maternal (sample 1) and paternal (sample 2) grandmothers respectively. While the first sample can be considered a full sample of primiparous Spanish-born women irrespective of their marital status; the second sample includes only primiparous Spanish-born who are married and therefore have in-laws. This allows us to document separately the influence of living close to maternal (sample 1) and paternal (sample 2) grandmothers on the occurrence of second births. For both samples we use data for primiparous mothers aged between 20 and 49 at the time their first child was born (year 2001) since at younger ages many women are still in full-time education and births are often the result of unplanned pregnancies. We excluded primiparous foreign-born mothers as they are much less likely to have maternal and paternal grandmothers living in Andalusia.

In addition, to answer RQ2, we investigate the association between geographical proximity to grandmothers and transition to second birth at four time points after first birth (*t*), namely at *t+2* years, *t+3* years, *t+4* years and *t+5* years. The choice of such time points derives from the examination of the unadjusted hazard estimates from *t+0* onwards, which indicate that the risk of having a second child among Spanish-born primiparous mothers rose prominently through the early years of motherhood, with most second children born between the second and fifth year following the birth of the first child. Further examination of the Kaplan-Meier estimates also indicates that around 75% of women who had a first child in 2001 had another child during the follow-up decade (see Figure 2). The study accounts for possible selectivity into second birth by following up one cohort of primiparous mothers at four time points after first birth in 2001. We are therefore able to assess the temporal sequence between exposure (i.e. geographical proximity to grandmothers(-in-law)) and outcome (second births) at *t+2* years, *t+3* years, *t+4* years and *t+5* years. At each subsequent time point, mothers who have already made the transition to second birth are excluded from the analysis and new estimates are developed using the remaining years of observation within the study period. Thus, a small number of women who had a second child before *t+2* are dropped from the analysis and the rest are followed up over eight years, while at *t+5*, the follow-up period is five years. By taking into consideration such temporal windows, we are also able to capture the influence of geographical proximity to grandmothers(-in-law) on the occurrence of second births as time progresses. Lastly, we removed cases with missing information on any of the independent variables or covariates through list wise deletion both from the full sample with all primiparous Spanish-born women irrespective of their marital status (*N* = 243 out of 34,115 or 0.7%) and from the sample of primiparous Spanish-born married women only (*N* = 320 out of 24,809 or 1.3%). The final analytical sample size for the former at *t+2* is 31,423, and the final analytical sample size for the latter at *t+2* is 22,950.

[Insert Figure 2 about here]

The main analysis investigates the influence of the distance between the residential location of Spanish-born primiparous mothers and the residential location of both maternal and paternal grandmothers on the transition to second birth (the dependent variable of interest). In order to test the null hypothesis that there is no difference between Spanish-born primiparous mothers living close to or far away from grandmothers(-in-law) in relation to the likelihood of a second birth, we employ both survival curves and the log-rank test. We repeated the analysis at four time points after first birth. For each time point, we calculated the observed number of second births in each sample of primiparous mothers by geographical distance to grandmothers and compared this with the number of second births that would be expected if there was no difference between the groups. While the survival functions for each group of primiparous mothers by geographical distance are not perfectly parallel but separate except at the very beginning and at the very end, the log-rank test of equality across strata for the predictor geographical proximity had a p-value of < 0.01 for each of the study periods analysed, thus providing evidence that geographical proximity is a significant predictor of the occurrence of second births. However, as Kaplan-Meier curves do not include other variables that may influence the occurrence of the event of interest, and the log-rank test cannot provide an estimate of the size of the difference between the groups, Cox regression models are employed for the main analysis (see below).

The availability of detailed information during the second, third, fourth and fifth year after the first birth, makes the LDAP a valuable dataset for examining the impact of significant kin on the occurrence of second births over time. As in previous fertility studies (Aassve et al. 2012; García-Morán and Kuehn 2017; Hank and Kreyenfeld 2003; Raymo et al. 2010; Rindfuss et al. 2007), we use geographical distance to grandmothers(-in-law) as an indirect measure of the availability of grandmother support. We considered two estimates of distance between primiparous mothers and their mothers(-in-law): straight line (i.e. Euclidian) and travel distances. Since the transportation system in Andalusia underwent substantial changes over the study period, we adopted a conservative approach using Euclidian distances between mothers' and grandmothers' residences at building-level to provide reliable estimates of geographical proximity at each of the four time points after first birth. For the calculation of distances, we assume the general principle of least-effort (L'Hostis 2015), thus all distances were computed using the Great Circle Distance, as follows: $D = 3963.0(arcos[sinT_1) \times \sin(T_2) + \cos(T_1) \times \cos(T_2) \times \cos(G_2G_1)])$, where T_i is the latitude and G_i is the longitude of locations 1 and 2 in radians. After computing all Euclidian distances between primiparous mothers' and grandmothers' residences, we ran models with different cut-off distances, particularly with regard to the longer distances. Although different specifications were found to fit the data, based on model fit tests, we chose the following cut-off distances: 1) co-residence; 2) <1km away; 3) 1-5km away; 4) 5-25km away; 5) 25+km away.

Our analyses are adjusted for a number of additional variables representing contextual characteristics and family background, as well as individual and household characteristics. The municipality of residence is coded as 1 = minor rural (less than 5,000 residents), 2 = large rural (between 5,000 and 10,000 residents), 3 = minor urban (between 10,000 and 50,000 residents), 4 = medium urban (between 50,000 and 100,000 residents), and 5 = large urban (more than 100,000 residents). Number of siblings is a count variable recoded as 1 = only child, 2 = one sibling, 3 = two siblings, and 4 = three or more siblings. Age of primiparous mothers and grandmothers(-in-law) is measured in years and based on the LDAP in 2001. Marital status of primiparous mothers is coded as 1 = single, 2 = married, and 3 = other (widowed, separated and divorced). Education level of primiparous mothers, spouses and grandmothers(-in-law) is coded as 1 = compulsory, 2 = post-compulsory (non-tertiary), and 3 = tertiary. Economic status of primiparous mothers, spouses and grandmothers(-in-law) is coded as 1 = employed, 2 = unemployed, and 3 = economically inactive. Housing tenure is coded as 1 = homeowner, 2 = private rented, 3 = public rented, and 4 = other. Number of rooms is a count variable, and number of cars is coded as 1 =

none, 2 = one, and 3 = two or more. Table 1 provides a descriptive analysis of the characteristics of the full sample with all Spanish-born primiparous women (sample 1) and married Spanish-born primiparous women only (sample 2) at *t+2*.

Statistical analysis

To estimate whether geographical proximity to (a) maternal grandmothers and (b) paternal grandmothers is associated with an increase likelihood of having a second birth, regression models are based on the flexible Cox proportional hazard model (Cox 1972) with the 'st' suite for survival analysis in Stata 15.1. The standard Cox regression can be expressed as:

$$h_s(t|X_1, \dots, X_k) = h_{0s}(t)\exp\left(\sum_{j=1}^{k} \beta_j X_j(t)\right)$$

where $h_s(t|X_1, \dots, X_k)$ is the hazard rate for individuals with characteristics $X_1, \dots, X_k$ at time t, $h_{0s}(t)$ is the baseline hazard at time t for stratum or province s, $s = 1, \dots, S$, and $\beta_j, j = 1, \dots, k$ are the estimated coefficients. Cox regression models the hazard rate or the number of second births among Spanish-born primiparous mothers (population at risk). We first model the bi-variate association between geographical proximity to grandmothers(-in-law) and the occurrence of second births (Model 1). Then, because a woman's fertility is influenced by a large number of factors, we add control variables in groups to build the full model. The vector X comprises predetermined control variables that can adjust for possible confounding factors. Hence, Model 2 controls for the municipality of residence as the geographical proximity of kin may vary between smaller rural municipalities and larger urban municipalities. In Model 3 we add adjustments for the number of siblings and for grandmothers'(-in-law) age, education and economic status. While some studies have documented the importance of childhood family experience in shaping fertility preferences (Fernández and Fogli 2006), having siblings might also reduce the availability of childcare if grandparents(-in-law) already care for other grandchildren (Aassve et al. 2012). The availability of grandmothers(-in-law) is also likely to vary depending on their own characteristics. Older grandmothers, for example, may not have the health and energy, and employed grandmothers may not have the time, to provide regular care for their grandchildren. Finally, Model 4 estimates the effect of geographical proximity to grandmothers(-in-law) on the likelihood of having a second birth after further adjusting for individual level characteristics of primiparous mothers (i.e. age, marital status, education and economic activity) known to influence the likelihood of a second birth, as well as variables that address the husbands' breadwinner capacity (i.e. education and economic activity of spouses) and joint household attributes (i.e. tenure, number of rooms and number of cars). All our models are stratified by province of residence, making them analogous to province fixed effects models (Allison 2009).

The following time-to-event data are used for our empirical analyses: (1) the time variable, which is computed in months as the total elapsed time between the month of first birth and the end of observation; and (2) the status variable, which in our study refers to whether or not a woman had a second birth. The transition to second birth is measured as the duration between first and second birth for those who have second births; for women who do not experience a second birth during the study period, duration is measured from first birth (2001) until they are right censored at end of the study period (year 2011). Thus, primiparous mothers who do not experience a second birth by the end of the study period are included in the analyses as part of the population at risk. To answer our first research question, we estimate models 2 years after the birth of a first child. To

answer our second research question, we estimate various models to reflect the population at risk 3, 4 and 5 years after first birth, with our key variable (geographical proximity to grandmothers) measured at each time point.

