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Grandmaternal childcare and kinship laterality. Is rural Greece exceptional?

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ABSTRACT

Grandmothers provide more childcare for their daughters' children than for those of their sons, almost everywhere. Exceptions occur where virilocal (patrilocal) postmarital residence makes the children of sons more accessible, but even under virilocality, preferential care of daughters' children, net of the effects of proximity, is often demonstrable. A unique counter-example has been reported by Pashos (2000, *Evolution & Human Behavior*, *21*, 97–109) who found that rural Greek grandmothers cared more for their sons' children even when effects of proximity were controlled; however, this result was based on an analysis in which everything from living in the same household to living in nearby villages was treated as equally close.

Here, we present new analyses that replicate Pashos's result, based on a large European survey with a finer differentiation of residential proximity. In interviews conducted in 2004–2007, rural, but not urban, Greek women indeed reported more care of sons' than of daughters' children, net of the effects of proximity and other variables, This rural reversal of the usual uterine (matrilateral) bias was not observed elsewhere in Europe. Greeks were not surveyed again until 2015, whereupon the pattern had disappeared, with rural women now exhibiting a strong uterine bias in grandchild childcare. It seems likely that the financial crisis of 2008–2009, which hit Greece especially hard, played some role in this dramatic change, but it cannot readily be traced to increases in either unemployment or multigenerational households.

1. Introduction

Child-care assistance by persons other than the parents is a characteristic feature of human reproduction. This alloparental support has evidently evolved as an essential component of our species' reproductive strategy because interbirth intervals in natural-fertility societies are much shorter than is childhood dependency, with the result that parental attention is routinely divided among young of different ages (Hrdy, 2009; Kramer, 2010). In traditional societies, the most assiduous alloparents tend to be grandmothers, and a strong case can be made that fitness returns from grandmaternal efforts have selected for the human female's exceptional robustness after the completion of her own reproduction (Hawkes, 2003; Hawkes, O'Connell, & Blurton Jones, 1997).

Many studies indicate that grandmothers care for their daughters' children preferentially in comparison to those of their sons (see Daly & Perry, 2017, for a review). Since Smith (1988), uncertain paternity has been the favored evolutionary explanation for this *uterine bias* (or, from the child's perspective, this *matrilateral bias*), and it is often treated, implicitly or explicitly, as the sole explanation (*e.g.*Bishop, Meyer, Schmidt, & Gray, 2009; Danielsbacka, Tanskanen, Jokela, & Rotkirch, 2011; Laham, Gonsalkorale, & von Hippel, 2005; Pollet, Nettle, & Nelissen, 2006). However, given the ubiquitous sex difference in human parental investment (Hrdy, 2009; Low, 2001), selection may be expected to favor a preference for the children of daughters regardless of differential parental certainty, because supporting children lightens the mother's load, freeing her to promote her fitness in other ways, and if she invests either in natal family or in children of a former or future partner, her own mother will garner inclusive fitness returns, whereas her mother-in-law will not (Perry & Daly, 2017).

Exceptions to the generally prevailing uterine bias are apparently confined to patrilineal societies with virilocal (also called “patrilocal”) postmarital residence practices that oblige brides to leave their natal families to dwell with their in-laws. In such circumstances, uterine grandchildren are relatively inaccessible, and the paternal grandmother (PGM) may provide more grandchild care than the maternal grandmother (MGM) (*e.g.*King & Elder, 1995; Pashos, 2000: Yi, Pan, Chang, & Chan, 2006; Kaptijn, Thomese, Liefbroer, & Silverstein, 2013; Perry, 2017a). However, the presence of a PGM does not necessarily promote grandchild well-being to the same degree as the presence of an MGM, as numerous studies of survival, growth, and other grandchild outcomes attest (*e.g.*, Fox et al., 2010; Gibson & Mace, 2005; Helton, Boutwell, &

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DiBernardo, 2017; Perry, 2017a; Sear & Mace, 2008; Strassmann & Garrard, 2011; Tanskanen & Danielsbacka, 2012). This suggests that PGMs tend, on average to be less committed to the children than MGMs, who are, as Pollet, Nettle, and Nelissen (2007) have shown, relatively willing to "go the extra mile".

When direct care of children is measured, evidence of a preference for uterine grandchildren often surfaces even under virilocality. A study of alloparental assistance in rural Bangladesh (Perry, 2017a) is illustrative. Postmarital residence is normatively patrilocal, and PGMs, who commonly see their agnatic grandchildren daily, provide more supplementary childcare than MGMs. However, young Bangladeshi mothers effortfully maintain close ties with their natal families (Perry, 2017b), and MGMs provided more childcare than PGMs when the effects of differential access were controlled (Perry, 2017a). These findings echo those of a study of the Oromo of rural Ethiopia by Gibson and Mace (2005), who reported that grandmothers disproportionately helped their daughters and benefited their uterine grandchildren even when their sons and agnatic grandchildren were closer at hand. Other societies in which postmarital residence is predominantly or normatively virilocal but young mothers nevertheless rely on their own mothers more than their mothers-in-law for child care assistance include Himba pastoralists in Namibia (Scelza, 2011) and Ngandu farmers in the Central African Republic (Meehan, 2008).

China provides perhaps the best-known (and certainly the most populous) example of a society in which virilocal marriage and ideology constrain matrilineal ties (*e.g.*Murphy, Tao, & Lu, 2011). Nevertheless, a Taiwanese study tells a story very like that in Bangladesh: paternal grandparents dwelt in the same household as their preschool-age grandchildren far more often than did maternal grandparents and provided more childcare *in toto*, but among those who *did* coreside, maternal grandparents provided childcare at exactly twice the rate of their paternal counterparts (Yi et al., 2006). In mainland China, rural marriages are still overwhelmingly patrilocal (Gruijters & Ermisch, 2019), and PGMs remain far more likely to reside with grandchildren than MGMs (Zeng & Xie, 2014), but there is evidence of longstanding matrilineal affiliation and support "under the radar" (Judd, 1989). In the cities, patrilocal traditions are apparently fading such that urban children may now be receiving more care from their MGMs than from their PGMs (C. Zhang, 2016), and rural China is also witnessing a rapid increase in matrilineal contact and support (W. Zhang, 2009).

The urban-rural distinction is of broad relevance. Cross-culturally, virilocality is associated with settled agriculture and with pastoralism, subsistence modes in which land and livestock are usually transmitted down patrilines or even owned by a corporate patrilineage (Wilkins & Marlowe, 2006). We might therefore expect that within societies, residing with or in close proximity to one's PGM will be relatively common on farms, and less prevalent in towns. King and Elder (1995) reported just such a pattern in a study of grandparent-grandchild relations in farm families *versus* town-dwellers in one rural Iowa (USA) county. Seventh-graders who lived on farms reported more contact with the PGM than with the MGM, whereas those who dwelt in town had slightly more contact with their MGMs (and less contact with grandparents generally). It is noteworthy, however, that both groups rated their relationship with the MGM as being of higher quality, on average, than that with the PGM (see also Chan & Elder, 2000).

