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Climate change concerns and fertility intentions: first evidence from Italy

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Abstract

The impact of climate change is being felt worldwide, with Europe experiencing the fastest rate of warming among all continents. Beyond socioeconomic consequences, climate change can potentially affect demographic outcomes, including fertility, in terms of both reproductive health and fertility behavior. However, to date, there is limited evidence on the relationship between climate change and fertility. With this paper, we intend to (1) expand the theoretical discussion on the role of uncertainty in childbearing decisions by moving beyond the common focus on economic uncertainty to explicitly consider the role of environmental uncertainty; (2) broaden the scholarly understanding of the relationship between climate change and fertility, which has mainly focused on objective measures of climate change, by investigating the role of climate change concerns; and (3) offer the first empirical evidence on the association between climate change concerns and fertility intentions for Italy using the 2016 Household Multipurpose Survey "Family and Social Subjects" (FSS) ($N = 4408$). Our results provide initial indications that environmental uncertainty may be linked to lower fertility intentions. Individuals who perceive climate change as a major issue or the biggest problem of the future tend to be less likely to report an intention to have a child. This pattern appears consistent across parity groups, and the findings remained stable net of sociodemographic characteristics and individuals' positioning on the conservative–liberal spectrum. Overall, these findings contribute to the discussion on how uncertainties and pessimism may shape childbearing intentions.

Keywords: Climate change, Fertility intentions, Uncertainty, Italy

Introduction

External shocks such as pandemics, conflicts and extreme weather events demonstrate that we face an uncertain future. In particular, since climate change is complex and multifaceted, with the locations and timeframes of its consequences being difficult to predict, this perception of uncertainty has been found to be related to people's concern about climate change (Visschers, 2018). Uncertainty refers to the absence of clarity about one's future possibilities, hindering the ability to make rational calculations concerning future events (Beckert, 2016; Beckert & Bronk, 2018). In this context of uncertainty, people tend to consider not only past experiences and present status (the "shadow of the past"), but also future expectations, which represent what people expect will happen based on the available information (the "shadow of the future"). This perspective aligns

with an established tradition in cultural sociology and social psychology that examines how future cognitions and imagined outcomes influence behavior (Bernardi et al., 2019; Huinink & Kohli, 2014; Mische, 2009; Vignoli et al., 2020a, 2020b).

Indeed, numerous studies have investigated the impact of uncertainty and future expectations on fertility. In introducing the concepts required to operationalize the role of the future in fertility dynamics, Vignoli et al., (2020a, 2020b, 2022) contended that future narratives—i.e., what people anticipate will happen in the future based on the facts at hand—are relevant to fertility dynamics, and relying on objective factors alone may possibly lead to erroneous perspectives on fertility decisions. However, while the literature on the uncertainty/fertility nexus is abundant (Adsera, 2011; Comolli & Vignoli, 2021; Gatta et al., 2021; Guetto et al., 2022; Kreyenfeld et al., 2012; Schneider, 2015; Vignoli et al., 2022), most existing studies on the matter have focused on economic uncertainty, assessing the extent to which such aspects as employment uncertainty (Gatta et al., 2021), information about future economic trends (Lappegård et al., 2022), and perceptions of job insecurity (van Wijk & Billari, 2024) are related to individuals' childbearing intentions and behaviors.

We posit that there is a need to expand the discussion around the role of uncertainty in family life courses from economic and employment uncertainty to other forms of uncertainty. Individuals exhibit increasing flexibility in interpreting social reality when making decisions about important life events, such as having children and the timing of childbearing. Our central thesis is that environmental circumstances—perhaps more perceived or anticipated than experienced—can shape childbearing intentions. Indeed, concerns over climate change may be one of the significant factors contributing to the ongoing fertility decline in Italy and other low-fertility countries. Yet, little research has been conducted on the influence of environmental uncertainty—that is, uncertainty arising because of climate change and its future consequences, on fertility intentions, despite mounting evidence of climate anxiety and fear over climate futures among young people (Crandon et al., 2022; Hickman et al., 2021). Moreover, scholarship on the matter appears inconclusive, with studies on the relationship between environmental uncertainty and fertility intentions yielding widely contrasting results (Arnocky et al., 2012; De Rose & Testa, 2015; Lockwood et al., 2022; Peters et al., 2023; Schneider-Mayerson & Leong, 2020; Zimmerman et al., 2024). This underscores the need for further research on the topic.

The present study contributes to the existing literature in several ways. First, it conceptualizes the potential role played by climate change concern in the reproductive decision-making process, offering novel empirical evidence on how individuals perceive their future and make specific decisions based on this perception. This is a step forward in scholarly research on the association between uncertainty and fertility decisions, in that it moves beyond the common focus on economic uncertainty (Matysiak & Vignoli, 2024). Second, this study adds to the blossoming field of research exploring the association between individuals' perceptions and concerns over climate change and fertility by using the most recent data on fertility intentions of a representative sample of the adult population. Third, it provides the first detailed empirical test of the association between climate change concerns and fertility intentions focusing specifically on Italy. The 2023 Census Report on Italy's social situation found that 84% of Italians expressed fear over

the "out-of-control climate". This trend reveals a broad segment of the population concerned about the long-term effects of climate change. Increasingly extreme weather events, which no longer feel exceptional, are amplifying these fears across the country (CENSIS, 2023). While De Rose and Testa (2015) included Italy in their broader European analysis, no prior study has exclusively examined this relationship within the Italian context. This is particularly significant given Italy's internationally notable fertility decline, with the Total Fertility Rate (TFR) reaching 1.24 in 2022 (Eurostat, 2024), one of the lowest levels in the country's history and the fourth-lowest among EU-27 countries after Malta (1.08), Spain (1.16), and Albania (1.21).

Background
The role of uncertainty for fertility decisions
The demographic literature on the determinants of contemporary fertility dynamics, particularly in low-fertility countries, has recently witnessed a surge of attention toward the role played by uncertainty (Comolli & Vignoli, 2021; Gatta et al., 2021; Lappegård et al., 2022; Novelli et al., 2021; Vignoli et al., 2020a, 2020b, 2022). The term "uncertainty" here refers to the impossibility of quantifying the probability of future outcomes (Knight, 1921/2006), thus eliciting a sense of uneasiness over a situation where envisioning our future—both in the long- and in the short-run—becomes difficult.

The process through which uncertainty influences fertility dynamics occurs in a complex interplay between past, present and future socioeconomic and political conditions. (Guetto et al., 2022; Lappegård et al., 2022; Vignoli et al., 2022), aptly described by the *narrative framework* (Vignoli et al., 2020a, 2020b). The idea is that, beyond the classic social determinants of fertility such as past and present employment and education (Balbo et al., 2013), the "shadow of the future" (Bernardi et al., 2019; Huinink & Kohli, 2014) also plays an important role in influencing childbearing intentions. In the presence of uncertainty, an imaginative dialogue occurs within the individual, in which past and present circumstances combine with expectations, imaginaries, and narratives of the future to influence fertility decisions. On the one hand, past experiences and structural constraints such as cultural characteristics, rules, and institutional settings constitute key elements at the basis of the childbearing decision. On the other hand, even when facing similar constraints and past experiences, individuals might expect different outcomes. As a result, the individual forms a personal narrative of the future, thus also forming a course of action for childbearing (Guetto et al., 2022; Vignoli et al., 2020a).