4. Results

Table 1 provides descriptive statistics for the two analytical samples of our study two years after the first birth. Both samples show the importance of geographical proximity to grandmothers in general, with just over 50% of primiparous mothers living within 5km of maternal grandmothers (sample 1) and around 60% of primiparous mothers living within 5km of paternal grandmothers (sample 2). An important difference between the two samples is that around 20% of maternal grandmothers co-reside with their primiparous daughters whereas only 4% of paternal grandmothers live with their daughters-in-law. Nearly 50% of the two samples of primiparous mothers live in large urban areas and the majority have one or more siblings. Both maternal and paternal grandmother tend to be under pensionable age but economically inactive and have only compulsory education. The mean age for all primiparous mothers is 29.5, and 29.7 years for the group of married primiparous mothers, which also constitutes the majority of all primiparous mothers in the full sample. Primiparous mothers with post-compulsory education account for just over half of all mothers, whereas within the other half of primiparous mothers around 20% are unemployed and the rest are economically inactive. Whilst there are similarities between the educational attainment of primiparous mothers and their spouses (if any), it is clear that spouses are more likely to be employed. Further, Table 1 shows that the great majority of primiparous mothers are homeowners (around 86%) and have one or more cars (around 90%).

[Insert Table 1 about here]

The results relevant to our first research question are summarised in Figure 3, which shows the relationships between the hazard of primiparous mothers having a second birth and geographical proximity to (a) maternal and (b) paternal grandmothers two years after the first birth from all four Cox models (see Appendix 1 for full models). The results (Figure 3a) indicate that, whilst living relatively close (1-5km) to maternal grandmothers appears to be positively associated with the transition to second births among primiparous mothers at *t+2*, such an association is not statistically significant compared to the reference group (>25km). Moreover, the presence of co-resident maternal grandmothers reduces the likelihood of second births by 3.8% among primiparous mothers at *t+2* compared to the reference group (>25km) after all adjustments are included (HR = 0.962, 95% CI: 0.919 – 1.006, $P < 0.1$), although the result for the final model is only marginally significant. Thus, two years after the first birth we observe that residing close to maternal grandmothers does not influence the occurrence of second births, whereas co-residence appears to reduce the likelihood of second births. In contrast, using the sample of married primiparous mothers (Figure 3b), we see that living in very close proximity (<1km) to paternal grandmothers at *t+2* has a positive influence on the occurrence of second births. In other words, compared to the reference group (>25km), living less than 1 kilometre away from paternal grandmothers is associated with an 8% increase in the likelihood of second births at *t+2* (HR = 1.079, 95% CI: 1.033 - 1.127, $P < 0.001$). Further, co-residence has no significant impact on the transition to second birth, albeit only 4% of paternal grandmothers live with their primiparous daughters-in-law. These findings suggest that the answer to our first research question differs depending on which grandmother is considered and how near to the primiparous mother they live. It may also differ depending on the time point after first birth at which models are estimated.

To examine temporal variations and answer our second research question, Figures 4 and 5 summarise results for the same suite of Cox models estimated at *t+3*, *t+4* and *t+5* for maternal (Figure 4) and paternal (Figure 5) grandmothers. Figure 4 shows that, whilst co-residence of maternal grandmothers with primiparous mothers is negatively associated with second births over time, the relationship is clear and statistically significant only at *t+4* and *t+5*. For primiparous mothers living close to maternal grandmothers (<1km or 1-5km), we see the opposite effect at *t+3* and *t+4*, namely a positive and statistically significant association after the inclusion of all adjustments, although this is no longer evident at *t+5*. More specifically, at *t+3* the likelihood of having a second birth among primiparous mothers who live within 1km and between 1 and 5 kms from maternal grandmothers increases by around 5.5% (HR = 1.055, 95% CI: 1.008 – 1.104, $P < 0.05$) and 4.9% (HR = 1.049, 95% CI: 0.997 – 1.104, $P < 0.1$) respectively compared to the reference group of those living further away (>25km). The hazard ratios for *t+4* are similar but stronger, with the likelihood of having a second birth four years after the first birth increasing by around 7% for both those living within 1 kilometre (HR = 1.067, 95% CI: 1.010 - 1.127, $P < 0.05$), and those living between 1 and 5 kilometres (HR = 1.066, 95% CI: 1.003 - 1.134, $P < 0.05$) from maternal grandmothers, compared to those living further away (>25km). All models show that there is no statistical significant difference between having maternal grandmothers living 5 to 25 kilometres away and more than 25 kilometres away for the occurrence of second births. These findings provide evidence that not only does geographical proximity to (maternal) grandmothers matter but that the impact on the likelihood of a second birth varies with time since first birth.

The pattern of association between geographical proximity to paternal grandmothers and transition to second birth among primiparous mothers is different to that for maternal grandmothers. Figure 5 summarises the results from Cox regression models for proximity to paternal grandmothers at the same three time points (see Appendices 3 and 4 for full models). At *t+3*, the positive effect of having a paternal grandmother living within 1 kilometre is significant and stronger than at *t+2*. The effect is also evident at *t+4* and *t+5*. Thus having a paternal grandmother living less than 1 km away is associated with an increase in the likelihood of a second birth of 10% at *t+3* (HR = 1.100, 95% CI: 1.046 - 1.156, $P < 0.001$), of 13% at *t+4* (HR = 1.132, 95% CI: 1.063 - 1.205, $P < 0.001$), and of 12% at *t+5* (HR = 1.123, 95% CI: 1.033 - 1.221, $P < 0.01$). In contrast to the results for maternal grandmothers, there is no is no clear effect on second births of having a paternal grandmother living 1 to 5 kms away and the association with co-residence is not statistically significant. It is interesting to note, however, that the association for co-residence changes from negative at *t+2* and *t+3* to positive at *t+4* and *t+5*, again underlining that relationships between primiparous women's proximity to grandmothers and their fertility may change over time.

Overall, our results indicate that living in close geographical proximity to both maternal and paternal grandmothers increases the likelihood of a second birth, whereas co-residence with maternal grandmothers – but not paternal grandmothers - decreases the likelihood of having a second child. A similar pattern is seen at most time points after first birth and across all four models, although associations may strengthen or weaken over time and with the addition of control variables. After adjusting for the municipality-type of residence (Model 2), for example, the positive influence of living less than 1 kilometre from grandmothers(-in-law) on transitions to second birth persists, thus indicating that the effect of locational nearness of significant kin operates similarly in both urban and rural areas. Further adjusting for family background (Model 3) decreases the strength of the associations but there remains statistically significant in most cases. In the final models (Model 4), we generally observe a further weakening of the associations. However, in some cases the inclusion of controls for individual and household characteristics strengthens the association, especially for primiparous mothers living close (<1km) to paternal grandmothers at *t+2*. Although results from the full models (Appendices 1-3) reveal that

demographic and socio-economic characteristics at individual and household level are key influences on transitions to second birth at all the time points since first birth, we have shown that geographical proximity between primiparous mothers and grandmothers(in-law) is another significant factor which requires consideration. Indeed, the consistency across all four models in our analyses suggests that the significant and positive effects of close geographical proximity to grandmothers(-in-law) on transitions to second birth are independent of municipality of residence, family background (including the characteristics of grandmothers), and the characteristics of primiparous mothers, their partners and households.

5. Discussion

The impact of living close to grandparents(-in-law) on a couple's fertility remains under-researched, especially in low and late fertility settings with a familistic tradition (Aassve et al. 2012; Mendez 2015; Raymo et al. 2010). The findings from this study provide new insights into the relationships between spatial proximity to grandmothers(-in-law) and transitions to second birth. Using geo-referenced data from a 10-year follow-up study of mothers aged 20-49 with one child born in 2001 and continued residence in Andalusia during the study period (2001-2011), this is the first study to examine whether geographical proximity to maternal or paternal grandmothers encourages second births over a long follow-up period.

All mothers in the study had a first birth in the same year and thus were making decisions about second births in the same socio-economic context over the follow-up decade. Primiparous mothers who had a second birth within two years of a first birth were dropped from the study as at least some of these births are likely to have been unplanned and therefore not influenced by having a grandmother living nearby. The full models estimate the risk of a second birth at various time points after first birth, and we demonstrate that primiparous mothers living within 5 kilometres of a grandmother are more likely to have a second child.

The positive effect of living close to a maternal grandmother varies over time since first birth, while a similar effect is evident for paternal grandmothers only if they live 'round the corner' (within 1 km). Whereas close geographical proximity to paternal grandmothers appears to have a positive influence at all time points, with the strongest effects four and five years after first birth, geographical proximity to maternal grandmothers is significant three and four years after the first birth. On the assumption that grandmothers may already be caring for the first child, the time dimension is important because differential demands will be placed on grandmothers depending on the age of the grandchild. For a child under 2 years, for example, the provision of formal childcare as an alternative to grandmother care was almost negligible in Andalusia at the beginning of the study period (Baizán 2009). For the 70 percent of mothers in our sample who were either employed or looking for work, there would have been little choice. If they wished to continue working after the birth of a second child, they would almost certainly have been reliant on grandparent care. In these circumstances, the burden on grandmothers along with considerations of work-life balance may have influenced the timing of transitions to second birth.

