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Offline social capital, online social capital, and fertility intentions: evidence from China

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China has experienced both ultra-low fertility and moderate aging in recent years, both of which pose serious challenges to the country's development. Previous studies have shown that social capital is one of the most important factors that influences fertility intentions, but so far empirical research on the relationship between social capital and fertility intentions is very limited. Therefore, this study aims to explore the impact of social capital on fertility intentions and its underlying mechanisms by combining offline and online social capital. Based on data from the Chinese General Social Survey, the fertility intentions of 7,518 respondents aged 18–60 years were analyzed and broken down by sex, region, and age. The marginal effects and mechanisms of offline and online capital on fertility intentions were explored using an ordered probit (oprobit) model, which revealed that individuals' fertility intentions are positively influenced by offline social capital but negatively influenced by online social capital. The role of social capital in shaping individuals' fertility intentions also varies by gender, region, and age. Women, eastern region groups, and those aged 30–60 years are more influenced by offline social capital, and their intentions become stronger as offline social capital accumulates. However, online social capital negatively affects the fertility intentions of women, Midwesterners, and 18–29 year olds. Furthermore, online and offline social capital mainly influence individuals' fertility intentions by affecting their perceptions of pensions, filial piety, and "social justice". Our findings suggest that increasing the value that individuals place on social capital is crucial for improving fertility intentions in China.

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Introduction

Over the past few decades, fertility policies in many countries have begun to shift from attempting to control to encouraging births (Lan, 2014), but the world's total fertility rate (TFR) has continued to decline. According to the World Bank, the world TFR has declined from 5.1 children per woman in 1964 to 2.4 in 2019 and is expected to fall to 1.9 in 2100 (The World Bank, 2021). 183 of 195 countries are predicted to have a TFR below the replacement level of 2.1 children per woman by the end of the century (Vollset et al. 2020). China is the most populous country in the world, with about one-fifth of the global population (United Nations, 2022), yet China's fertility level has been below replacement level for more than 20 consecutive years, and the country has entered into a stage of ultra-low fertility (Wang et al. 2020). According to the National Bureau of Statistics of China, the birth rates from 2016 to 2020 were 13.57‰, 12.64‰, 10.86‰, 10.41‰ and 8.52‰ consecutively, continuing clear downward trend (Fig. 1) (National Bureau of Statistics, 2020).

There is a close relationship between Chinese fertility intentions and China's territory and culture. China has a vast territory and a three-tiered administrative system of provinces (municipalities directly under the central government and autonomous regions), counties (autonomous counties and cities) and townships, with a total of 34 administrative units at the provincial level (including 23 provinces, 4 municipalities directly under the central government, and 5 autonomous regions, as well as the Hong Kong and Macao Special Administrative Regions). First, the vastness and diversity of the territory historically provided the Chinese people with a rich living environment and resources, which to a certain extent influenced people's concepts of procreation. China's agrarian society caused people to be more dependent on land and labor, and as a result higher fertility rates were often seen as a way to secure family continuity and social stability. However, with modernization, especially urbanization,

people's lifestyles and values have changed dramatically, and this has also affected fertility intentions to some extent.

Second, Chinese culture has a profound influence on fertility intentions. In traditional Chinese culture, the concepts of family and clan play important roles, and having a large number of children and grandchildren is regarded as a symbol of family prosperity. To a certain extent, this concept encourages people to have more children. However, with social changes and cultural diversification, modern young people's views on family and childbearing are changing. They are more focused on personal development and quality of life and as a result have relatively low fertility intentions. Therefore, a comprehensive understanding of Chinese fertility intentions requires a comprehensive consideration of the impact of both territory and culture.