Importantly, while the decision to have a child is always taken in a condition of fundamental uncertainty,[1] numerous studies have emphasized the increasing sense of fear, generalized anxiety, and societal uncertainty that characterizes contemporary times (Comolli & Vignoli, 2021; Guetto et al., 2022). This growing pervasiveness of uncertainty makes the study of its impact on contemporary fertility dynamics increasingly crucial. As such, it comes as no surprise that scholarly research on this relationship is abundant (see, for example, Adsera, 2011; Comolli & Vignoli, 2021; Gatta et al., 2021; Guetto et al.,

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[1] A condition of fundamental uncertainty entails the impossibility to foresee or estimate the impact that an action taken today will have tomorrow (Vignoli et al., 2020a, 2020b).

2022; Ivanova & Balbo, 2024; Kreyenfeld et al., 2012; Lappegård et al., 2022; Novelli et al., 2021; Schneider, 2015; Vignoli et al., 2022).

However, existing research has primarily focused on economic uncertainty, measured through numerous different indicators. These include, but are not limited to, labor market indicators (Adsera, 2011; Gatta et al., 2021), indexes of persistent joblessness (Busetta et al., 2019), indexes of Consumer Confidence (CCI) (Comolli, 2017), perception of resilience to job loss (Gatta et al., 2021), market volatility (Comolli, 2017) and indicators of Google research trends of financial stability (Comolli & Vignoli, 2021). Investigating the relationship between uncertainty and fertility decisions exclusively through the lens of economic uncertainty provides an incomplete picture. A growing number of studies linking climate change with mental health aspects such as "eco-anxiety" have suggested the importance of considering *other* types of uncertainty so as to unlock new insights into how individuals navigate fertility decisions in increasingly uncertain times.

Recent steps forward in this direction were taken by Ivanova and Balbo (2024), who explored the role of societal pessimism on fertility in the Netherlands. In so doing, the authors extended the *narrative framework* by moving beyond the focus on the impact of individuals' own future on fertility to explore the role of fears and beliefs about the future of potential children. They investigated the influence of societal pessimism on fertility behavior by employing a measure based on individuals' opinions about the societal conditions for the next, rather than the present, generation. The measure is based on various aspects of living standards, such as environment, social life, employment, and more. While Ivanova and Balbo's (2024) focus on societal pessimism provides crucial insights into how concerns about the future of the next generation influence fertility, their definition of "societal pessimism" encompasses a broad range of issues. This extensive scope could potentially obscure the influence of each specific type of concern. Investigating the contribution of specific sources of concern can help identify which dimensions of uncertainty influence fertility decisions and shed light on potential policy interventions. An important contribution in this regard was the recent study by Golovina and Jokela (2024), which explored how worries over specific personal and social issues influence childbearing behavior in Germany. In this work, the authors documented a negative relationship between various kinds of social and environmental worries and fertility. Their findings highlight the relevance of broadening the study of the influence of uncertainty on fertility to include areas beyond the economic domain.

Environmental uncertainty and fertility

The topic of climate change has come to occupy a prominent position in both public and academic discourse, emerging as the "defining issue of our time" (Guterres, 2018) due to the global scope and unprecedented magnitude of its impacts. Media narratives concerning the impact of climate change on livelihoods, both current and projected, are increasingly pervasive, often picturing a future characterized by food insecurity, more frequent extreme weather events, rising sea levels, and increasingly recurrent heatwaves (Abnett, 2024; Dickie, 2023; Poynting & Stallard, 2021; Smith, 2024; Watts, 2023). This continuous exposure to alarming projections can significantly contribute to heightened anxiety and concerns over the sustainability of our environment and way of life, hence fostering a heightened sense of fear regarding the future of the next generation. As

such, the question of whether prospective parents are factoring climate change and its potential consequences for their children's livelihood in their fertility decision-making is becoming increasingly important.

Existing literature on the interplay between climate change and fertility dynamics has largely focused on objective measures of climate change, such as variations in precipitations (Simon, 2017) and extreme temperatures (Conte Keivabu et al., 2023; Hajdu, 2024). These studies typically examine the relationship between exposure to extreme climatic conditions and birth rates at an aggregate level, often finding that high temperatures lead to a decline in birth rates nine to ten months later. The underlying mechanisms however remain unclear, particularly whether this is driven by physiological effects or behavioral responses to heat. Building on the *narrative framework*, we argue that it is necessary to move beyond a mere focus on objective environmental variables to also consider subjective assessments and future narratives (Vignoli et al., 2020a, 2020b, 2022). A study at the micro-level would also allow for closely scrutinizing individuals' perceptions of and attitudes toward the surrounding climate and their childbearing plan. This approach addresses the gap from an ecological-aggregated level analysis where individual experiences and perspectives are not directly captured. Indeed, subjective appraisals of environmental conditions, such as concern about future climate change, may also impact fertility planning. Typical explanations for the link between concern about climate change and childbearing decisions include (1) the known ecological impact of reproduction and (2) fears for the future of potential children. Regarding the former, it has been shown that, given the impact of each person on resource consumption, having one fewer child constitutes the single highest-impact action a person can take to reduce their ecological footprint. Specifically, analyzing emissions from high-impact actions based on studies from developed countries, Wynes and Nicholas (2017) showed that having one fewer child can result in a yearly reduction in CO_2-equivalent per year per individual emissions of 23,700–117,700 kg. Indeed, a study on New Zealanders and American young adults who considered their knowledge of climate change crucial in their reproductive decision-making highlighted the environmental impact that each additional child would have on the planet as one of the key reasons for deciding against having any children (Helm et al., 2021). Similar findings were reported by Nakkerud (2023) based on interviews with 16 participants in Norway. Likewise, focusing on pro-environmental behavior, Powdthavee et al. (2024) found a negative relationship between "green" environmental concerns and fertility, with a person particularly unconcerned with engaging in pro-environmental behaviors being 50% more likely to go on to have a child six years after the measurement of environmental concern than a very committed environmentalist. Thus, part of the reason to avoid or reduce fertility because of each person's ecological footprint is also rooted in the responsibility that some people feel toward the health of the planet, and the ability to ensure a sustainable future for all its inhabitants.

As for fear for the future of potential offspring, research has shown that people consider the safety of tomorrow's planet, and how it will affect their children's well-being and health when making reproductive decisions. A fear of a "doomed" and "bleak" future (Helm et al., 2021), as well as concerns about the well-being of any potential child in a climate-changed future (Fu et al., 2023), have been shown to pervade the reasoning and reproductive decision-making process of climate-aware individuals.