Perhaps more surprising is our finding that primiparous mothers who have their own mothers living with them have the lowest likelihood of having a second birth two years after having a first child; other things being equal, co-residence might be expected to facilitate childcare and therefore encourage fertility. One possible explanation is that maternal grandmothers who are co-resident are in poorer health and therefore less able to look after young children. The data set does not include health measures that could shed further light on this finding but comparing the average age of co-resident maternal grandmothers with the average age of non-co-resident maternal

grandmothers, shows that the former tend to be older. It is plausible, therefore, that primiparous mothers with co-resident maternal grandmothers are part of the sandwich generation, both caring for their own child and providing care and support for their older mothers. In these circumstances, the negative effect on second births may reflect the heightened demands on mothers.

We cannot determine the precise mechanism through which the residential proximity of grandmothers(-in-law) encourages transitions to second birth but it is likely that our results capture the effect of grandmother-provided childcare support as there was a very limited supply of formal care for very young children in Andalusia during the study period. It could be that mothers who found themselves living close to grandparents were more likely to decide to have a second child but is also possible that primiparous mothers who wanted a second child, chose to live near their mothers(-in-law) in order to accomplish their childbearing plans. The available data do not allow us to disentangle the relative importance of each scenario nor to identify causal direction. Sensitivity tests (not shown) among the full sample of primiparous mothers by education reveal that the positive effect of geographical proximity is not confined to a particular educational group, suggesting that the effect is not limited to less mobile socio-economic groups. Moreover, it is possible that different pathways lead to the same outcome, with some primiparous mothers lacking sufficient economic resources for childcare while others respond to the high opportunity costs of temporary labour force exit, but both taking advantage of proximate grandmother childcare. Decisions regarding fertility, residence and childcare arrangements are highly interdependent. More work remains to be done in order to understand fully the dynamics of cause and effect related to family support and fertility outcomes but the current study provides a good starting point by showing that living close to maternal and/or paternal grandmothers at particular times after first birth is an important factor encouraging second births among primiparous mother in Andalusia.

6. Conclusion

Our findings both extend and clarify the results of previous studies in Europe, which have used different samples and less precise measures of geographical proximity. Our contribution to the literature is therefore threefold. First, we estimate geographical proximity using geo-referenced data that allows us to measure distance between the actual residence of primarous mothers and the grandmothers. This level of locational detail is missing from other studies which have relied on cruder distinctions such as living ‘in the same town/city or municipality’ (Hank and Kreyenfeld, 2003; Rindfuss et al., 2007; Raymo et al., 2010) or ‘within 25 kilometres’ (Hank, 2007; Aassave et al., 2012) to define close intergenerational proximity. In contrast, in defining residential closeness we are able to distinguish between grandmothers living within 1 kilometre and between 1 and 5 kilometres from our sample of mothers. One reason that Hank and Kreyenfeld (2003) did not find an effect of residential closeness to grandparents on second births in West Germany may be their use of an inadequate measure of geographical proximity, although it should also be noted that the wider context differs from that in Andalusia as formal childcare is a more available option.

Secondly, we provide separate estimates for the effects of geographical proximity to maternal and paternal grandmothers. The register-based data from Andalusia enables the identification of both grandmothers for the large sample of (married) Spanish-born mothers whereas other studies have used samples of grandparents from a number of European countries (Aassave et al., 2012) that is not representative of the availability of proximate grandmother-care for the children of their daughters(-in-law). An interesting extension to the current study would be to investigate the *relative* proximity of maternal and paternal grandmothers in order to ascertain whether the

positive effect of grandmother proximity on second births is more strongly associated with the nearest grandmother.

Lastly, unlike previous studies, we investigate the relationships between grandmother proximity and the risk of a second birth over time since first birth, showing that proximity matters more at some time points than at others. These findings raise new questions about how intergenerational residential proximity intersects with decisions about birth spacing. The majority of primiparous mothers in Europe who have a second child, do so within 5 years of the first birth, with the most common spacing being around 3 years after first birth (Kreyenfeld et al., 2017) when our findings show the significant effects of grandmother proximity in Andalusia. Whether living close to grandmothers(-in-law) encourages second births *per se* (quantum) and/or encourages primiparous mothers to have a second birth sooner after a first birth (tempo) is an important topic for further investigation.

In low fertility contexts, the rates of transition to second birth play a key role in influencing overall fertility levels and trends. To maintain or increase current fertility rates therefore requires the maintenance or enhancement of second birth rates, as well as maintaining or reducing levels of childlessness. In Andalusia, it appears that grandmothers make a significant contribution to second birth rates if they live close to their daughters(-in-law) by being available for childcare. This confirms the significance of family support for fertility at a time when debates about the erosion of family solidary in Western societies have come to the fore (Hank 2007; Dykstra 2010). In contexts such as Andalusia, there are still normative expectations of intensive grandmothering (Ortega and Fernández Alonso 2018) but these expectations may erode as the next generation become grandparents. Around 70 percent of the primiparous mothers in our samples were in the labour market compared with under 20 percent of grandmothers(-in-law), suggesting a generational change in women's engagement with paid work. Thus, even those who will live close to their daughters(-in-law) in the future may not be available to provide intensive childcare, especially if retirement age increases. For countries like Spain with low or very low fertility, it would be unwise to continue to rely on informal childcare to sustain fertility. Rather, the extension of flexible and affordable formal childcare, especially to areas such as Andalusia, is urgently needed in order to avoid the negative economic and social consequences of falling fertility and rapid population ageing.

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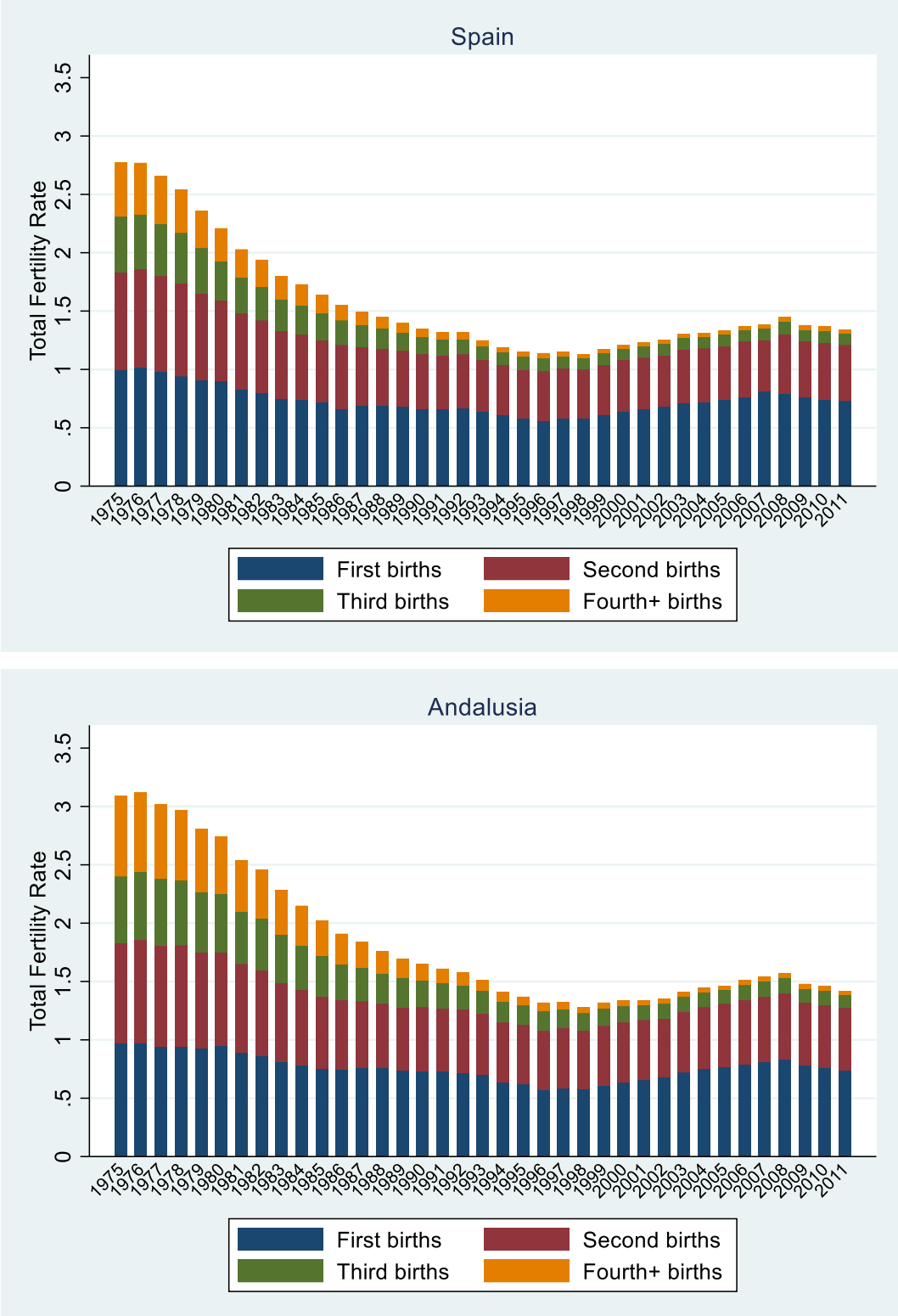
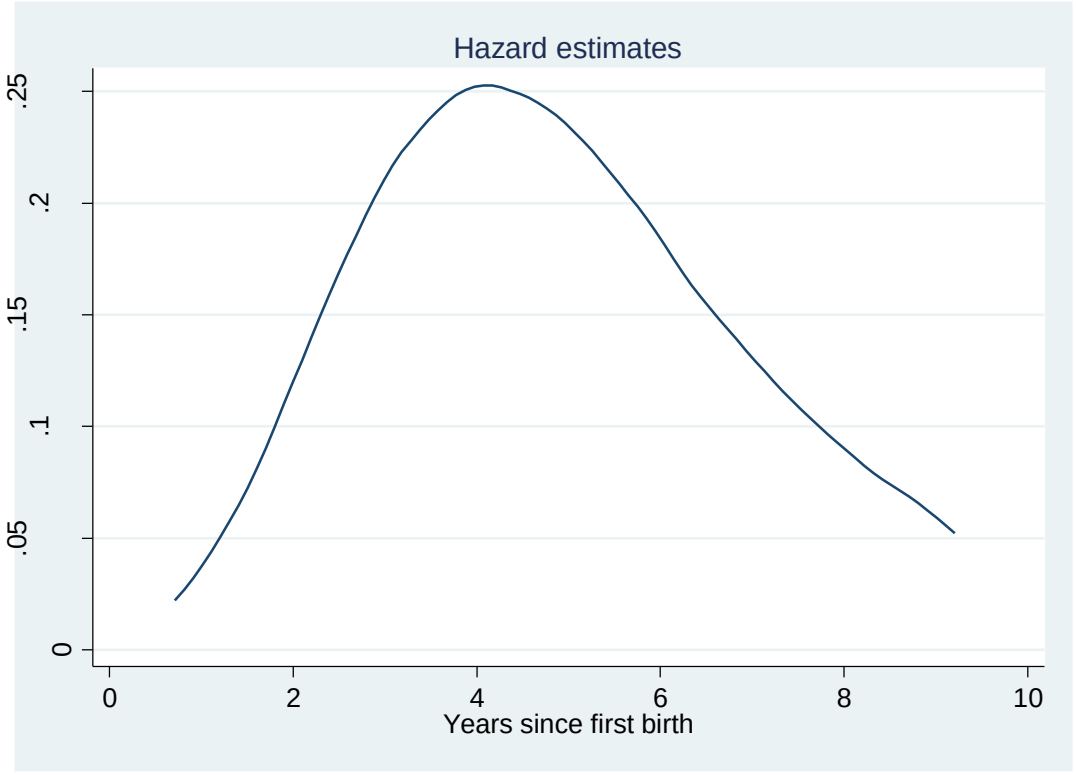
Figure 1. Total fertility rates by parity in Spain and Andalusia, 1975-2011