In sum, the literature reviewed above (and, more extensively, by Daly & Perry, 2017) is consistent with the proposition that while virilocality may constrain grandmothers' contact with their daughter's children, it does not obliterate an underlying tendency to care preferentially for them when differential access is suitably controlled. We are aware of just one exception: a study of rural *versus* urban Greeks, from which Pashos (2000) concluded that the culture and ideology of rural Greece socialize women to prefer their agnatic grandchildren regardless of proximity.

1.1. Urban versus rural Greeks - The Pashos (2000) study

In 1996, Alexander Pashos administered a questionnaire to Greek adults whom he had "recruited opportunistically". Among other questions, respondents were asked how far away each of their grandparents had resided when they were children under the age of 7 years, and "how much each grandparent had cared for" them up to that age, using a 7-point scale from 1 (not at all) to 7 (very much). There was an urban group of respondents ($n = 153$), from the cities of Athens and Thessaloniki, and a rural group ($n = 155$) "from traditional, rural districts of Macedonia". Details concerning age are sparse, but it can be inferred that the median respondent's age was about 27, and that few were older than 45; it follows that the grandmaternal childcare in question occurred mainly in the 1960s and early 1970s. (Pashos also interviewed a sample of young German adults, and called his study a "cross-cultural comparison" of Greece and Germany. However, unlike for Greeks, Pashos did not explicitly compare urban and rural upbringings in his German sample, in which he reported the usual uterine bias in grandmaternal care, replicating Euler & Weitzel, 1996.)

As expected, the rural Greek respondents had resided significantly nearer to their paternal grandparents than to their maternal grandparents, and PGMs were rated as having provided significantly more care than MGMs. Among urban Greeks, by contrast, there was no difference in proximity, and MGMs were rated as having provided significantly more care. These results echo those found elsewhere, as summarized above, but Pashos conducted a further analysis that led him to conclude that rural Greek PGMs provided more childcare than MGMs even when they lived "equally far away". From this, he inferred that "the cultural framework" of "traditional Greece" has engendered a "patrilateral rather than matrilateral bias" (page 107; see also Pashos, 2017).

To the best of our knowledge, this finding of a patrilateral bias when differential proximity was controlled is unique. However, Pashos's evidence on this point could be stronger. His analysis entailed collapsing an initial 10-point proximity scale into just three categories and coding those who lived in the same household, in the same town, and even in "a neighboring village" as all living in equal, maximal proximity. Whether rural Greek grandmothers would continue to exhibit a patrilateral bias net of proximity if distance were differentiated more finely remains an open question. Resolving this issue was the primary motivation for the present study, which makes use of grandmaternal reports of caregiving in urban and rural Greece in a large international survey, to address three related questions:

(1) Can Pashos's finding of an urban / rural contrast in the laterality of grandmaternal care be replicated on the basis of the testimony of grandmothers, rather than grandchildren?
(2) If question 1 is answered in the affirmative (and it is), will the urban / rural contrast persist when residential proximity is more finely differentiated and controlled?
(3) If question 2 is answered in the affirmative (and it is), does a similar interactive effect of laterality by urban *versus* rural residence prevail elsewhere in Europe?

1.2. The Survey of Health, Ageing and Retirement in Europe (SHARE)

SHARE was launched in 2004 in eleven European countries, plus Israel (Börsch-Supan et al., 2013). The target population is residents over 50 years of age at the time of interview, who speak an official language of the country where they reside and who are not living "in an institution such as a prison", plus their partners. In most countries (including Greece), persons residing in institutions for the elderly were included in the sampling frame, but in Austria, France, Italy, and Switzerland, they were not (Klevmarken, Swensson, & Hesselius, 2005).

Through 2015, six Waves had been completed at roughly two-year intervals. Many respondents have been interviewed in two or more

Waves, but there are also new interviewees, as well as changes in the list of participating countries, at each Wave. All Waves except Wave 3 have included identical questions on a variety of topics, one of which is the frequency and nature of respondents' contacts with their children and grandchildren. In Waves 1 and 2, these questions were asked of all grandparents, but only with reference to the first four children named by each respondent; from Wave 4 on, they have been asked of only one member of each grandparental couple (usually the woman, but often the man), and with reference to up to 20 children.

In 2004–2005, a total of 30,434 Wave 1 interviews were conducted in the 12 participating countries, including 2897 in Greece. In 2006–2007, another 37,174 interviews (and three countries) were added in Wave 2; the 3412 Greek interviewees included 2469 who had been interviewed in Wave 1 and 943 new participants. Greece then dropped out of Waves 4 and 5, and did not participate again until Wave 6 in 2015, at which time 68,231 interviews were conducted; the 4937 Greek interviewees included 2257 who had been interviewed in Waves 1 and/or 2, and 2680 who were responding to the questions for the first time.

Although the initial and subsequent interviews of a recontacted respondent are virtually identical, there is one crucial difference. If the interview is your first and you affirm that you have one or more grandchildren, you are then asked "During the last twelve months, have you regularly or occasionally looked after [your grandchild/your grandchildren] without the presence of the parents?" In re-interviews, the question instead begins "During the time since the last interview…". The latter variant therefore taps a longer (and variable) period: about two years for those who are interviewed in successive Waves and sometimes much longer. For Greeks who were re-interviewed in Wave 6, the interval had been between 8 and 11 years. Both for this reason and because including re-interviews would create a substantial incidence of pseudo-replication, analyses here are restricted to participants' first interviews.

SHARE participants who report that they have indeed cared for grandchildren in the absence of the parents are then asked for which of their children they provided grandchild care, and for each child named, "On average, how often did you look after the child(ren) of [child name] in the last twelve months? Was it… (1) almost daily, (2) almost every week, (3) almost every month, or (4) less often?"

2. Methods

The unit of analysis in what follows is the "grandchild set", which is either a sibling group or an individual grandchild. Making the grandchild set our basic unit is necessitated by two facts: the SHARE interview does not identify the individual grandchildren who were cared for, and only the age of the youngest child in each sibling group is recorded. These limitations make it impossible to restrict analysis to the care of children of a specified age range. The best available approximation is to include only those grandchild sets in which the youngest child had not yet reached a certain age. In the analyses to follow, that threshold is the 13th birthday.