Yet, despite the scholarly evidence suggesting that such anxieties and the ecological impact of childbearing influence fertility decisions, the strength and direction of this association remain unclear, as studies investigating the relationship between concern with climate change and fertility have reached widely contrasting findings (Arnocky et al., 2012; Davis et al., 2019; De Rose & Testa, 2015; Dillarstone et al., 2023; Szczuka, 2022; Zimmerman et al., 2024). Arnocky et al. (2012), in their study on Canadian students, highlighted a negative association between pollution-related health concerns and fertility intentions; similarly, Bielawska-Batorowicz et al. (2022) found that stronger concerns over the impact of climate change on health decreased the likelihood of positive reproductive intentions. On the other hand, the authors reported a null association between climate preoccupation (measured in terms of information seeking, involvement in climate action, and concerns over its socioeconomic consequences) and fertility intentions. In their systematic review on the link between climate change, mental health, and childbearing decision-making, Dillarstone et al. (2023) reported a negative association between climate change concern and attitudes toward childbearing. However, while Szczuka (2022) found a positive association between climate change-related concerns and smaller ideal family size in general in Hungary and personally in the Czech Republic, the author also reported a strong negative association in Slovakia, where those regarding climate change as the most serious threat facing the world were more likely to report an ideal family size of at least two children. Another counterintuitive finding was reported by De Rose and Testa (2015) who, analyzing the relationship in the EU-27 countries using Eurobarometer data, found a positive relationship between concerns about climate change and intended number of children. Other studies have reported heterogeneities in the findings once accounting for demographic and socioeconomic characteristics. For example, in their study on the relationship between environmental attitudes and fertility desires among 12th graders in the U.S., Rackin et al. (2023) found that individuals who agreed with the idea that the government should deal with environmental problems tended to report a lower number of desired children. Yet, this result could be explained away by political identity and religiosity. Similarly, Bastianelli (2024) found a negative association between climate change concerns and fertility intentions in Finland, Estonia, and Sweden. This association, however, was primarily driven by childless individuals, as no significant association was observed among parents. Null or negligible impacts of climate preoccupation on various fertility indicators have been further reported in other studies (Bodin & Björklund, 2022; Gordon, 2021; Peters et al., 2023).

The observed heterogeneity in prior findings regarding the climate preoccupation/fertility nexus may be attributable to the inconsistent operationalization of both the dependent and the key explanatory variable. On the one hand, the fertility outcomes investigated are starkly different, ranging from intended, realized fertility to ideal number of children, both on personal and societal levels. Similarly, environmental uncertainty has been measured in diverse ways, among which are pollution-related health concerns, measures of efforts individuals put into gathering information on climate change, steps taken to address it, opinion regarding the severity of climate change as a threat to the human population, and so forth. As such, investigating the environmental uncertainty–fertility nexus by operationalizing the former in terms of climate change

preoccupation can help elucidate whether fears toward the future of the Earth are associated with childbearing decisions.

In this study, we advance the existing literature on uncertainty and childbearing decisions by focusing on the role of environmental uncertainty and exploring its relationship with fertility intentions in Italy. In so doing, we further contribute to the scholarship on the association between climate change—particularly the perception of it—and fertility intentions. Importantly, given scholarly evidence of heterogeneous impacts of climate change concerns on fertility by parity (Bastianelli, 2024), we also examine whether these concerns influence fertility decisions differently for individuals with and without children. In addition, we control for individuals' adherence to liberal values. Indeed, it could be argued that any association between concerns about climate change and fertility intentions might be spurious, driven by the fact that, for instance, individuals who are more concerned about climate change are also more likely to hold liberal values, which have been shown to be associated with lower fertility intentions (Fieder & Huber, 2018). As such, we offer further insights on the complex interplay between climate change, the sense of uncertainty and the anxiety it elicits within individuals, and the intention to have a child or not.

Data and methods

Data

This study draws on data from the 2016 edition of the FSS survey, conducted by the Italian Institute of Statistics in 2016. This survey collected information on nearly 25,000 individuals aged 18 or older, with a response rate of 77.35%.

Our key dependent variable was fertility intentions. We focused on intentions so as to capture the broader pattern of the childbearing decision-making process, without aiming to reflect a close proxy of actual fertility behavior. Such intentions were based on the subject's response to the question on whether they intended to have a child in the future. Individuals who responded positively to any of the questions about wanting a child either in the following three years or at some point in the future were coded as wanting a child, while individuals reporting negative fertility intentions for both the following three years and the future were coded as wanting no child at any time. The fertility intentions variable was thus binary, with 1 indicating positive fertility plans and 0 otherwise.

Environmental uncertainty was our main explanatory variable. The survey assessed the subjects' perceptions about climate change by asking whether they believed climate change to be: (1) not a problem; (2) a problem; or (3) the biggest problem of the future.

Analytical strategy

Given the dichotomous nature of our dependent variable, we investigated how environmental uncertainty influences fertility intentions using a logistic regression model. We included controls for factors that could potentially confound the relationship between the two. In terms of demographic characteristics, we controlled for gender (1 = male, 2 = female) and age, modeled in its squared version in light of the reverse-U-shaped association between age and fertility intentions. We further controlled for parity, distinguishing between individuals with zero, one, two, or three (or more) children. We also controlled for relevant socioeconomic characteristics, including respondents' education

(categorized into 1 = bachelor's degree or above, 2 = high school degree, and 3 = middle school or lower), employment status (categorized into 1 = employed and 2 = not employed[2]), and parental educational background. This latter aspect was measured as a dummy concerning whether any of the respondent's parents had attained tertiary education. We further included key characteristics of the partner, such as their education and employment status (following the same coding as for the respondents).

Lastly, we also controlled for the respondents' closeness to liberal values, employing a survey instrument to do so. Individuals were presented with a series of statements reflecting attitudes on various social issues (e.g., marriage, family structure, gender roles, immigration). Respondents were then asked to report their level of agreement with each statement using a five-point Likert scale ranging from "Absolutely agree" to "Absolutely disagree". Since a higher score on the Likert scale indicates agreement with liberal values, statements that expressed more conservative values were recoded to maintain consistency. This recoding meant reversing the scoring so that all variables uniformly represent alignment with liberal values. To measure an individual's closeness to liberal values, we calculated a composite score by summing the recoded values for all. Thus, a higher total score reflects a stronger liberal orientation.

For our analysis we focused on individuals who were cohabiting or married at the time of survey. This choice was motivated by the intention to assess realistic fertility intentions. Indeed, partnered individuals exhibit a higher chance of expressing fertility preferences that predict actual future childbearing behavior (Gatta et al., 2021). The restriction to partnered individuals resulted in a sample of 13,355 subjects. Of these, we selected individuals aged 18–50, further restricting our sample to 5073 subjects. Information on environmental uncertainty was unavailable for a small group of participants ($N = 31$). Given their negligible representation within the sample (0.61%), selection bias in our analysis is unlikely to be a major concern. Similarly, no information on future fertility intentions was available for 433 of the remaining individuals (8.59% of the sample). We further excluded individuals for whom information on partners' employment status or education was unavailable ($N = 73$, i.e., 1.58% of the remaining sample), individuals for whom no information on parents' education was provided ($N = 126$, 2.78% of the remaining sample), and individuals for whom it was not possible to retrieve any information on their positioning on the conservative–liberal continuum ($N = 2$, 0.05%). This led to a final sample of 4408 individuals.