Source: Own elaboration using data from the National Institute of Statistics (Spain).

Figure 2. Kaplan-Meier and hazard estimates of transition to second birth among Spanish-born primiparous mothers from *t+0* onwards in Andalusia, 2001-2011



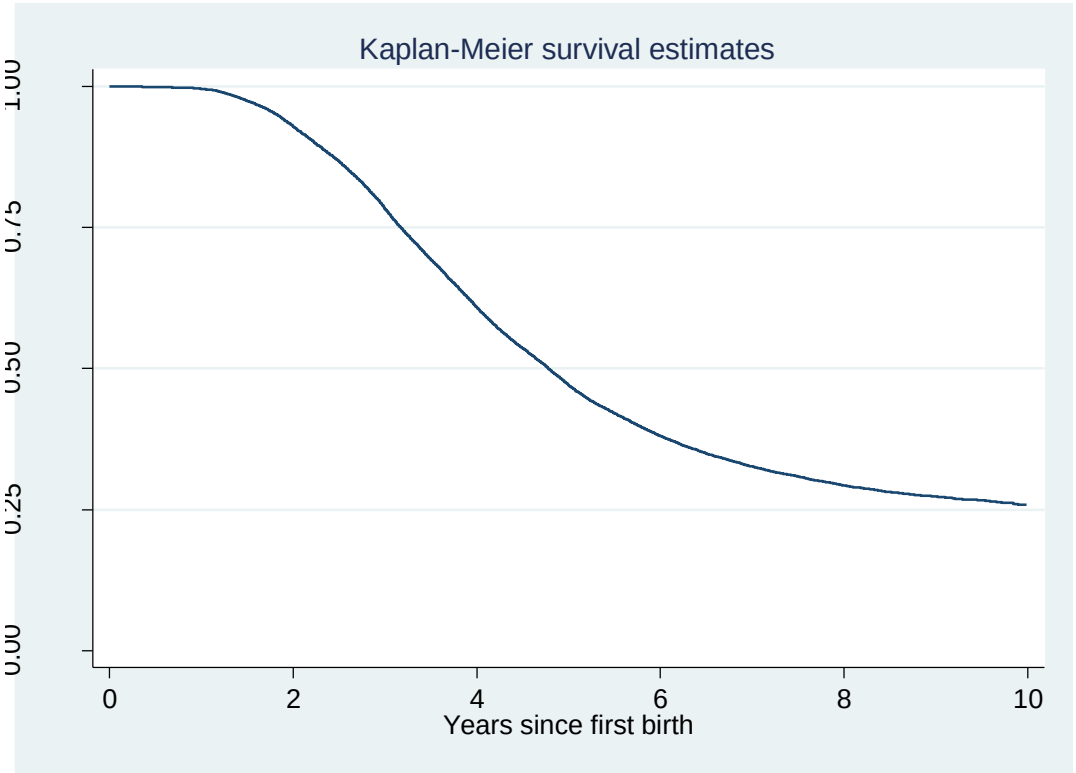


Table 1. Sample characteristics for primiparous Spanish-born mothers at *t+2* (percentages or standard deviations)

	Sample 1 *N* = 31,423	Sample 2 *N* = 22,950
Contextual characteristics		
Geographical proximity to grandmother (%):		
Co-residence	6353 (20.2)	844 (3.7)
<1km	9927 (31.6)	8372 (36.5)
1-5km	6067 (19.3)	5834 (25.4)
5-25km	3483 (11.1)	3391 (14.8)
>25km	5593 (17.8)	4509 (19.7)
Municipality-type of residence (%)		
Minor rural (<5,000 residents)	2481 (7.9)	1967 (8.6)
Large rural (>=5,000 and <10,000 residents)	2405 (7.7)	1838 (8.0)
Minor urban (>=10,000 and <50,000 residents)	8290 (26.4)	6356 (27.7)
Medium urban (>=50,000 and <100,000 residents)	3118 (9.9)	2147 (9.4)
Large urban (>=100,000 residents)	15129 (48.2)	10642 (46.4)
Family background		
Number of siblings (%):		
Only child	1644 (5.2)	3700 (16.1)
One sibling	7897 (25.1)	5166 (22.5)
Two siblings	10038 (31.9)	6422 (28.0)
Three or more siblings	11844 (37.7)	7662 (33.4)
Grandmother's age (SD)	58.6 (6.7)	60.5 (6.8)
Grandmother's education (%)		
Compulsory	28706 (91.4)	21045 (91.7)
Post-compulsory (non-tertiary)	1403 (4.5)	999 (4.4)
Tertiary	1314 (4.2)	906 (4.0)
Grandmother's economic status (%)		
Employed	4542 (14.5)	2791 (12.2)
Unemployed	1585 (5.0)	961 (4.2)
Economically inactive	25296 (80.5)	19198 (83.7)