Analysis is further restricted to the responses of grandmothers who were at least 50 years old. (Younger persons are excluded from the SHARE survey unless they have partners over 50.) We do not consider the responses of grandfathers here, because grandmothers care at higher rates, and when grandfathers do provide care, they often do so primarily as members of a caregiving couple (*e.g.*Euler & Weitzel, 1996; Knudsen, 2012; see also discussion by Gaulin et al., 1997). This is evidently the case in the SHARE data, too; see SI (Supplementary Information), section 1. Analysis is also limited to the children of the respondents' "own" children, rather than of their step-, adoptive, or foster children. The SHARE data provide these distinctions with respect to the respondents' children, but not with respect to *their* children, so an unknown number of the middle generation's step-, adoptive, and foster children have been included.

Following Hank and Buber (2009) and Žilínčíkova and Kreidl (2018), we present results for each of two binary (yes/no) measures of grandchild care: *Ever Care* was coded "yes" if a particular grandchild set was reportedly cared for at all, and *Frequent Care* if such care was provided "almost every week" or more. Results of additional analyses in which care is treated as a five-level dependent variable are presented in the Results section or the SI, where appropriate. We focus on the two binary-split measures Ever Care and Frequent Care because they may reflect different childcare arrangements, and although they are obviously not independent of one another, some variables affect the two in opposite directions. Hank and Buber (2009), for example, found that northern Europeans surpassed southern Europeans in their rates of Ever Care in SHARE Wave 1 but this contrast was reversed for Frequent Care, and Žilínčíkova and Kreidl (2018) found that divorce and national differences in divorce rates have different effects on the two measures. Also, according to Coall, Hilbrand, and Hertwig (2014), "biological grandparents" exhibited a higher incidence of Frequent Care than "non-biological grandparents" in SHARE Wave 1, but a lower incidence of Ever Care.

Our primary focus is on variation in relative rates of Ever Care and Frequent Care as a function of laterality (uterine *versus* agnatic grandchildren, *i.e.* the progeny of daughters *versus* sons) and of urban *versus* rural residence of the grandmother. SHARE codes the residential locales of interviewees into five categories: (1) a big city; (2) the suburbs or outskirts of a big city; (3) a large town; (4) a small town; and (5) a rural area or village. (This variable was left uncoded for 1.07% of Greek respondents, whose data were necessarily omitted from the analyses presented here.) In order to make comparisons similar to those by Pashos, we have reduced the codes to just two: category (5) is recoded as "rural" and all others as "urban". Effect sizes are presented as Odds Ratios (O.R.); values > 1.0 indicate a uterine (matrilateral) bias, and values < 1.0 an agnatic (patrilateral) bias. These O.R.s are derived either from simple cross-tabulations or, in the case of multivariate analyses, from the output of logistic regressions, from which we also derive "predicted" probabilities of caregiving net of the effects of other variables. Model fit is assessed and compared on the basis of the Bayesian Information Criterion (BIC), and pseudo-R^2 values are those of Nagelkerke (1991).

A crucial control variable is residential proximity. SHARE respondents are asked whether each of their children resides (1) "in the same household"; (2) "in the same building"; (3) "less than 1 kilometre away"; (4) "between 1 and 5 kilometres away"; (5) "between 5 and 25 kilometres away"; (6) "between 25 and 100 kilometres away"; (7) "between 100 and 500 kilometres away"; (8) "more than 500 kilometres away"; or (9) "more than 500 kilometres away in another country". This variable was coded for every case in the Greek samples, and for over 99.9% of cases in the rest of Europe. We collapsed options (8) and (9) into a single category, and the resultant 8-point scale is our measure of proximity (reverse-coded so that higher values indicate closer proximity). Note, however, that SHARE interviews do not elicit the distance between the residences of a respondent and her grandchildren, but only between respondents and *their* children (the grandchildren's parents), which therefore must serve as our proxy measure of respondent-grandchild proximity. Using this measure is unlikely to have produced error due to children having become independent, since our focus is on the care of children 12 years of age or younger. There is, however, another source of error that is likely to have been more serious, albeit of unknown magnitude: unknown numbers of grandchildren may have been in the custody either of an estranged partner of the respondent's child, or of the grandmother herself, in which cases the residential distance between a respondent and her child misrepresents her proximity to that child's children.

Finally, logistic regression analyses incorporate three additional control variables, each of which proves to be a significant predictor (net of all the others) of grandchild care in Greece and elsewhere in Europe: the grandmother's age (in years), her health status, and how many

grandchild sets were potential competitors for her attention. (For the latter purpose, we include all grandchild sets regardless of age.) There were no missing values for any of these variables, and collinearity among the predictors was low, with 0.09 being the maximum R^2 value for any pair of predictors (namely, health status and age, in Greece). For the full correlation matrices, see SI, section 2.

The health status measure is a single self-report item: "Would you say your health is (1) very good, (2) good, (3) fair, (4) bad, or (5) very bad?" This widely used measure (reverse-coded here to make the scale an index of good health) has good validity as a predictor of mortality, even when other health measures are controlled (Idler & Benyamini, 1997), and it has recently been shown to be a valid indicator of both physical and mental health in each of 19 European countries (Baćak & Ólafsdóttir, 2017).

We first present combined data for Waves 1 and 2, in which 628 Greek grandmothers (503 urban; 125 rural) and 836 grandchild sets (656 urban; 180 rural) met the criteria for inclusion. We then present separately the data from Wave 6, in which 472 grandmothers (338 urban; 134 rural) and 645 grandchild sets (466 urban; 179 rural) met the criteria. Because eligible grandmothers had an average of just 1.35 eligible grandchild sets and a large majority had exactly one, the analyses presented ignore clustering within grandmothers and treat grandchild sets as if they were independent, following the recommendations of Clarke (2008) and McNeish (2014), who have shown that using multilevel (clustered) regression techniques with so many small clusters systematically distorts certain variance estimates and is thus inferior to non-clustered regression. As a robustness check, however, clustered regressions were also run and produced virtually identical results to those presented in the results to follow; see SI section 3.

All analyses were conducted in Stata 13.1.

3. Results

3.1. Urban-rural contrasts in laterality biases in Greece: SHARE waves 1 and 2

Table 1 presents rates of self-reported child care by urban *versus* rural Greek grandmothers. Among urban Greeks, there was a strong and highly significant uterine bias in Ever Care, Frequent Care, and the mean level of care, whereas among the rural respondents, there were agnatic biases in all care measures that were also substantial in magnitude but fell short of statistical significance. The 95% confidence intervals for urban *versus* rural Odds Ratios are far apart, suggesting that differences between the two are genuine, which is confirmed by likelihood ratio tests which show that the fit of logistic regressions

Table 1
Rates of self-reported child care by urban *versus* rural Greek grandmothers in SHARE Waves 1 and 2 (2004–2007). For the binary care measures, an Odds Ratios > 1.0 indicates a uterine bias, and O.R. < 1.0 an agnatic bias. The five-level ordinal care measure ranges from 0 ('never') to 4 ("almost daily").