We began by estimating four models. In the first, we explored the association between concern with climate change and fertility intentions net of key demographic characteristics. In Model 2, we further included controls for the respondent's socioeconomic characteristics. In Model 3 partners' socioeconomic characteristics were included. Eventually, in Model 4, we further included the control for the person's score on the scale of liberal values. Subsequently, to examine whether the relationship between environmental uncertainty and fertility intentions differed by parenthood status and number of children, we estimated an interaction model where the climate change concerns variable was interacted with the parity variable. All models included region-fixed effects so as to account for unobserved geographical characteristics such

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[2] Respondents were classified as employed if they were seeking new or first employment. Homemakers, students, and those unable to work or in other conditions, were classified as not working.
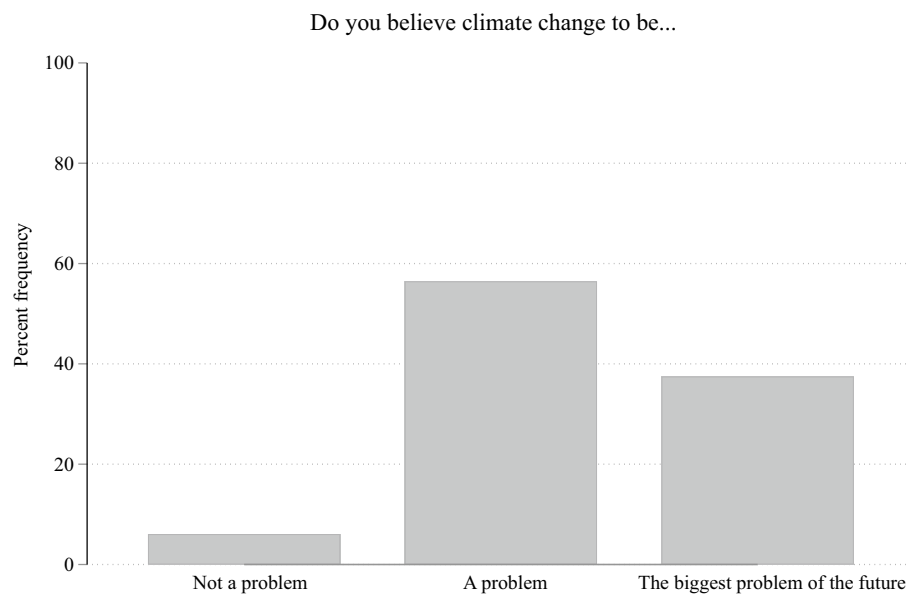
Do you believe climate change to be...

Fig. 1 Percent frequency of climate change concern. Source: Authors' elaborations on FSS data (weighted statistics)

as climate change exposure and vulnerability, cultural norms around family size, economic opportunities, and costs of living, all of which may have influenced both concerns about climate change and fertility intentions.

Results

Descriptive statistics

Figure 1 provides descriptive statistics on environmental uncertainty in our sample. The majority (56%) of the respondents perceived climate change as a problem while a little over one-third (38%) considered it to be a major problem in the future. Only 6% of respondents reported not considering climate change as a problem.

To explore whether preoccupation with climate change varies across regions, in Fig. 2 we mapped region-level percentages of individuals who believed climate change to be the biggest problem of the future. We observed substantial cross-regional heterogeneity. Valle D'Aosta was identified as the region hosting the lowest percentage of very eco-anxious individuals, with only 18% of the population believing climate change to be the most serious problem we will face in the future.[3] At the other end of the eco-anxiety spectrum, Abruzzo was the region with the highest percentage of deeply concerned individuals (46%).

Table 1 provides descriptive statistics of the analyzed sample. Roughly one-fourth of the sample declared positive fertility intentions. This figure remained stable across different levels of perception of climate change as a problem, with no notable differences by environmental uncertainty. The sample comprised 45% male

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[3] Further descriptive statistics revealed for Valle D'Aosta to also be the region with the highest percentage of eco-skeptical individuals, believing climate change not to be a problem (Results available upon request).

Table 1 Descriptive statistics: characteristics of individuals by intention to have a child in the future

	Whether the person intends to have a child in the future		Whole sample
	No	Yes	Total
N	3226 (73.2%)	1182 (26.8%)	4408 (100%)
Climate change is…			
Not a problem	191 (71.6%)	76 (28.4%)	267 (6.1%)
A problem	1843 (74.1%)	646 (25.9%)	2489 (56.5%)
The biggest problem of our future	1192 (72.1%)	461 (27.9%)	1652 (37.5%)
Sex			
Male	1384 (69.9%)	595 (30.1%)	1979 (44.9%)
Female	1842 (75.8%)	588 (24.2%)	2429 (55.1%)
Parity			
Childless	220 (35.1%)	406 (64.9%)	626 (14.2%)
One child	699 (56.3)	542 (43.7%)	1241 (28.2%)
Two children	1751 (90.2%)	191 (9.8%)	1943 (44%)
Three or more children	556 (92.9%)	43 (7.1%)	598 (13.6%)
Education			
Bachelor or above	541 (64.9%)	292 (35.1%)	833 (18.9%)
High school	1447 (73.5%)	521 (26.5%)	1967 (44.6%)
Middle school or lower	1238 (77%)	370 (23%)	1608 (36.5%)
Employment status			
Not working	997 (74.6%)	339 (25.4%)	1336 (30.3%)
Working	2228 (72.5%)	844 (27.5%)	3072 (69.8%)
Any parent has tertiary education			
No	2989 (73.8%)	1059 (26.2%)	4048 (91.8%)
Yes	237 (65.8%)	123 (34.2%)	360 (8.2%)
Partner's education			
Bachelor or above	559 (65%)	301 (35%)	861 (19.5%)
High school	1413 (72.7%)	530 (27.3%)	1943 (44.1%)
Middle school or lower	1253 (78.1%)	351 (21.9%)	1604 (36.4%)
Partner's employment status			
Not working	797 (72%)	308 (28%)	1104 (25.1%)
Working	2429 (73.5%)	875 (26.5%)	3303 (74.1%)
	Mean (S.D.)		
	Whether the person intends to have a child in the future		Whole sample
	No	Yes	Total
Age	42.2 (5.2)	35 (5.7)	40.3 (6.2)
Scale of liberal values	15.9 (3.5)	15.2 (3.7)	15.7 (3.6)

Source: Authors' elaborations on FSS data (weighted statistics)

respondents and 55% females. Among the males, approximately 30% reported their intention to have a child. This figure was slightly lower among females (roughly 25%). Around 14% of our sample reported being childless, roughly 30% had one child, and almost half (45%) had two children, with the remaining 13% reporting three or more children. Among childless individuals, approximately 65% reported positive fertility intentions. We found this figure to consistently decrease as parity increased, with only 7% of individuals with three or more children reporting the intention to have a further

child. In terms of socioeconomic characteristics, 20% of the sample held a bachelor's degree or higher education diploma, roughly 45% had a high school education and 36% had a middle school degree or lower. Among individuals with bachelor's degree or higher education diplomas, roughly 35% reported positive childbearing intentions. This percentage was found to decrease at successively lower levels of education. As for employment status, approximately two-thirds of the sample were employed. Childbearing intentions appeared to be similar across employed and non-employed individuals. Similar patterns were observed for partners' education and employment status. As for age, the mean age of individuals in the sample was approximately 40 years. Individuals who reported the intention to have a child in the future had a mean age of about 35 years, while those who reported not wanting any children in the future had a mean age of approximately 42 years.