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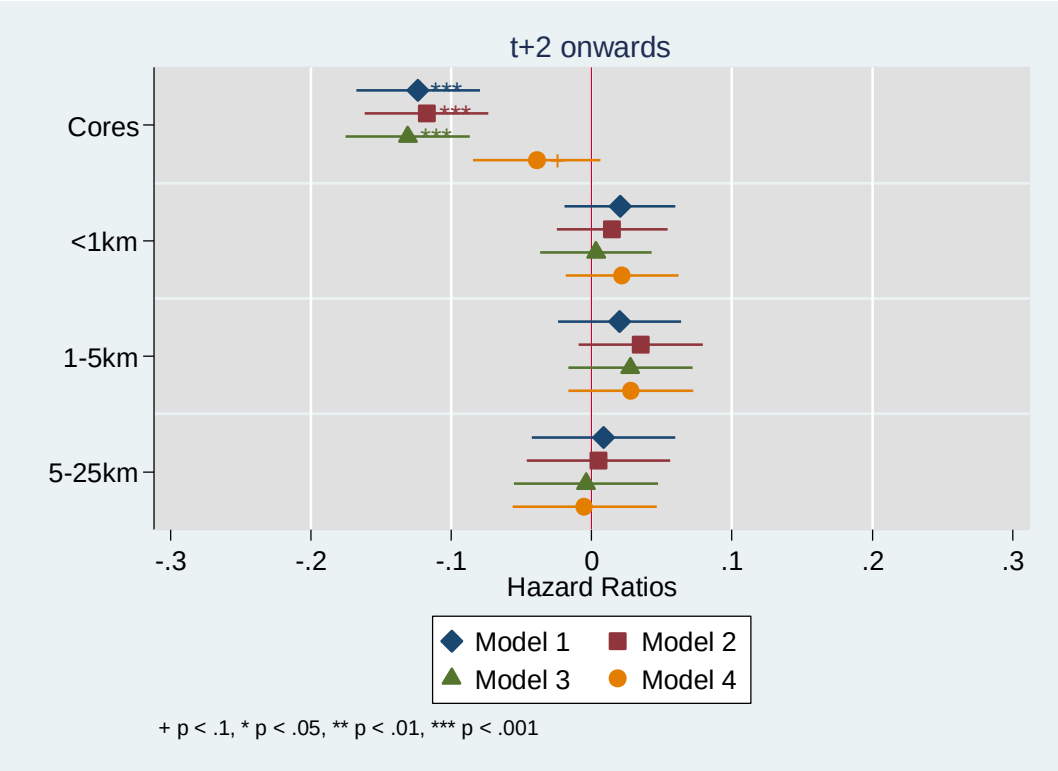
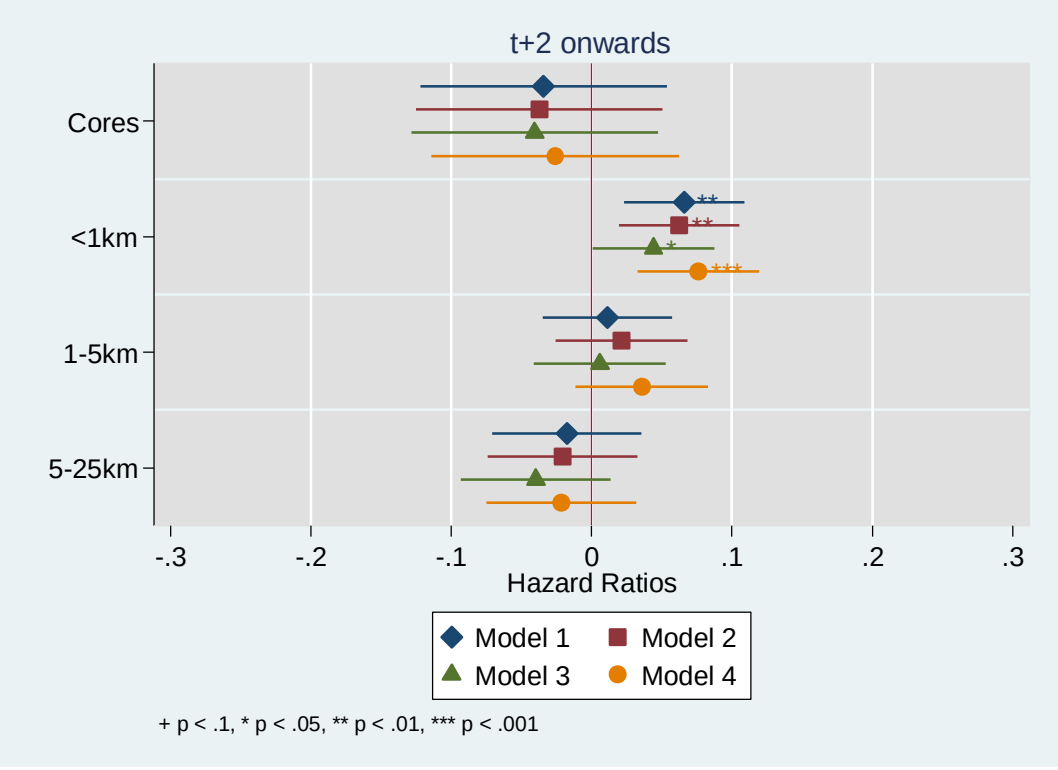
	Sample 1 *N* = 31,423	Sample 2 *N* = 22,950
Individual and household characteristics		
Age (SD)	29.5 (3.3)	29.7 (3.1)
Marital status (%)		
Single	4135 (13.2)	
Married	26665 (84.9)	22950 (100.0)
Other	623 (2.0)	
Education (%)		
Compulsory	14643 (46.6)	11158 (48.6)
Post-compulsory (non-tertiary)	7910 (25.2)	5513 (24.0)
Tertiary	8870 (28.2)	6279 (27.4)
Economic status (%)		
Employed	15604 (49.7)	10823 (47.2)
Unemployed	6434 (20.5)	4611 (20.1)
Economically inactive	9385 (29.9)	7516 (32.8)
Spouse's education (%)		
Compulsory	17326 (55.1)	12055 (52.5)
Post-compulsory (non-tertiary)	7966 (25.4)	5792 (25.2)
Tertiary	6131 (19.5)	5103 (22.2)
Spouse's economic status (%)		
Employed	28673 (91.3)	21030 (91.6)
Unemployed	2243 (7.1)	1602 (7.0)
Economically inactive	507 (1.6)	318 (1.4)
Tenure (%)		
Homeowner	27010 (86.0)	19898 (86.7)
Rented home (private)	1888 (6.0)	1050 (4.6)
Rented home (social)	1174 (3.7)	966 (4.2)
Other	1351 (4.3)	1036 (4.5)
Number of rooms (SD)	5.1 (1.2)	5.1 (1.1)
Number of cars (%)		
None	3148 (10.0)	1688 (7.4)
One	19662 (62.6)	14938 (65.1)
Two or more	8613 (27.4)	6324 (27.6)

Note: Sample 1 is used to test the association in relation to maternal grandmothers and includes all primiparous mothers irrespective of their marital status, whereas sample 2 is used to test the association in relation to paternal grandmothers and only includes married primiparous mothers.

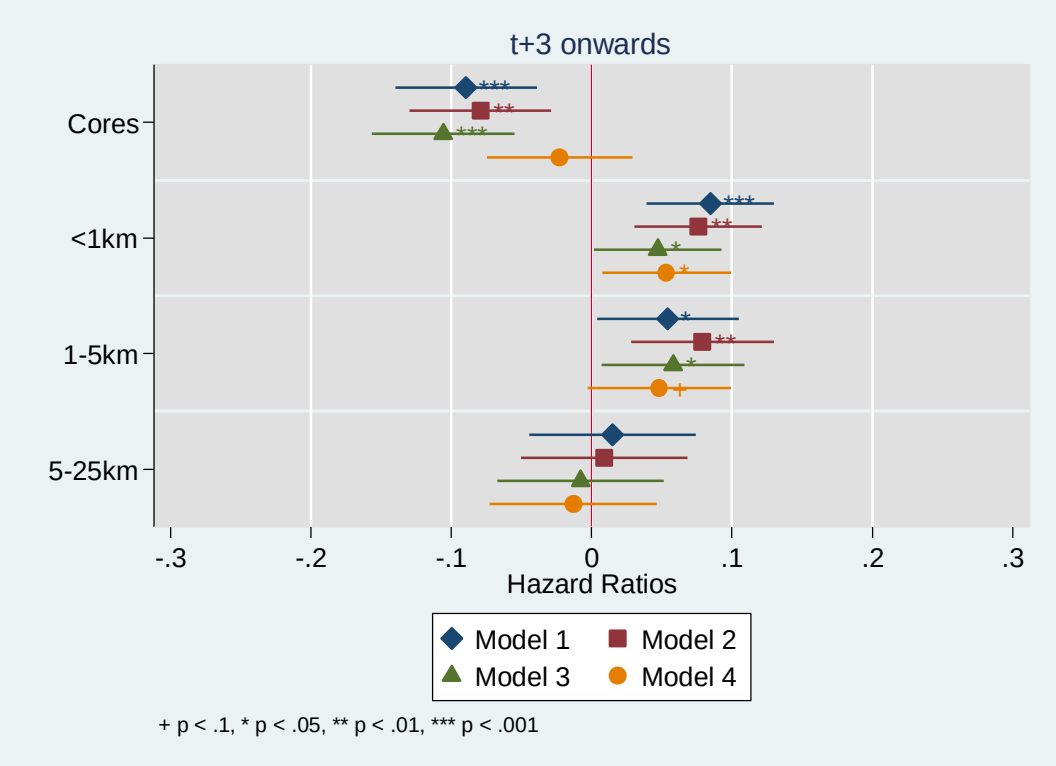
Figure 3. The association between geographical proximity to (3a, top) maternal and (3b, bottom) paternal grandmother and second birth risk among Spanish-born primiparous mothers at *t+2* and *t+3*. Cox regression models.