	Urban		Rural	
	Agnatic	Uterine	Agnatic	Uterine
N	325	331	94	86
Ever Care - proportion yes	0.514	0.677	0.521	0.395
Laterality bias - Odds Ratio (95% CI)	1.98 (1.44–2.72)		0.60 (0.33–1.09)	
chi-square (1 df)	18.07, $p < .0001$		2.97, $p = .090$	
Frequent Care - proportion yes	0.342	0.508	0.426	0.291
Laterality bias - Odds Ratio (95% CI)	1.99 (1.45–2.72)		0.55 (0.30–1.03)	
chi-square (1 df)	18.49, $p < .0001$		3.54, $p = .060$	
Mean level of care (0 to 5)	1.49	2.11	1.63	1.16
t (df)	4.77 (654), $p < .0001$		−1.86 (178), $p = .065$	

predicting care on the basis of kinship laterality and urban *versus* rural residence is significantly improved by including the interaction between the two predictors: (Ever Care: Likelihood Ratio $\chi^2_{1df} = 12.27$, $p < .001$; Frequent Care: $\chi^2_{1df} = 13.26$, $p < .001$). Similarly, for the 5-level care measure, a 2 × 2 analysis of variance indicates a highly significant laterality by urban / rural interaction ($F_{1,832\ df} = 14.95$, $p < .001$). The urban / rural dichotomy as defined for these analyses appears to correspond to a genuine cleavage point: a matrilateral bias in care is evident in "big cities" (Ever Care O.R. = 1.87; Frequent Care O.R. = 1.60), in "suburbs and outskirts" (Ever Care O.R. = 2.15; Frequent Care O.R. = 1.74), in "large towns" (Ever Care O.R. = 1.73; Frequent Care O.R. = 2.63), and in "small towns" (Ever Care O.R. = 3.03; Frequent Care O.R. = 1.81), and is reversed only in "villages and rural areas" (Ever Care O.R. = 0.60; Frequent Care O.R. = 0.55).

Fig. 1 shows that this urban-rural contrast is not an artifact of differences in residential proximity. Among urban dwellers, uterine grandchildren were cared for at higher rates than their agnatic counterparts regardless of proximity, whereas among rural dwellers, agnatic grandchildren were the more frequently cared for. (For purposes of this Figure, some adjacent levels of the proximity variable have been combined to prevent there being cells with an N of less than five in the rural data.) These results support Pashos's conclusion that there is an urban-rural contrast in laterality preference even when uterine and agnatic grandchildren live equally far away from the grandmother.

To assess the robustness of these contrasts when additional potential confounds were controlled, logistic regressions similar to those reported above were run for each care measure, with proximity and the grandmother's age, self-reported health status, and number of grandchild sets included as additional predictors. Including these variables substantially improved the prediction of caregiving (increasing pseudo-R^2 from 0.049 to 0.280 and reducing BIC by 137.6 points for Ever Care, and increasing pseudo-R^2 from 0.039 to 0.310 and reducing BIC by 166.8 points for Frequent Care), but it did not change the basic pattern of results with respect to laterality in urban *versus* rural settings (see Table 2 and Fig. 2). Likelihood ratio tests again confirm the significance of the urban / rural by laterality interaction (Ever Care: Likelihood Ratio $\chi^2_{1df} = 10.61$, $p = .001$; Frequent Care: $\chi^2_{1df} = 8.82$, $p = .003$), as does an Ordinal Logistic Regression analysis of predictors the 5-level care variable (see SI section 4).

As expected, proximity had a strong effect, especially on Frequent Care, and grandchild sets indeed appear to "compete" for care. Older age was associated with reduced caregiving, and good health was associated with a higher rate of Ever Care, but not of Frequent Care. Finally, separate regressions on the urban and rural samples indicated that the uterine bias among urban grandmothers was reduced (relative to the raw data Odds Ratios in Table 1) by the inclusion of the additional predictors (Ever Care: O.R. = 1.68; Frequent Care: O.R. = 1.52), but remained significant, while the agnatic bias among rural grandmothers was enhanced (Ever Care: O.R. = 0.48; Frequent Care: O.R. = 0.46), and now attained statistical significance ($p < .05$) for both care measures.

3.2. Urban-rural contrasts in laterality biases elsewhere in Europe: SHARE waves 1 and 2

Pashos (2000) attributed the agnatic bias in grandmaternal care in rural Greece to effects of "traditional Greek culture". However, the patrilineal inheritance of farms in conjunction with patrilocal post-marital residence have been traditions not only in Greece, but throughout Europe (*e.g.*Fauve-Chamoux & Arrizabalaga, 2005). Are the Greek results truly exceptional, then, or should we be invoking "traditional *rural* culture" as a possible source of widespread urban-rural contrasts? To address this question, we ran regressions like those for Greece in each of the fourteen European countries that participated in SHARE Wave 1, 2, or both. Fig. 3 presents the results for urban *versus* rural laterality biases in Ever Care, country by country. Results for