Figure 3 presents a histogram that shows the distribution of scores on the liberal values scale, with respective percentage distribution. Approximately half of the sample has scores ranging from 14 and 20 on the scale, signaling that the sample tends to align more closely with liberal values than with conservative values.

Regression results

The results are presented in Table 2. Consistent with expectations, we observed a negative and statistically significant association between environmental uncertainty and fertility intentions in all four models, so that, *ceteris paribus*, individuals who believed climate to be a problem or the biggest problem of the future were less likely to report positive fertility intentions. Specifically, individuals believing climate change to be a problem were 0.4 times less likely to report wanting children in the future—a difference found to be statistically significant. This association was found to persist when
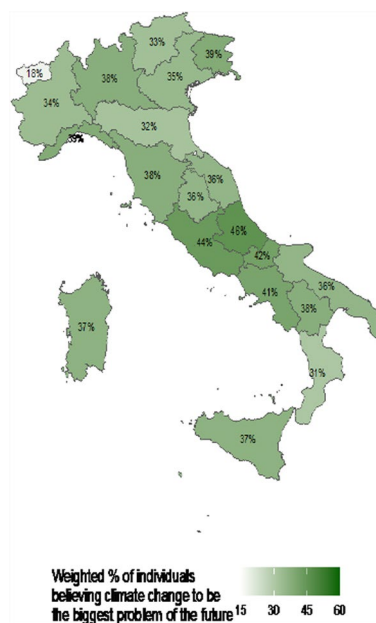

Fig. 2 Proportion (%) of the survey subjects reporting climate change to be the biggest problem of the future by region. Source: Authors' elaborations FSS data (weighted statistics)
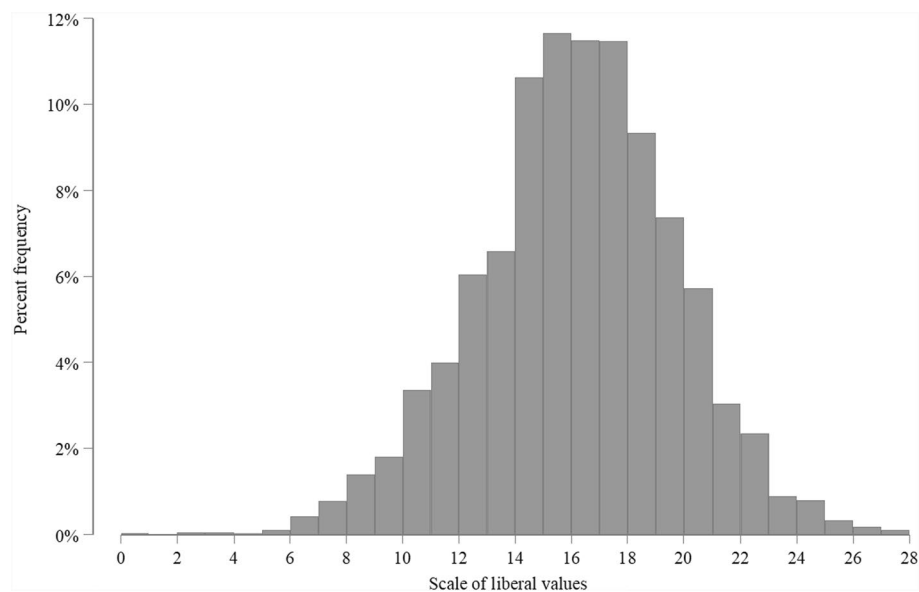
Fig. 3 Percentage distribution of the liberal values scale. Source: Authors' elaborations FSS data (weighted statistics)

considering relevant sociodemographic confounders or individuals' alignment with more liberal values. To facilitate interpretation, Fig. 4 illustrates the respective predicted probabilities of reporting the intention to have a child by levels of environmental uncertainty, estimated from the full model (Model 4). We reported the confidence intervals for pair-wise comparisons (5% significance level), which, following Knol et al. (2011), were estimated to be at 83.4%. Indeed, when looking graphically at the difference in effect estimates between two subgroups, an overlap of the 95% confidence intervals does not necessarily mean that differences are statistically insignificant. The use of the 83.4% interval in graphic representations is necessary in order to have an average level of 5% for Type I errors in pair-wise comparisons (Goldstein & Healy, 1995; Knol et al., 2011). While among individuals who believed climate change to be a problem the probability of reporting the intention to have a child in the future was 23.6%, the probability for those believing climate change to be a problem or the biggest problem of the future were 15.6% and 17%, respectively, implying respective differences of 8 and 6.6 percentage points. This result suggests that climate change concern could be regarded as a significant deterrent to having children.

Regarding the role played by the other predictors in the model, the findings revealed that, compared to men, women tended to be less likely to report positive fertility intentions, and that parents were less likely than childless individuals to report the intention to have a child in the future, with this difference becoming more pronounced as the number of children increased. As for what concerns the role of education, individuals with a high school degree displayed roughly about 25% lower odds of reporting positive fertility intentions, relative to respondents with a bachelor's or higher education degree. No statistically significant difference was observed between employed individuals and those not participating in the workforce. In terms of partners' characteristics, partners' level of education was also found to play a role

Table 2 Result of logistic regression model

	Model 1	Model 2	Model 3	Model 4
Climate change is… (Ref: Not a problem)				
A problem	0.60* (0.12)	0.58** (0.12)	0.58** (0.12)	0.60* (0.12)
The biggest problem of our future	0.63* (0.13)	0.63* (0.13)	0.64* (0.13)	0.67 (0.14)
Age	1.37** (0.13)	1.32** (0.13)	1.30** (0.13)	1.30** (0.13)
Age^2	0.99*** (0.00)	0.99*** (0.00)	0.99*** (0.00)	0.99*** (0.00)
Sex (Ref: Male)				
Female	0.47*** (0.05)	0.46*** (0.05)	0.51*** (0.06)	0.53*** (0.06)
Parity (Ref: Childless)				
One child	0.35*** (0.05)	0.36*** (0.05)	0.36*** (0.05)	0.37*** (0.05)
Two children	0.04*** (0.01)	0.04*** (0.01)	0.04*** (0.01)	0.04*** (0.01)
Three or more children	0.02*** (0.01)	0.03*** (0.01)	0.03*** (0.01)	0.02*** (0.01)
Education (Ref: Bachelor or above)				
High school		0.66** (0.08)	0.76* (0.10)	0.76* (0.10)
Middle school or lower		0.70* (0.10)	0.87 (0.14)	0.89 (0.15)
Employment status (Ref: Not working)				
Working		1.09 (0.14)	1.05 (0.13)	1.07 (0.14)
Any parent with university degree (Ref: No)				
Yes		1.12 (0.20)	1.01 (0.18)	1.01 (0.18)
Partner's education (Ref: Bachelor or above)				
High school			0.68** (0.09)	0.68** (0.09)
Middle school or lower			0.57*** (0.09)	0.58*** (0.09)
Partner's employment status (Ref: Not working)				
Working			0.83 (0.10)	0.84 (0.10)
Scale of closeness with liberal values				0.95*** (0.01)
Constant	1.55 (2.78)	4.15 (7.55)	7.07 (12.95)	13.64 (25.17)
Observations	4408	4408	4408	4408