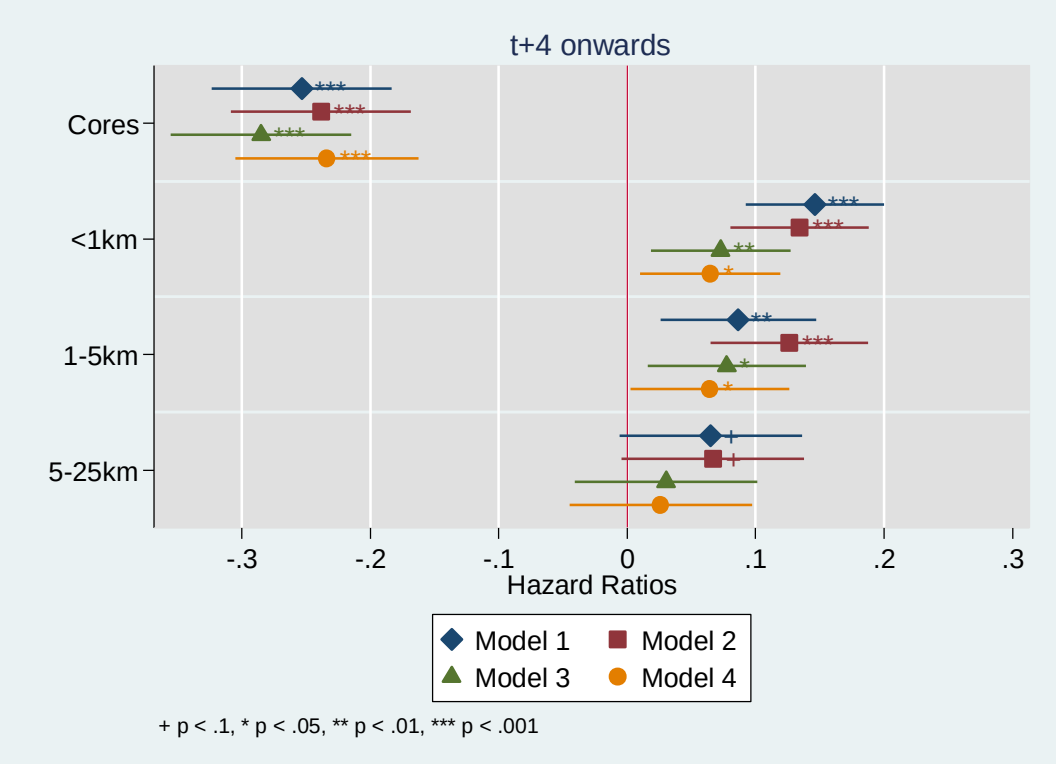


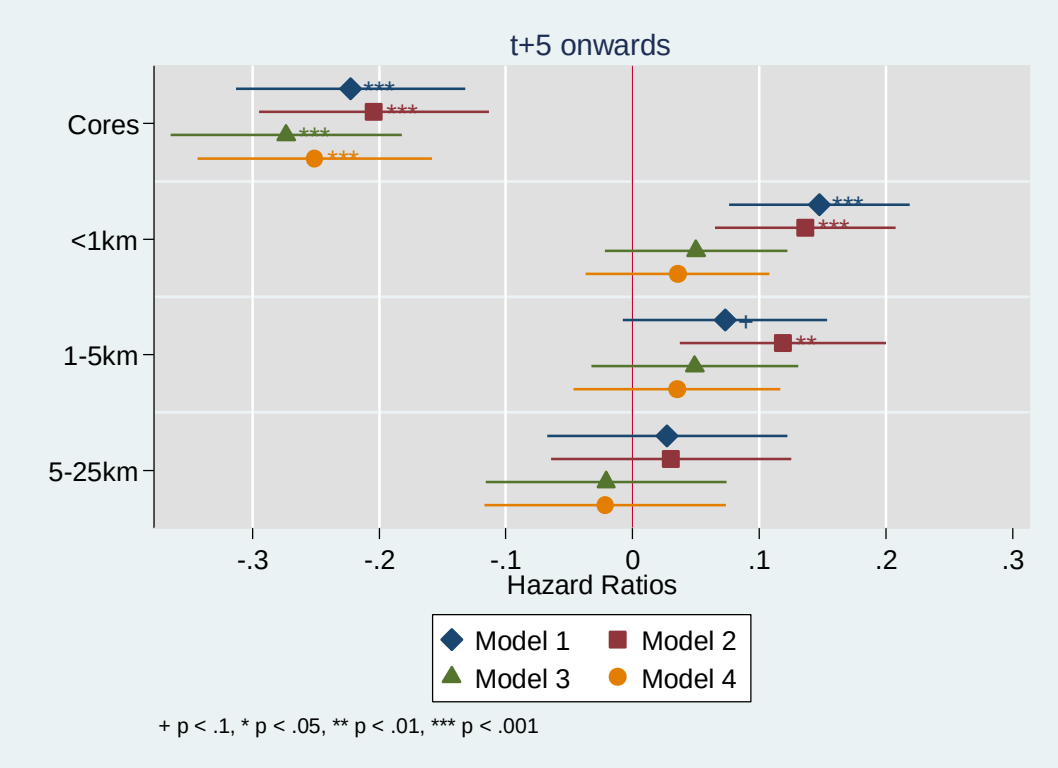


All hazard ratios are shown with 95% confidence intervals.
Reference category is 25km and over. All models stratified by province of residence.
Model 1: Adjusted for geographical proximity to grandmother.
Model 2: As model 1, plus adjustment for municipality-type of residence.
Model 3: As model 2, plus adjustment for family background (number of siblings and grandmother characteristics).
Model 4: As model 3, plus adjustment for individual and household characteristics.

Figure 4. The association between geographical proximity to maternal grandmother and second birth risk among Spanish-born primiparous mothers at *t+3*, *t+4* and *t+5*. Cox regression models.