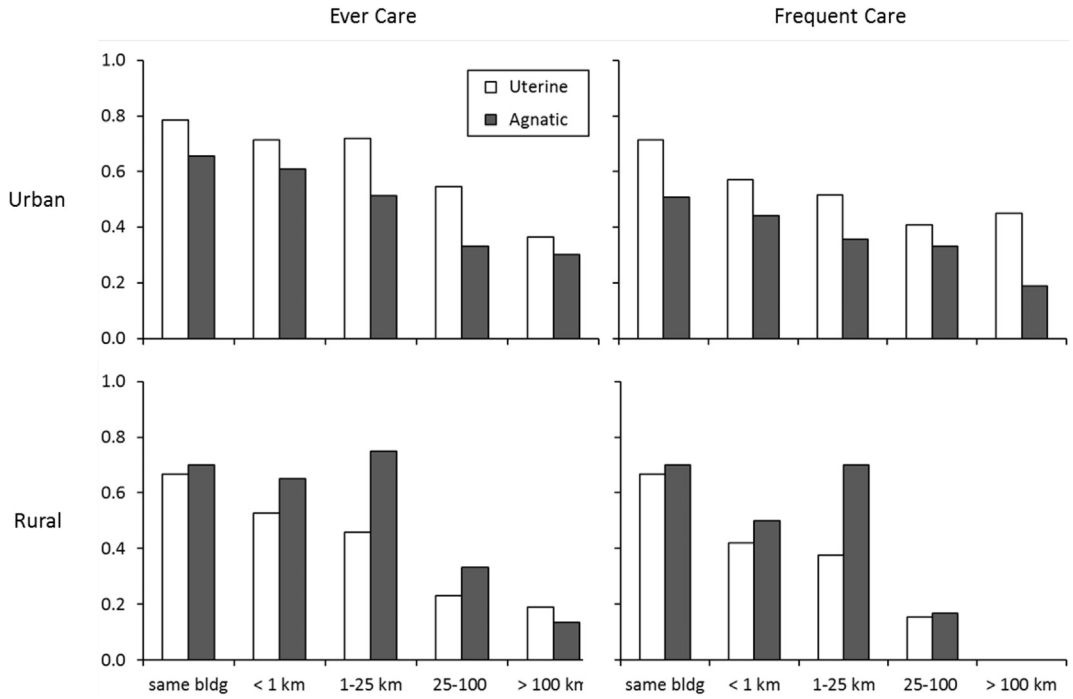

Fig. 1. Proportions of uterine *versus* agnatic grandchildren receiving grandmaternal care in Greece, SHARE Waves 1 & 2, by residential proximity and urban *versus* rural residence.

Frequent Care were similar, and are presented along with fuller details for both care measures in SI section 5. In short, it appears that rural Greece is indeed exceptional. Although certain countries exhibited urban-rural differences in the same direction as Greece, others exhibited an opposite contrast with the uterine bias stronger in rural areas, and nowhere other than in Greece did any agnatic bias, net of proximity, even approach statistical significance (SI section 5).

That said, there *is* evidence that the uterine bias in grandmaternal care was generally somewhat weaker in rural Europe than in its cities and towns. When regressions similar to those for Greece were run for all of Europe excluding Greece, the Laterality Odds Ratios for Ever Care were 1.56 urban and 1.48 rural, and for Frequent Care 1.99 urban and 1.45 rural. All four values represent highly significant ($p < .00001$) uterine biases, but further regressions with a Laterality x Urban-Rural interaction term and cases clustered within country demonstrated a significant urban *versus* rural difference in the magnitude of the uterine bias for Frequent Care (Likelihood Ratio $\chi^2_{1df} = 9.20$, $p = .002$), although not for Ever Care ($\chi^2_{1df} = 0.38$, $p > .5$).

Finally, further regressions in which cases were coded as Greek or "other" (*i.e.* elsewhere in Europe) demonstrated significant 3-way interactions (Laterality * urban / rural * Greece / other) for both Ever Care ($p = .003$) and Frequent Care ($p = .028$), as well as showing that Laterality * urban / rural interactions, although directionally similar, were significantly greater in Greece than in the rest of Europe (Ever Care Likelihood Ratio $\chi^2_{3df} = 10.15$, p = .02; Frequent Care Likelihood Ratio $\chi^2_{3df} = 8.26$, $p = .04$).

In sum, an urban / rural contrast in the Laterality bias in SHARE Waves 1 and 2 is apparently not peculiar to Greece, but that contrast is larger in Greece than elsewhere in Europe and a reversed (agnatic or patrilateral) bias is demonstrable only in rural Greece.

3.3. Urban-rural contrasts in the uterine bias in SHARE wave 6

Greece opted out of SHARE Waves 3 to 5, but resumed participation in the survey in Wave 6, which was conducted in 2015. Wave 6 results contrast strikingly with those that had been collected earlier (Table 3 and Fig. 4). Both urban and rural Greek women now reported higher rates of care of uterine than of agnatic grandchildren, and there was no longer a significant interaction between laterality and urban *vs* rural residence for either care measure. Logistic regressions in which data from all Waves in which Greece participated confirmed significant 3-way interactions among laterality, urban *vs* rural, and Waves 1–2 *vs*

Table 2
Odds Ratios (with 95% Confidence Intervals) for five potential predictors of child care by Greek grandmothers participating in SHARE Waves 1 and 2, derived from two logistic regressions.

	Ever care		Frequent care	
	O.R. (95% C.I.)	p	O.R. (95% C.I.)	p
Laterality * urban/rural interaction	0.29 (0.14–0.61)	**0.001**	0.30 (0.14–0.67)	**0.003**
Laterality: uterine grandchild *cf.* agnatic	1.67 (1.17–2.38)	**0.005**	1.53 (1.07–2.19)	**0.020**
Urban residence *cf.* rural	1.67 (0.99–2.83)	0.055	2.28 (1.31–3.97)	**0.003**
Proximity (8 point scale)	1.40 (1.28–1.52)	**0.000**	1.67 (1.51–1.84)	**0.000**
Grandmother's age (years)	0.95 (0.93–0.97)	**0.000**	0.95 (0.93–0.97)	**0.000**
… health (5 point scale)	1.30 (1.09–1.54)	**0.003**	1.03 (0.87–1.22)	0.730
… number of grandchild sets	0.54 (0.43–0.67)	**0.000**	0.60 (0.48–0.75)	**0.000**
Pseudo R-squared (Nagelkerke)	0.280		0.310	

bold p-values are those significant at p < .05

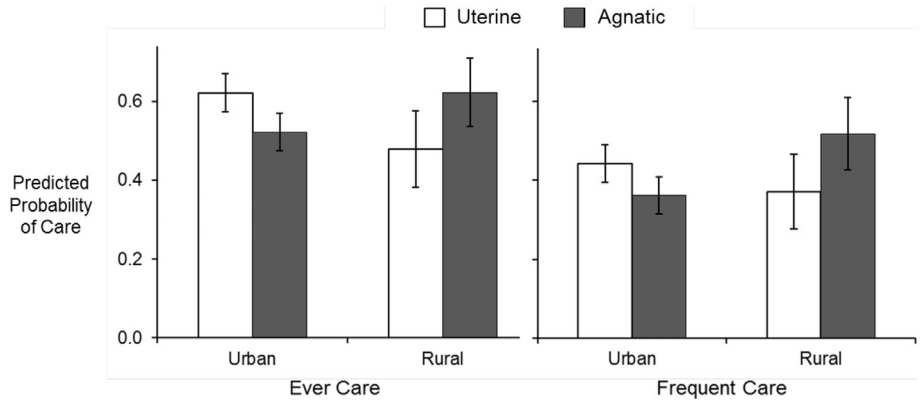

Fig. 2. Predicted probabilities that urban and rural Greek grandmothers in SHARE Waves 1 and 2 provided care to uterine and agnatic grandchildren (± 95% C.I.), derived from two logistic regressions, net of the effects of the four additional variables in Table 2.