Exponentiated coefficients. S.E. in parentheses. *p < 0.05, **p < 0.01, ***p < 0.001

Source: Authors' elaborations on FSS data

in fertility intentions, with respondents whose partner had high or middle school diplomas displaying, respectively, 0.32 and 0.42 lower odds of reporting positive fertility intentions than individuals whose partners held a bachelor's degree or higher. On the other hand, partners' employment status did not appear to be significantly associated with fertility intentions. Interestingly, we noted a statistically significant relationship between individuals' closeness to liberal values and the intention to have children, so that the odds of reporting the intention to have a child in the future decreased by a factor of **0.05** with each unit increase in closeness to liberal values.

Considering previous findings of parity-related heterogeneities in the impact of climate change concerns on fertility intentions (Bastianelli, 2024), we also estimated a regression model where environmental uncertainty was interacted with parity. This model incorporated all covariates included in Model 4, ensuring that the results accounted for the full set of demographic, socioeconomic, and attitudinal factors, as well as region-fixed effects (see Table 3). The interaction between climate change concern and parity suggests that the association between environmental uncertainty and fertility intentions does not significantly vary across different parities.
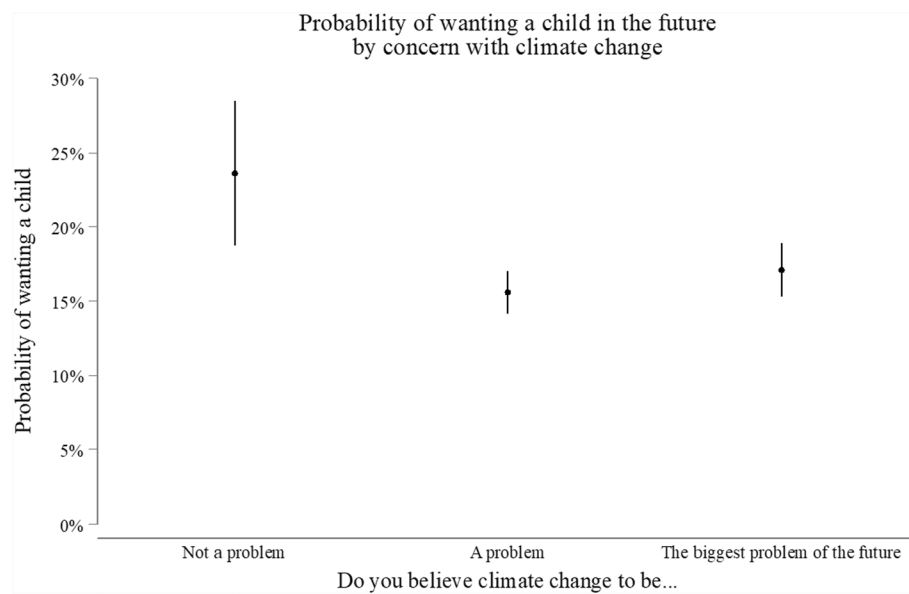
Fig. 4 Probability of reporting positive fertility intentions by environmental uncertainty. Source: Authors' elaborations on FSS data. Confidence intervals for pair-wise comparisons (5% significance level)

We further explored the existence of differences in the association by scores on the liberal scale. Yet, also in these instances, the liberal scale does not moderate the environmental uncertainty/fertility intentions nexus.

Robustness checks and additional analyses

To assess the robustness of our findings, we conducted several sensitivity analyses. First, to understand whether our results may have been driven by selection mechanisms, we estimated a logistic regression model to explore the characteristics of individuals who reported climate change not to be a problem, so as to determine whether they represented a distinct sociodemographic group. We found that individuals with three or more children were more likely to report climate change as not being a problem compared to childless individuals (Table 4).

In light of this, a further sensitivity analysis involved restricting the analysis to individuals with fewer than three children to ascertain whether the observed negative association between environmental uncertainty and fertility could have been driven by higher-parity individuals. In addition, we chose to further focus on individuals up to age 40. In fact, only approximately 10% of individuals aged 40–49 report positive fertility intentions, underscoring the limited relevance of childbearing decisions in this age group. As such, we restricted the analysis to younger individuals to minimize potential bias and explore the relationship for individuals for whom childbearing was most relevant. This led to a sample of 1716 individuals, with the results reported in Table 5. Our findings appeared to be robust, as even within this subsample, the association between environmental uncertainty and fertility intentions remained negative and statistically significant, signaling that (1) the observed positive relationship between parity and eco-skepticism does not confound the key

Table 3 Result of interaction model: climate preoccupation x parity

	Interaction model: climate preoccupation x parity
Climate change is… (Ref: Not a problem)	
A problem	0.84 (0.45)
The biggest problem of our future	1.13 (0.62)
Parity (Ref: Childless)	
One child	0.40 (0.25)
Two children	0.08*** (0.05)
Three or more children	0.05*** (0.03)
Age	1.30** (0.13)
Age²	0.99*** (0.00)
Sex (Ref: Male)	
Female	0.53*** (0.06)
Interaction climate preoccupation x parity	
A problem x One child	0.98 (0.62)
A problem x Two children	0.52 (0.33)
A problem x Three children or more	0.58 (0.42)
The biggest problem of the future x One child	0.82 (0.53)
The biggest problem of the future x Two children	0.40 (0.26)
The biggest problem of the future x Three children or more	0.33 (0.26)
Education (Ref: Bachelor or above)	
High school	0.76* (0.10)
Middle school or lower	0.89 (0.15)
Employment status (Ref: Not working)	
Working	1.07 (0.14)
Any parent with university degree (Ref: No)	
Yes	1.01 (0.18)
Partner's education (Ref: Bachelor or above)	
High school	0.68** (0.09)
Middle school or lower	0.58*** (0.09)
Partner's employment status (Ref: Not working)	
Working	0.84 (0.10)
Scale of closeness with liberal values	0.95*** (0.01)
Constant	9.71 (18.33)
Observations	4408

Exponentiated coefficients. S.E. in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Source: Authors' elaborations on FSS data

relationship under investigation and (2) preoccupation with climate change persists as a significant factor influencing childbearing intentions.