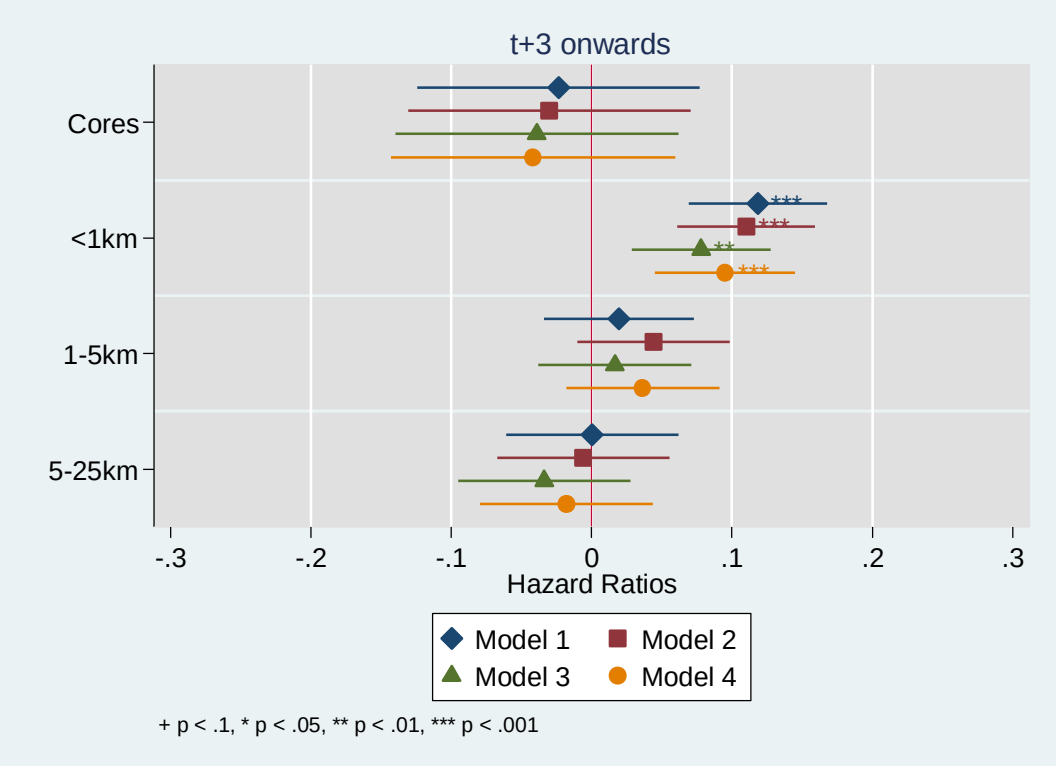


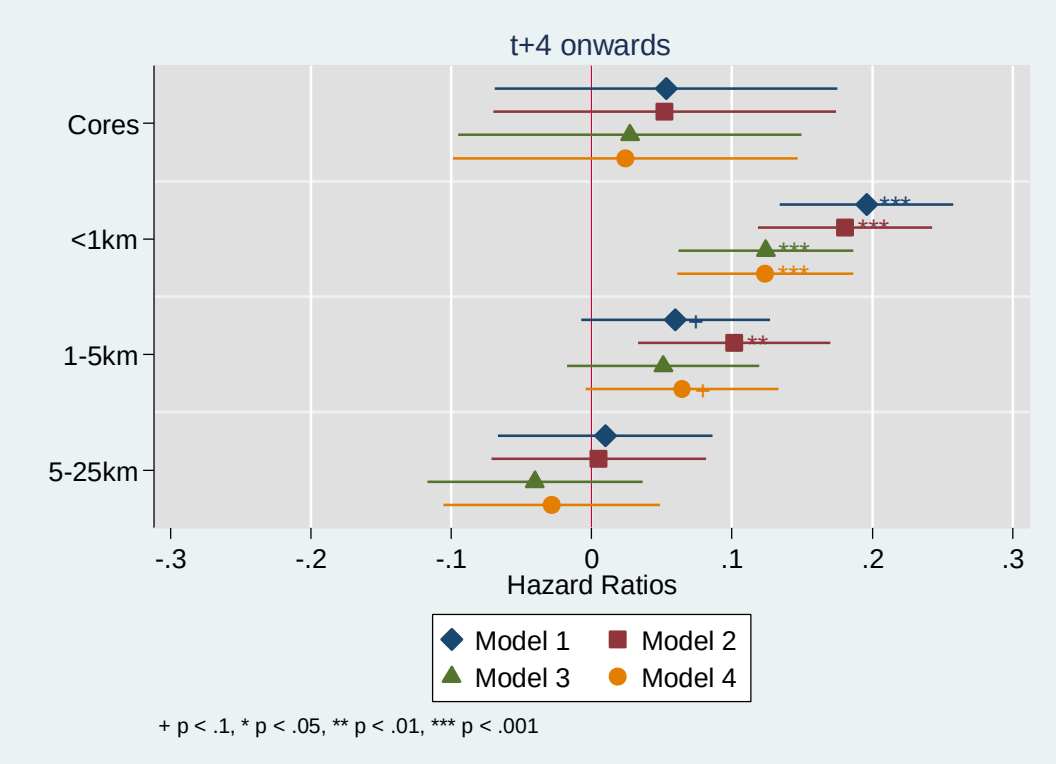


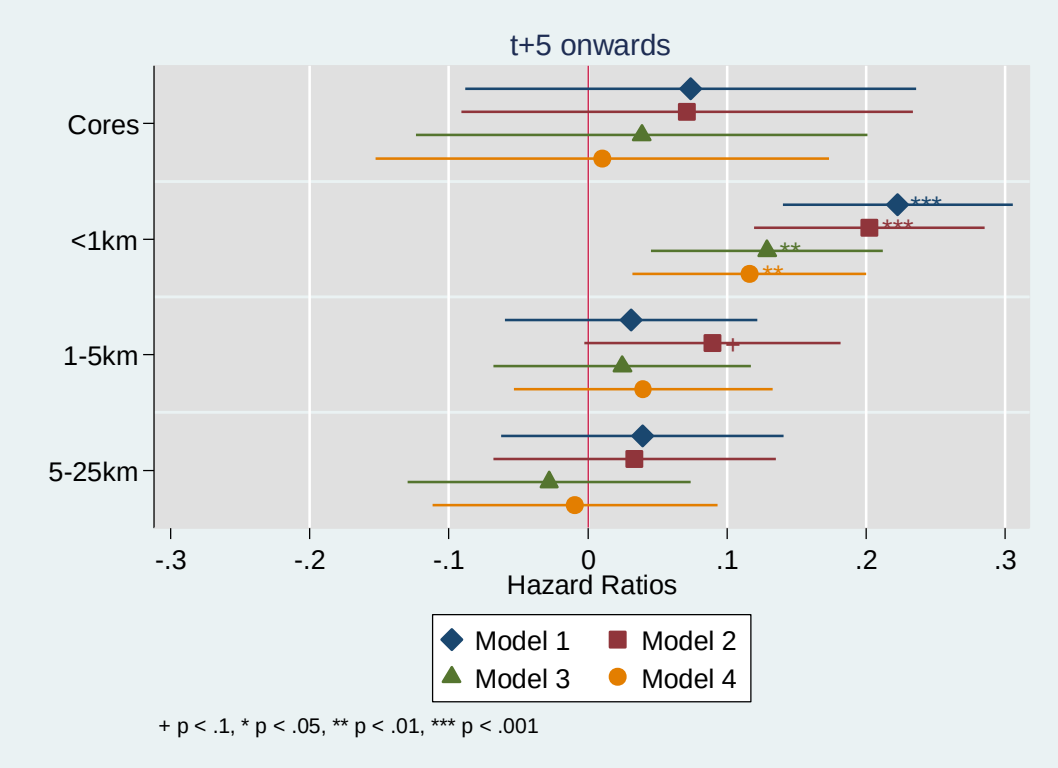


All hazard ratios are shown with 95% confidence intervals.
Reference category is 25km and over. All models stratified by province of residence.
Model 1: Adjusted for geographical proximity to grandmother.
Model 2: As model 1, plus adjustment for municipality-type of residence.
Model 3: As model 2, plus adjustment for family background (number of siblings and grandmother characteristics).
Model 4: As model 3, plus adjustment for individual and household characteristics.

Figure 5. The association between geographical proximity to paternal grandmother and second birth risk among Spanish-born primiparous mothers at *t+3*, *t+4* and *t+5*. Cox regression models.







All hazard ratios are shown with 95% confidence intervals.
Reference category is 25km and over. All models stratified by province of residence.
Model 1: Adjusted for geographical proximity to grandmother.
Model 2: As model 1, plus adjustment for municipality-type of residence.
Model 3: As model 2, plus adjustment for family background (number of siblings and grandmother characteristics).
Model 4: As model 3, plus adjustment for individual and household characteristics.

Appendix 1. The association between geographical proximity to (a) maternal (b) paternal grandmother and second birth risk among Spanish-born primiparous mothers at *t+2*. Full Cox regression models.

	(a) maternal		*(b) paternal*	
	HR	95% CI	HR	95% CI
Contextual characteristics				
Geographical proximity to grandmother:				
Co-residence	0.962	0.919 , 1.006	0.974	0.892 , 1.064
<1km	1.022	0.982 , 1.064	1.079	1.033 , 1.127
1-5km	1.028	0.984 , 1.075	1.036	0.989 , 1.086
5-25km	0.995	0.945 , 1.047	0.979	0.928 , 1.032
>25km	1 (ref)		1 (ref)	
Municipality-type of residence				
Minor rural	1 (ref)		1 (ref)	
Large rural	1.040	0.974 , 1.112	1.017	0.945 , 1.095
Minor urban	0.979	0.927 , 1.034	0.966	0.909 , 1.026
Medium urban	0.946	0.883 , 1.013	0.948	0.877 , 1.025
Large urban	0.949	0.898 , 1.002	0.922	0.867 , 0.981
Family background				
Number of siblings				
Only child	1 (ref)		1 (ref)	
One sibling	1.070	1.001 , 1.144	1.061	1.008 , 1.117
Two siblings	1.109	1.038 , 1.184	1.081	1.030 , 1.136
Three or more siblings	1.137	1.065 , 1.213	1.099	1.048 , 1.153
Grandmother's age (SD)	1.003	1.001 , 1.006	0.996	0.993 , 0.998
Grandmother's education				
Compulsory	1 (ref)		1 (ref)	
Post-compulsory (non-tertiary)	1.076	1.007 , 1.149	1.049	0.971 , 1.132
Tertiary	1.106	1.032 , 1.185	1.227	1.133 , 1.328
Grandmother's economic status				
Employed	1 (ref)		1 (ref)	
Unemployed	0.951	0.888 , 1.019	1.009	0.926 , 1.099
Economically inactive	0.994	0.956 , 1.034	1.056	1.006 , 1.108

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	(a) maternal		*(b) paternal*	
	HR	95% CI	HR	95% CI
Individual and household characteristics				
Age (SD)	0.934	0.929 , 0.939	0.939	0.934 , 0.945
Marital status				
Single	1 (ref)			
Married	1.535	1.465 , 1.609		
Other	0.772	0.682 , 0.875		
Education				
Compulsory	1 (ref)		1 (ref)	
Post-compulsory (non-tertiary)	1.104	1.066 , 1.143	1.093	1.050 , 1.138
Tertiary	1.246	1.198 , 1.295	1.276	1.220 , 1.334
Economic status				
Employed	1 (ref)		1 (ref)	
Unemployed	0.931	0.897 , 0.965	0.989	0.948 , 1.031
Economically inactive	0.976	0.944 , 1.008	0.985	0.949 , 1.022
Spouse's education				
Compulsory	1 (ref)		1 (ref)	
Post-compulsory (non-tertiary)	1.051	1.015 , 1.089	1.098	1.055 , 1.142
Tertiary	1.358	1.303 , 1.415	1.344	1.282 , 1.408
Spouse's economic status				
Employed	1 (ref)		1 (ref)	
Unemployed	0.947	0.897 , 0.999	0.952	0.895 , 1.012
Economically inactive	0.877	0.785 , 0.981	0.848	0.739 , 0.974
Tenure (%)				
Home owner	1 (ref)		1 (ref)	
Rented home (private)	0.876	0.824 , 0.931	0.907	0.840 , 0.978
Rented home (social)	1.012	0.944 , 1.085	0.978	0.906 , 1.056
Other	0.991	0.928 , 1.058	1.002	0.932 , 1.078
Number of rooms (SD)	1.027	1.015 , 1.040	1.026	1.012 , 1.040
Number of cars				
None	1 (ref)		1 (ref)	
One	1.189	1.130 , 1.250	1.174	1.102 , 1.250
Two or more	1.255	1.188 , 1.326	1.243	1.162 , 1.331
AIC	340,174		249,338	
Log likelihood	-170,054		-124,638	
No. of subjects	31,423		22,950	
No. of failures	21,653		16,563	

Appendix 2. The association between geographical proximity to maternal grandmother and second birth risk among Spanish-born primiparous mothers at *t+3*, *t+4* and *t+5*. Full Cox regression models.

	t+3		*t+4*		*t+5*	
	HR	95% CI	HR	95% CI	HR	95% CI
Contextual characteristics						
Geographical proximity to grandmother:						
Co-residence	0.977	0.928 , 1.029	0.791	0.737 , 0.850	0.778	0.709 , 0.853
<1km	1.055	1.008 , 1.104	1.067	1.010 , 1.127	1.036	0.964 , 1.114
1-5km	1.049	0.997 , 1.104	1.066	1.003 , 1.134	1.036	0.954 , 1.124
5-25km	0.987	0.930 , 1.047	1.027	0.956 , 1.102	0.979	0.890 , 1.077
>25km	1 (ref)		1 (ref)		1 (ref)	
Municipality-type of residence						
Minor rural	1 (ref)		1 (ref)		1 (ref)	
Large rural	1.068	0.992 , 1.151	1.070	0.977 , 1.171	1.003	0.888 , 1.133
Minor urban	0.998	0.938 , 1.061	0.952	0.883 , 1.026	0.968	0.877 , 1.067
Medium urban	0.954	0.882 , 1.031	0.884	0.804 , 0.973	0.901	0.796 , 1.020
Large urban	0.954	0.897 , 1.015	0.886	0.821 , 0.956	0.877	0.794 , 0.969
Family background						
Number of siblings						
Only child	1 (ref)		1 (ref)		1 (ref)	
One sibling	1.075	0.997 , 1.159	1.099	0.999 , 1.208	1.132	0.998 , 1.285
Two siblings	1.097	1.018 , 1.182	1.110	1.011 , 1.218	1.140	1.006 , 1.291
Three or more siblings	1.099	1.021 , 1.184	1.085	0.989 , 1.190	1.097	0.970 , 1.242
Grandmother's age (SD)	1.003	1.001 , 1.006	1.003	0.999 , 1.006	1.003	0.998 , 1.007
Grandmother's education						
Compulsory	1 (ref)		1 (ref)		1 (ref)	
Post-compulsory (non-tertiary)	0.968	0.040 , 0.436	0.905	0.813 , 1.007	0.815	0.702 , 0.946
Tertiary	0.986	0.043 , 0.743	0.869	0.772 , 0.979	0.769	0.650 , 0.910
Grandmother's economic status						
Employed	1 (ref)		1 (ref)		1 (ref)	
Unemployed	0.967	0.895 , 1.045	0.928	0.844 , 1.020	0.988	0.875 , 1.117
Economically inactive	1.008	0.964 , 1.054	1.009	0.955 , 1.066	1.011	0.940 , 1.088