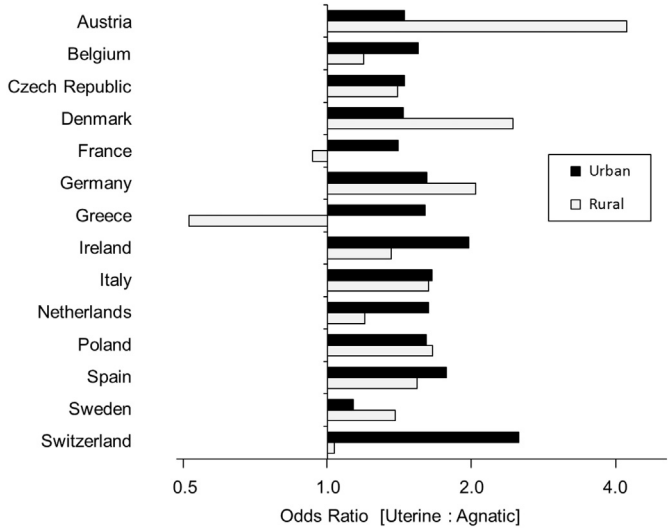

Fig. 3. Odds Ratios for grandchild laterality in Ever Care by urban *versus* rural grandmothers in SHARE Waves 1 and 2, country by country. These O.R.s are outputs of country-specific logistic regressions, net of the effects of the four additional variables in Table 2. For 95% Confidence Intervals, see SI section 5.

Wave 6 (z = 3.05, p = .002 for Ever Care; z = 2.02, p = .043 for Frequent Care).

In Wave 6, model fit was superior (*i.e.* a lower BIC) for both care measures when the laterality by urban-rural interaction term was omitted, so Table 3 presents regression results without it. When urban and rural respondents were considered separately, the magnitude of the uterine bias was now slightly greater among the rural respondents (Fig. 4), and was statistically significant only for the Ever Care measure in the rural subgroup (tests and fuller statistics in SI section 6).

3.4. Before and after the financial crisis of 2008–2009

Why did rural Greek grandmothers switch from a significant agnatic bias in grandchild care in Waves 1 and 2 to a significant uterine bias in Wave 6? Fig. 5 shows that this radical change in the laterality of grandmaternal care in rural Greece was not duplicated in the rest of Europe.

It is plausible that the financial crisis of 2008–2009 played some role in the dramatic change in rural Greece, but the SHARE data provide no clear evidence that the shift was mediated by changes in employment status, residential proximity, or the prevalence of three-generation households. The unemployment rate in Greece more than tripled between the dates of Waves 1–2 and Wave 6 (Giannakis & Bruggeman, 2017). However, it was youth who were hardest hit, and changes in employment status of the SHARE respondents and their grandchildren's parents were relatively modest: 79.1% of sons who were the fathers of eligible grandchildren were “full-time employed” in Waves 1–2 *vs* 76.9% in Wave 6; those who were “unemployed” had risen, but only to 5.8%. For daughters, 47.6% were “full-time employed” in Waves 1–2, and 46.3% in Wave 6, but those described as “unemployed” had jumped from 4.5% to 18.8%; the mismatch between a small drop in employment and a big increase in unemployment reflects declines in both those called homemakers and those working part-time. As regards the grandmothers' own employment status, a large majority described themselves as retired or as homemakers, regardless of Wave or urban-rural residence; those who described themselves as employed increased slightly from 10.1% in Waves 1–2 to 11.7% in Wave 6, and yet the proportion who called themselves unemployed *also* increased, more substantially, from 0.9% to 5.5%.

Whereas changes in employment status of Greek SHARE respondents and their children from Waves 1–2 to Wave 6 appear modest,

Table 3
Odds Ratios (with 95% Confidence Intervals) for five potential predictors of child care by Greek grandmothers participating in SHARE Wave 6, derived from two logistic regressions. N (urban) = 465. N (rural) = 179.

	Ever care		Frequent care	
	O.R. (95% C.I.)	p	O.R. (95% C.I.)	p
Laterality: uterine grandchild *cf.* agnatic	1.46 (1.05–2.03)	**0.023**	1.57 (1.07–2.29)	**0.021**
Urban residence *cf.* rural	0.97 (0.68–1.40)	0.884	0.97 (0.64–1.49)	0.905
Proximity (8 point scale)	1.25 (1.14–1.37)	**0.000**	1.69 (1.48–1.90)	**0.000**
Grandmother's age (years)	1.00 (0.98–1.02)	0.994	0.98 (0.96–1.01)	0.131
… health (5 point scale)	0.96 (0.81–1.13)	0.596	0.95 (0.79–1.16)	0.637
… number of grandchild sets	0.69 (0.57–0.85)	**0.000**	0.71 (0.56–0.90)	**0.004**
Pseudo R-squared (Nagelkerke)	0.085		0.211	

bold p-values are those significant at p < .05

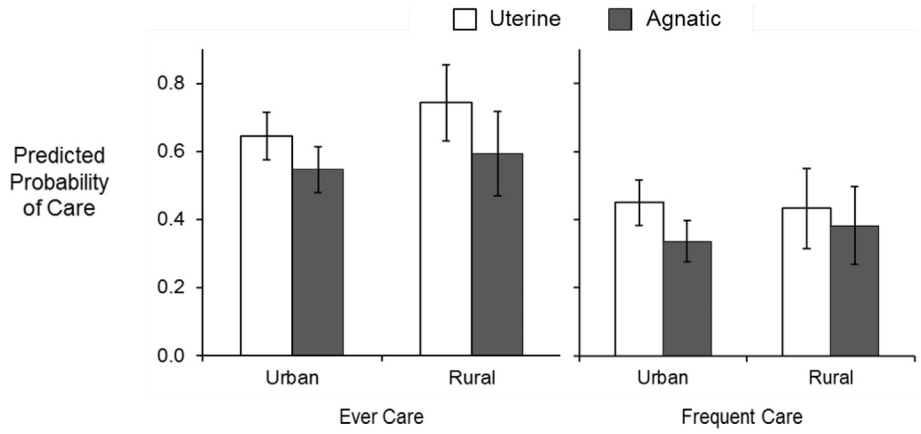

Fig. 4. Predicted probabilities that Greek grandmothers in SHARE Wave 6 provided care to uterine and agnatic grandchildren (± 95% C.I.), derived from two logistic regressions, net of the effects of the four additional variables in Table 3.

there was more striking evidence of financial pain in the responses to a question about "difficulty making ends meet". In the first two Waves, 31.7% of Greek grandmothers (30.3% of urban dwellers, and 34.4% of rural dwellers) reported that they could make ends meet "only with great difficulty"; in Wave 6, this proportion had risen to 50.3% (urban: 51.1%; rural: 49.2%). Nevertheless, this variable was not a significant predictor of child care by Greek grandmothers, neither in Waves 1–2 nor in Wave 6, and including it as an additional predictor detracted from model fit (produced an increase in BIC) in all analyses of the Greek data.