Considering that our dependent variable combines individuals who do not want children either in the following three years or at any point in the future, we conducted a further robustness check focused on assessing whether the observed association may have been driven by one of the two groups. To do so, we estimated the full model (Model 4) separately for the variable on fertility intentions in the following three years and that for fertility intentions in the future. The results revealed that, while the association between climate preoccupation and fertility intentions was negative for both timeframes

Table 4 Results of logistic regression model: O.Rs. of believing climate change not to be a problem

	Model 5
Whether the person wants a child in the future (Ref: No)	
Yes	1.41 (0.27)
Parity (Ref: Childless)	
One child	1.02 (0.23)
Two children	1.15 (0.27)
Three or more children	2.32** (0.60)
Age	0.99 (0.01)
Sex (Ref: Male)	
Female	0.67* (0.11)
Education (Ref: Bachelor or above)	
High school	1.27 (0.28)
Middle school or lower	1.68* (0.41)
Working status (Ref: Not working)	
Working	0.83 (0.14)
Partner's education (Ref: Bachelor or above)	
High school	0.80 (0.16)
Middle school or lower	0.92 (0.21)
Partner's working status (Ref: Not working)	
Working	0.92 (0.15)
Any parent with university degree (Ref: No)	
Yes	0.98 (0.28)
Constant	0.06*** (0.04)
Observations	4408

y: Climate preoccupation (0: The individual believes climate change to be a problem or the biggest problem of the future, 1: The individual does not believe climate change to be a problem.); exponentiated coefficients. S.E. in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Authors' elaborations on FSS data

considered, it was only significant for fertility intentions in the following three years, and involving exclusively those who perceive climate change to be a problem ($b = 0.63*$, S.E. $= 0.13$), but not those perceiving it as the greatest problem of the future ($b = 0.72$, S.E. $= 0.15$). Regarding fertility intentions in the future, it should be noted that, out of the 4408 individuals in the sample, the question on whether they intended to have a child at any point in the future was exclusively asked to those who reported not wanting a child in the following three years (3376 people). Of these, only 3.58% reported wanting a child in the future. This low proportion suggests that the lack of statistical precision for this estimate may be due to sample size limitations, reducing the power of the analysis. In all, these findings suggest that the association is unlikely to be driven solely by one group, though larger or more balanced samples would be needed to confirm this definitively.

A further robustness check involved the examination of the association between climate change concerns and the ideal number of children. Unlike fertility intentions, however, this association did not reach statistical significance. One possible explanation for this null result is that "ideal" conditions tend not to incorporate the role played by factors that may negatively affect childbearing, such as negative economic circumstances, time availability, and so forth (Philipov & Bernardi, 2012). As a result, the link between preoccupation with climate change and ideal family size may be weaker

Table 5 Result of logistic regression model on individuals aged 18–40, with up to two children

	Model 1	Model 2	Model 3	Model 4
Climate change is… (Ref: Not a problem)				
A problem	0.49* (0.15)	0.45* (0.14)	0.44* (0.14)	0.45* (0.14)
The biggest problem of our future	0.52* (0.17)	0.49* (0.16)	0.49* (0.16)	0.51* (0.17)
Age	1.57* (0.34)	1.43 (0.32)	1.44 (0.32)	1.41 (0.32)
Age^2	0.99** (0.00)	0.99* (0.00)	0.99* (0.00)	0.99* (0.00)
Sex (Ref: Male)				
Female	0.58*** (0.08)	0.54*** (0.08)	0.57*** (0.09)	0.59** (0.10)
Parity (Ref: Childless)				
One child	0.45*** (0.09)	0.47*** (0.09)	0.49*** (0.10)	0.51*** (0.10)
Two children	0.04*** (0.01)	0.04*** (0.01)	0.04*** (0.01)	0.04*** (0.01)
Education (Ref: Bachelor or above)				
High school		0.60** (0.10)	0.67* (0.12)	0.67* (0.12)
Middle school or lower		0.55** (0.11)	0.68 (0.15)	0.68 (0.15)
Employment status (Ref: Not working)				
Working		1.07 (0.18)	1.05 (0.18)	1.07 (0.18)
Any parent with university degree (Ref: No)				
Yes		1.30 (0.30)	1.19 (0.28)	1.20 (0.28)
Partner's education (Ref: Bachelor or above)				
High school			0.76 (0.14)	0.77 (0.14)
Middle school or lower			0.63* (0.14)	0.65 (0.14)
Partner's employment status (Ref: Not working)				
Working			1.01 (0.18)	1.04 (0.18)
Scale of closeness with liberal values				0.94*** (0.02)
Constant	0.15 (0.54)	1.21 (4.52)	1.33 (4.97)	4.00 (15.15)
Observations	1716	1716	1716	1716

Exponentiated coefficients. S.E. in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Source: Authors' elaborations on FSS data

and less directly observable. In addition, ideal number of children here is measured via responses to the question "What do you think is the ideal number of children for a family?". As such, replies to this question should probably be interpreted as being more reflective of the individual's opinion toward societal norms surrounding fertility (Karhunen et al., 2023), rather than personal plan toward childbearing. In any event, we believe that the association between climate concern and the ideal number of children should deserve attention in future research.

As an additional robustness check, we addressed the outlier status of Valle D'Aosta, where only 18% of individuals identified climate change as the most pressing future issue—a stark contrast to the other regions, where this percentage ranged between 31% and 46%. To evaluate whether this distinctiveness influenced our results, respondents from Valle D'Aosta were randomly reassigned to one of the other 20 regions. This approach allowed us to determine whether our results were biased by the region's distinct climate concerns patterns and its small sample size. Our results (presented in Appendix, Table 6) remain robust, indicating that the inclusion of Valle D'Aosta as a distinct region did not bias our findings.

Lastly, we tested whether the association between climate change concerns and fertility intentions was robust to different specifications of the climate concern variable.

Specifically, we repeated the analysis by (a) employing "Climate change is a problem" as a reference; (b) including in the same category individuals who believed climate change to be a problem or the biggest problem of the future, and then comparing them to those who did not believe climate change to be a problem. The results were always consistent, with climate concern being negatively associated with the intention to have children.

Discussion and conclusion

The societal challenges ahead extend beyond economic unpredictability and shifts in the labor market, encompassing a broader spectrum of uncertainties gradually permeating the social fabric of contemporary nations (Matysiak & Vignoli, 2024). This shift is not confined to economic spheres, but extends to the environmental dimension. With this article we sought to examine how environmental uncertainty —here proxied by climate change concern—shapes fertility intentions in Italy. In so doing, we complement both the literature on the relationship between uncertainty and fertility and that between climate change and fertility intentions. Our results provide initial indications that environmental uncertainty may be linked to lower fertility intentions. Individuals who perceive climate change as a major issue or the biggest problem of the future tend to be less likely to report an intention to have a child. These findings remained stable net of sociodemographic characteristics and individuals' positioning on the conservative–liberal spectrum.