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	t+3		*t+4*		*t+5*	
	HR	95% CI	HR	95% CI	HR	95% CI
Individual and household characteristics						
Age (SD)	0.917	0.911 , 0.922	0.898	0.891 , 0.904	0.878	0.870 , 0.887
Marital status						
Single	1 (ref)		1 (ref)		1 (ref)	
Married	1.601	1.519 , 1.687	1.508	1.417 , 1.604	1.414	1.307 , 1.529
Other	0.812	0.708 , 0.933	0.807	0.685 , 0.950	0.760	0.619 , 0.933
Education						
Compulsory	1 (ref)		1 (ref)		1 (ref)	
Post-compulsory (non-tertiary)	1.094	1.051 , 1.138	1.076	1.025 , 1.130	1.029	0.964 , 1.098
Tertiary	1.203	1.150 , 1.259	1.132	1.069 , 1.199	1.064	0.985 , 1.149
Economic status						
Employed	1 (ref)		1 (ref)		1 (ref)	
Unemployed	0.930	0.893 , 0.969	0.932	0.885 , 0.980	0.905	0.846 , 0.968
Economically inactive	0.957	0.922 , 0.994	0.947	0.904 , 0.992	0.901	0.847 , 0.957
Spouse's education						
Compulsory	1 (ref)		1 (ref)		1 (ref)	
Post-compulsory (non-tertiary)	1.030	0.990 , 1.072	0.992	0.944 , 1.042	0.964	0.903 , 1.029
Tertiary	1.234	1.175 , 1.295	1.074	1.007 , 1.145	0.990	0.906 , 1.082
Spouse's economic status						
Employed	1 (ref)		1 (ref)		1 (ref)	
Unemployed	0.916	0.862 , 0.973	0.900	0.836 , 0.970	0.957	0.871 , 1.051
Economically inactive	0.893	0.788 , 1.013	0.961	0.826 , 1.117	0.960	0.787 , 1.169
Tenure (%)						
Home owner	1 (ref)		1 (ref)		1 (ref)	
Rented home (private)	0.877	0.818 , 0.940	0.825	0.757 , 0.899	0.853	0.765 , 0.952
Rented home (social)	0.980	0.905 , 1.062	0.987	0.894 , 1.088	0.999	0.878 , 1.137
Other	0.983	0.913 , 1.059	0.969	0.883 , 1.064	0.960	0.850 , 1.086
Number of rooms (SD)	1.026	1.012 , 1.040	1.019	1.002 , 1.036	1.008	0.985 , 1.030
Number of cars						
None	1 (ref)		1 (ref)		1 (ref)	
One	1.233	1.165 , 1.305	1.230	1.149 , 1.317	1.284	1.176 , 1.403
Two or more	1.295	1.216 , 1.378	1.310	1.214 , 1.413	1.350	1.223 , 1.492
AIC	258,129		162,096		89,616	
Log likelihood	-129,032		-81,015		-44,775	
No. of subjects	26,492		20,561		15,915	
No. of failures	16,722		10,791		6,145	

Appendix 3. The association between geographical proximity to paternal grandmother and second birth risk among Spanish-born primiparous mothers at *t+3*, t+*4* and *t+5*. Full Cox regression models.

	t+3		*t+4*		*t+5*	
	HR	95% CI	HR	95% CI	HR	95% CI
Contextual characteristics						
Geographical proximity to grandmother:						
Co-residence	0.959	0.867 , 1.061	1.024	0.906 , 1.158	1.010	0.858 , 1.189
<1km	1.100	1.046 , 1.156	1.132	1.063 , 1.205	1.123	1.033 , 1.221
1-5km	1.037	0.982 , 1.095	1.067	0.996 , 1.143	1.041	0.948 , 1.142
5-25km	0.982	0.924 , 1.045	0.972	0.900 , 1.050	0.991	0.894 , 1.098
>25km	1 (ref)		1 (ref)		1 (ref)	
Municipality-type of residence						
Minor rural	1 (ref)		1 (ref)		1 (ref)	
Large rural	1.058	0.973 , 1.150	1.091	0.983 , 1.210	1.077	0.938 , 1.237
Minor urban	0.991	0.925 , 1.061	0.987	0.906 , 1.076	0.993	0.887 , 1.112
Medium urban	0.941	0.861 , 1.029	0.897	0.803 , 1.003	0.900	0.777 , 1.042
Large urban	0.919	0.856 , 0.986	0.894	0.818 , 0.976	0.866	0.771 , 0.973
Family background						
Number of siblings						
Only child	1 (ref)		1 (ref)		1 (ref)	
One sibling	1.074	1.013 , 1.138	1.081	1.004 , 1.163	1.128	1.021 , 1.247
Two siblings	1.075	1.016 , 1.137	1.082	1.008 , 1.161	1.085	0.985 , 1.196
Three or more siblings	1.070	1.013 , 1.130	1.064	0.993 , 1.140	1.132	1.031 , 1.243
Grandmother's age (SD)	0.996	0.993 , 0.999	0.994	0.990 , 0.998	0.995	0.990 , 1.000
Grandmother's education						
Compulsory	1 (ref)		1 (ref)		1 (ref)	
Post-compulsory (non-tertiary)	1.051	0.049 , 0.286	0.904	0.795 , 1.028	0.861	0.720 , 1.029
Tertiary	1.113	0.057 , 0.038	0.907	0.783 , 1.051	0.697	0.557 , 0.872
Grandmother's economic status						
Employed	1 (ref)		1 (ref)		1 (ref)	
Unemployed	1.007	0.914 , 1.109	1.006	0.892 , 1.134	1.015	0.868 , 1.188
Economically inactive	1.058	1.002 , 1.118	1.058	0.988 , 1.133	1.044	0.953 , 1.144

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	t+3		*t+4*		*t+5*	
	HR	95% CI	HR	95% CI	HR	95% CI
Individual and household characteristics						
Age (SD)	0.922	0.916 , 0.928	0.908	0.900 , 0.915	0.887	0.877 , 0.897
Education						
Compulsory	1 (ref)		1 (ref)		1 (ref)	
Post-compulsory (non-tertiary)	1.085	1.037 , 1.136	1.038	0.980 , 1.099	1.032	0.956 , 1.114
Tertiary	1.224	1.162 , 1.289	1.130	1.057 , 1.209	1.068	0.974 , 1.172
Economic status						
Employed	1 (ref)		1 (ref)		1 (ref)	
Unemployed	0.990	0.944 , 1.039	1.020	0.961 , 1.083	1.000	0.923 , 1.084
Economically inactive	0.981	0.941 , 1.024	0.973	0.923 , 1.026	0.949	0.885 , 1.019
Spouse's education						
Compulsory	1 (ref)		1 (ref)		1 (ref)	
Post-compulsory (non-tertiary)	1.078	1.030 , 1.127	1.022	0.965 , 1.082	0.977	0.905 , 1.055
Tertiary	1.237	1.170 , 1.307	1.079	1.003 , 1.161	1.024	0.926 , 1.132
Spouse's economic status						
Employed	1 (ref)		1 (ref)		1 (ref)	
Unemployed	0.946	0.883 , 1.014	0.915	0.839 , 0.997	0.910	0.813 , 1.019
Economically inactive	0.818	0.696 , 0.961	0.899	0.741 , 1.091	0.931	0.723 , 1.200
Tenure (%)						
Home owner	1 (ref)		1 (ref)		1 (ref)	
Rented home (private)	0.910	0.835 , 0.993	0.908	0.815 , 1.013	0.907	0.785 , 1.048
Rented home (social)	0.891	0.814 , 0.975	0.878	0.784 , 0.983	0.906	0.783 , 1.049
Other	1.003	0.923 , 1.089	1.007	0.908 , 1.117	1.078	0.942 , 1.232
Number of rooms (SD)	1.018	1.002 , 1.035	1.013	0.992 , 1.033	1.007	0.980 , 1.034
Number of cars						
None	1 (ref)		1 (ref)		1 (ref)	
One	1.207	1.124 , 1.295	1.223	1.122 , 1.335	1.311	1.167 , 1.471
Two or more	1.261	1.168 , 1.363	1.291	1.173 , 1.421	1.322	1.162 , 1.503
AIC	186,571		113,412		61,128	
Log likelihood	-93,255		-56,675		-30,533	
No. of subjects	19,035		14,317		10,811	
No. of failures	12,648		7,930		4,424	