Grandmothers in Greece and elsewhere were substantially more likely to provide care, especially Frequent Care, for uterine grandchildren if the daughter/mother was employed, whereas in Greece (although not in Europe generally), a son's employment status had no demonstrable effect on his mother's provision of care to his children. The relevant analyses are detailed in SI section 7. Unfortunately, the SHARE interview elicits the employment status of interviewees' children but not of those children's spouses, and it is therefore impossible to conduct a full analysis of the effects of the employment status of grandchildren's mothers and fathers on grandmaternal childcare. If we add whether the grandmother herself was working to the list of predictors in the logistic regressions reported in Tables 2 and 3, full-time employment was always associated with reduced child care, but that reduction was statistically significant in only one instance, namely that for Frequent Care by urban-dwelling grandmothers in Waves 1 and 2. In no case did including this predictor improve model fit or affect which other predictors were significant.

Changes in residential proximity or in the incidence of three-generation households do not seem to be implicated in the dramatic change shown in Fig. 4. Overall, Greek grandmothers coresided with children who had children, and hence presumably with their grandchildren, in 3.9% of cases in Waves 1 and 2, and in 4.0% of cases in Wave 6. Both before and after the financial crisis, the urban grandmothers tended to live slightly nearer to daughters with children than to sons with children and rural grandmothers the reverse, but these contrasts never neared statistical significance. As for coresiding in the same household, rural grandmothers in Waves 1 and 2 actually dwelt with daughters who had children slightly (not significantly) more often than with sons, despite exhibiting a significant agnatic bias in childcare, and in Wave 6, they actually dwelt with sons slightly (not significantly) more often than with daughters, despite exhibiting a significant uterine bias. In short, the data on proximity and coresidence provide no obvious insights into the reasons for the dramatic reversal in childcare by laterality. It must be noted, however, that it is impossible to determine whether the incidence of grandmaternal custody of children in the absence of the parents (*e.g.* while daughters/mothers were labor migrants) might have increased.

Finally, one might hypothesize that changing fertility and a difference in the ages of the grandchildren may have been relevant to changing rates of grandmaternal care. In particular, if Greeks responded to the financial crisis by reducing birth rates (which they apparently did, albeit only slightly; Simou, Stavrou, Kanavou, Koutsogeorgou, & Roumeliotou, 2013), then the Wave 6 grandchildren may have included relatively few infants and toddlers (born after the financial crisis), in

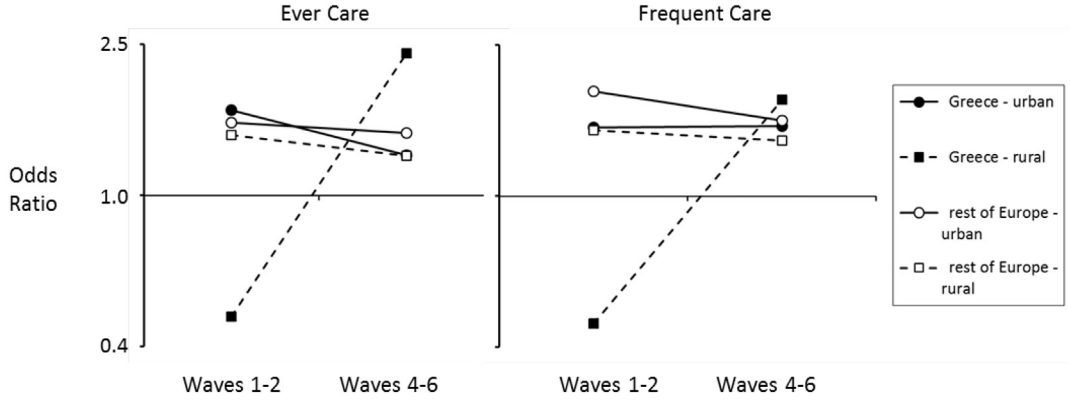

Fig. 5. Laterality biases in care by urban *versus* rural grandmothers in Greece and elsewhere in Europe before (Waves 1–2) and after (Waves 4–6) the financial crisis of 2008–9. The data are derived from logistic regressions, net of the effects of the additional variables in Table 3. The "rest of Europe" comprises countries other than Greece in which interviews were conducted in both periods (Austria, Belgium, the Czech Republic, Denmark, France, Germany, Italy, the Netherlands, Poland, Spain, Sweden, and Switzerland).

comparison to the data from Waves 1 and 2. This hypothesis is not borne out by the SHARE data, however: the youngest child was under 6 years of age in 52.0% of the eligible grandchild sets in Waves 1 and 2, and in 52.8% in Wave 6. A substantial, gradual decline in fertility has been underway in Greece, especially in rural areas, for at least a century (Zafeiris & Kaklamani, 2019), which has presumably reduced the proportions of grandmothers who *have* both uterine and agnatic grandchildren for whom they might have provided care; it is not obvious, however, why such changes would engender a reversal (rather than simply a dampening) of laterality biases.

4. Limitations

The research reported here is based on self-report data, which necessarily entail some risk of invalidity due to faulty memory and/or biased self-presentation. Further limitations derive from details of what SHARE respondents were and were not asked.

Our measures of caregiving are based on questions about whether respondents had cared for grandchildren "in the absence of the parents", but are silent on the specifics of such care, and the fact that this question is asked only with respect to a "grandchild set" (a sibling group) limits inferences about such distinctions as caring for infants *vs* minding school-age children. Our measures may also miss much of what is captured by the ratings of closeness and solicitude that are commonly included in studies based on the reports of grandchildren, including that by Pashos (2000). This may be especially important if the extent to which grandparental presence and "care" entail genuine investment, on the one hand, or are relatively self-serving and perhaps even exploitative, on the other, varies in relation to laterality (Strassmann & Garrard, 2011).

Some European grandparents are surely their grandchildren's primary caretakers, but SHARE does not ask whether this is the case, and such cases cannot be identified. In a paper analyzing data from SHARE Wave 1, Coall et al. (2014) proposed that even grandparents who look after the children "almost daily" (the maximum option) must rarely be custodial grandparents, because they seldom claim to have spent > 10 h a day in caregiving (a variable that we did not make use of). We question this inference, however, because a custodial grandparent cannot be assumed to have counted hours when the children were asleep, at school, out with friends, or simply out of sight, as hours spent caring for them. Moreover, it is impossible to identify those grandchildren who are in the custody of an estranged partner of the respondent's child. Other things that it would be useful to know but were not recorded include the employment status of children's partners, and which "grandchildren" were not the respondent's lineal descendants because they were the step-, adoptive or foster children of their own children.