Nonetheless, the statistical significance and magnitude of the association changes when different measures of fertility plans were considered. For instance, climate concerns are significantly associated with short-term fertility intentions (*i.e.*, in the next 3 years), but not with long-term fertility intentions (i.e., in the general future). As such, more research, based on larger sample sizes, is needed to ascertain whether the lack of a statistically significant association between climate concern and fertility in the general future is due to the small proportion of respondents that declares environmental concerns not to be a problem or whether, rather, the influence of preoccupation towards climate change is confined to short-term fertility intentions. Additionally, our findings show no significant link between climate change concerns and fertility ideals. Fertility ideals reflect societal norms about family size rather than personal childbearing intentions. Therefore, this lack of association underscores the need to distinguish between normative ideals and fertility intentions when studying the impact of environmental uncertainty on fertility.

Our study overall aligns with previous research highlighting that individuals who are more concerned about climate change are less inclined to report the intention to have a child (Arnocky et al., 2012; Bielawska-Batorowicz et al., 2022; Dillarstone et al., 2023; Lockwood et al., 2022), lending additional support to the notion that individuals are increasingly factoring the state of the environment in their reproductive plans. Mechanisms behind this relationship could include ethical concerns about the carbon footprint of each additional person and worries over the quality of life of the future generation. These factors collectively contribute to a reevaluation of reproductive decisions in the context of environmental sustainability. Furthermore, our analysis of parity-related heterogeneities in the relationship between concern about climate change and reproductive

intentions indicates that the observed negative association is not influenced by individuals' parity status, at least in Italy. This result stands in contrast to previous research finding a significant association between climate change concerns and childbearing intentions exclusively among childless individuals (Bastianelli, 2024). Again, our finding of a lack of a statistically significant association could have been driven by the fact that only 249 individuals (5.65% of the analyzed sample) reported climate change not to be a problem, an aspect reducing the statistical power of the interaction analysis and thus hindering the ability to detect significant effects. To be sure, the wording of the question on "climate change concerns" in the Italian survey used inherently biases responses, leading to a lower proportion of respondents selecting "not a problem," partly due to social desirability bias. We hope that future data collection programs in Italy will refine the wording of this question and that a new, internationally harmonized battery of questions on climate change concerns will be systematically implemented in demographic surveys.

This study is not without limitations. Among these, the cross-sectional nature of the data we employed prevents us from making any causal claim. Therefore, our results should be interpreted as associational in nature. In addition, the analysis was clearly affected by measurement errors, due to the operationalization of the variable on preoccupation toward climate change via a single item characterized by peculiar modalities. It should further be noted that we cannot exclude the possibility that the observed relationship between climate-related concerns and fertility intentions may have been influenced by unobserved individuals' general personal traits, such as higher levels of risk attitudes (Gatta et al., 2021). Consequently, those more preoccupied with climate change may have reported lower fertility intentions not solely due to climate anxiety, but as a reflection of their overall cautious outlook. However, Gatta et al. (2021) showed that the inclusion of risk attitudes among the control variables in an analysis exploring the influence of employment uncertainty on fertility intentions does not alter the significance and strength of the association between the two. In addition, in our analysis we attempted to mitigate the potential confounding role of personal traits by using a scale measuring attitudes toward liberal values, thus capturing broader personality traits and value systems. Since liberal values are often associated with openness to change and optimism (Furnham & Fenton-O'Creevy, 2018; Jost et al., 2003), incorporating this scale helped control for underlying pessimistic or risk-averse tendencies, allowing us to more accurately identify the role played by climate-related concerns. Despite this, we cannot exclude that our measure of climate preoccupation captures other realms of future narratives or other types of concern.

Besides these limitations, this study has some important strengths. First, it contributes to the literature by providing a comprehensive examination of the role of climate change perceptions on fertility intentions, complementing existing research that primarily focuses on the relationship between direct exposure to extreme climatic events and childbearing (Conte Keivabu et al., 2023; Hajdu, 2024; Simon, 2017). By explicitly considering individuals' perceptions of climate change and its implications for their reproductive decisions, the study adds to the existing literature on how subjective beliefs shape fertility intentions. This enhances our understanding of the interplay between environmental concerns and fertility behaviors, contributing to a more holistic approach

in demographic research. In addition, the study contributes to scholarship on the uncertainty/fertility nexus by focusing on a novel type of uncertainty (namely its environmental variety), thereby allowing us to move beyond the conventional focus on economic preoccupations. Lastly, while exploratory in nature, it represents a first attempt to examine the relationship between preoccupation with climate change and fertility intentions in Italy—a context characterized by lowest-low fertility levels. The results corroborate the central role of uncertainties and pessimism in shaping fertility in Italy.

Appendix
See Table 6.

Table 6 Results of sensitivity analysis, logistic regression model (reassignment of Valle D'Aosta respondents)

	Model 1	Model 2	Model 3	Model 4
Climate change is… (Ref: Not a problem)				
A problem	0.60* (0.12)	0.58** (0.12)	0.59** (0.12)	0.60* (0.12)
The biggest problem of our future	0.64* (0.13)	0.64* (0.13)	0.65* (0.13)	0.67 (0.14)
Age	1.37** (0.13)	1.32** (0.13)	1.30** (0.13)	1.30** (0.13)
Age^2	0.99*** (0.00)	0.99*** (0.00)	0.99*** (0.00)	0.99*** (0.00)
Sex (Ref: Male)				
Female	0.47*** (0.05)	0.46*** (0.05)	0.51*** (0.06)	0.53*** (0.06)
Parity (Ref: Childless)				
One child	0.35*** (0.05)	0.35*** (0.05)	0.36*** (0.05)	0.37*** (0.05)
Two children	0.04*** (0.01)	0.04*** (0.01)	0.04*** (0.01)	0.04*** (0.01)
Three or more children	0.02*** (0.01)	0.03*** (0.01)	0.03*** (0.01)	0.02*** (0.01)
Education (Ref: Bachelor or above)				
High school		0.67** (0.09)	0.76* (0.10)	0.77 (0.10)
Middle school or lower		0.71* (0.10)	0.88 (0.14)	0.89 (0.15)
Employment status (Ref: Not working)				
Working		1.09 (0.14)	1.05 (0.13)	1.07 (0.14)
Any parent with university degree (Ref: No)				
Yes		1.13 (0.20)	1.02 (0.18)	1.02 (0.18)
Partner's education (Ref: Bachelor or above)				
High school			0.68** (0.09)	0.68** (0.09)
Middle school or lower			0.57*** (0.09)	0.58*** (0.09)
Partner's employment status (Ref: Not working)				
Working			0.83 (0.10)	0.84 (0.10)
Scale of closeness with liberal values				0.95*** (0.01)
Constant	1.55 (2.77)	4.06 (7.38)	6.97 (12.74)	13.05 (24.00)
Observations	4408	4408	4408	4408

Exponentiated coefficients. S.E. in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Source: Authors' elaborations on FSS data

Declarations

Competing interests
The authors have no competing interests to declare.

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