The complex cross-national implementation of the SHARE survey entailed many country-specific decisions. According to Klevmarken et al. (2005), the research teams in different countries encountered a diversity of problems in identifying and accessing the target population, and based their sampling on methods ranging from the use of a national registry through regional directories (with some regions opting out) to starting from a telephone directory; all participating countries except Austria reportedly "attempted proper probability sampling" in Wave 1, but only a minority fully achieved this objective. Rural areas were apparently oversampled in some countries and undersampled in others: 55.7% of Swiss interviewees in Waves 1–6 resided in "a rural area or village", for example, which is more than twice the percentage expected on the basis of the Swiss population at large (Europa, 2018), while at the other extreme, only 6.3% of Spanish interviewees were rural/village dwellers, which is less than a quarter of the population-based expectation.

Regression analysis of real-world data sets is typically a somewhat procrustean enterprise, and that is certainly the case with SHARE. Following other analysts (*e.g.*Hank & Buber, 2009), we rendered grandmaternal care binary and thus suitable for logistic regression in two ways (Ever Care and Frequent Care), presenting results for both. Collinearity among predictors was slight (SI section 2), but there is one assumption for logistic regression that the analyses presented here sometimes failed, according to Stata's diagnostics, namely that the logit of the dependent variable is a linear function of each predictor. In exploratory analyses, any regression that failed tests for this assumption could be made to pass by including non-linear transformations of one or more of proximity, age, and health status, as additional predictors, but while both the untransformed and transformed predictor variables might both be statistically significant, in no case was model fit (as assessed by BIC) improved by retaining both, nor by replacing the independent variable with any simple transformation such as the log or the best fitting power transformation (as identified by the Box-Tidwell procedure); neither did exploratory analyses in which we introduced interactions between various pairs of these predictors improve model fit. The violations of the linearity assumption could be eliminated by reducing all predictors to binary form, but at least as regards proximity, this would destroy much of the point of our analysis, since a crucial question was whether Pashos's conclusion about laterality preferences could be upheld with proximity more finely differentiated. An alternative remedy is to sacrifice the ordinality inherent in the proximity and health status variables, and replace them with dummy variables representing their eight and five values, respectively. As a further check of the robustness of the reported results, we ran additional logistic regressions like those whose results are presented in Table 2, but with proximity and health status converted to categorical predictors in this way, and as is detailed in SI Section 8, the impacts and significance levels of the other predictors of childcare (the laterality by urban/rural interaction, age, and the number of competing grandchild sets) scarcely differed between these analyses and those reported in Table 2.

5. Discussion

Pashos (2000) found that Greeks whose childhoods had been spent in rural settings reported having received more care from their paternal grandmothers (PGMs) than from their maternal grandmothers (MGMs), whereas the reverse was true for those who had grown up in towns and cities. In this study, we replicate this contrast in the data from SHARE Waves 1 and 2. What made Pashos's study exceptional was his further conclusion that rural Greek PGMs provided more childcare than MGMs even when they lived "equally far away". This, too, was upheld by the Wave 1 and 2 results reported here (Figs. 1 and 2), in which grandparent / grandchild proximity is more finely differentiated than was the case in the Pashos study.

Although the data used by Pashos and in the present study are all self-reports, they are very different. Pashos's adult subjects reported retrospectively on care they had received as young children, decades earlier, in the 1960s and 1970s; the SHARE interviewees were reporting on care that they had provided to their grandchildren in 2003–2006, in the twelve months prior to interview, and we included care of somewhat older dependent children. In our view, these methodological and temporal differences enhance the persuasiveness of the replication. Rural Greek grandmothers really do seem to have cared preferentially for their sons' children for reasons other than differential proximity, an agnatic bias that has not yet been demonstrated elsewhere (see Daly & Perry, 2017).

It is all the more striking, then, that this preference was reversed in interview data from 2015 (Wave 6) when rural Greek grandmothers switched to a significant uterine bias. The reasons for this turnabout remain unknown. It seems likely that the financial crisis of 2008–2009, which hit Greece harder than the rest of Europe (Ifanti, Argyriou, Kalofonou, & Kalofonos, 2013; Sotiropoulos & Bourikos, 2014), was somehow relevant, but preliminary efforts to assess whether the change might have been mediated by changes in unemployment, fertility, or the incidence of coresiding three-generation families (section 3.4)

revealed no “smoking gun”.

Like Pashos, we assume that traditional culture and ideology that prioritize patrilineal links were of relevance to the agnatic preferences exhibited by rural grandmothers before 2015. It would thus be interesting to know whether other measures might indicate a weakening of support for that ideology coincident with the switch in laterality of care. In the Pashos study, both urban and rural Greeks born after 1969 reported having received more care from the MGM than did those born earlier, whereas there was no such cohort effect on reported care by PGMs, and Pashos suggests that this may have been an early sign of the erosion of traditional patrilineal culture. The results for SHARE Waves 1–2, however, demonstrate that an agnatic bias in rural Greece was still visible decades later, only to disappear between 2006 and 2015. It would also be interesting to know whether similar changes can be observed in other components of grandparental investment such as financial support.

In a child protection context, Perry, Daly, and Macfarlan (2014) have reported that Canadian MGMs and PGMs scarcely differed in their willingness to provide care when their financial, social and health circumstances were good, but that participation by PGMs fell away under duress, at which times MGMs stepped up to fill the gap, leaving a strong matrilateral bias. The rural Greek data reported here match this account nicely, but the urban data do not, since care by MGMs and PGMs exhibited similar declines after the financial crisis (compare Figs. 2 and 4).

It is unlikely that Pashos's finding of a patrilateral investment bias even after proximity is controlled, which our results have upheld, is literally unique to rural Greece. Further research on other virilocal societies, as well as work exploiting additional data sources, are still required to illuminate the diversity in patterns of grandmaternal care and its rationales. The SHARE study continues, so evidence on the stability or instability of the switch from a patrilateral to a matrilateral bias in rural Greece should be forthcoming.

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Data availability

This study uses data from SHARE Waves 1, 2, and 6 (DOIs: https://doi.org/10.6103/SHARE.w1.610, https://doi.org/10.6103/SHARE.w2.610, https://doi.org/10.6103/SHARE.w6.610). These and other SHARE data are available to “the entire research community” (see http://www.share-project.org/). See Börsch-Supan et al. (2013) for further details about the survey methodology. Code used for analyses reported here is available from the authors by request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.evolhumbehav.2019.04.004.

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