The policy orientations of the Chinese government have also had an impact on fertility intentions. For example, the government's family planning policy in the past limited the number of children people could have, which changed people's conception of childbearing to a certain extent. In recent years, however, the Chinese government has begun to encourage childbearing in an effort to cope with the problems of population aging and declining birth rates. A separate two-child policy was implemented at the end of 2013, a full two-child policy in early 2016 (Zeng and Hesketh, 2016), and a three-child policy in mid-2021 (Tatum, 2021). In addition, the government has also continued to improve the maternity service system, has gradually implemented a system of maternity and childcare allowances, and has promoted development of childcare services and education. Although this series of policies has provided support measures aimed at reducing childbirth and childcare costs and creating a social environment conducive to childbirth, the overall effect of fertility policy adjustments has been less than expected. Data from the Seventh National Census show that China's TFR in 2020 was only 1.3 (National Bureau of Statistics, 2020). Furthermore, a

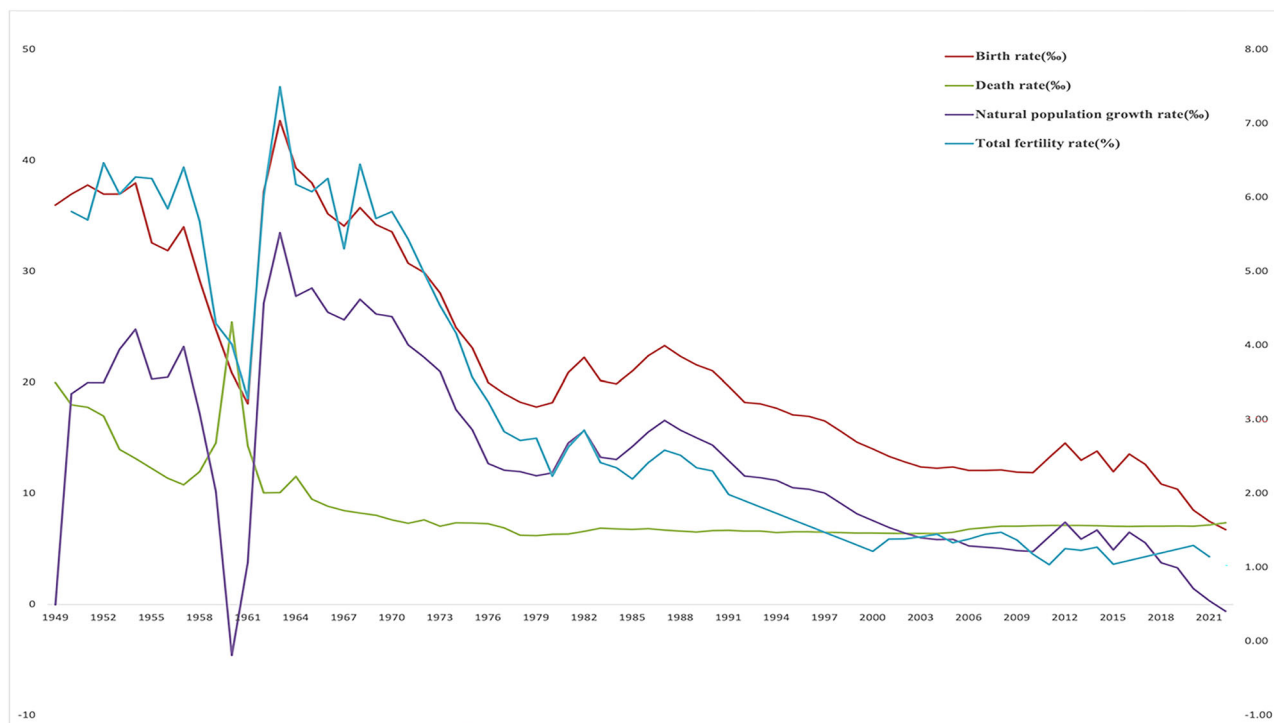


Fig. 1 China's population from 1949 to 2022. China's birth rate, natural population growth rate, and total fertility rate gradually declined. The source of data is the China Statistical Yearbook published by the National Bureau of Statistics of China.

recent study showed that the fertility intention of the Chinese people to have a second child was about 60% and only 13% for a third child (Jing et al. 2022) and that COVID-19 reduced fertility intentions among women of childbearing age, which may have complicated recent efforts to increase low fertility rates (Chen et al. 2022a). Low fertility is now considered a major cause of the declining working-age population and of population aging in China, and is one of the most problematic current socioeconomic issues (Liu et al. 2020). An exploration of fertility intentions is therefore indispensable.

The term fertility intention refers to an individual's subjective attitudes toward fertility behavior, including desired number of children, desired spacing between pregnancies, and expected family size. It captures an individual's or family's desire to have children formed by assessing various information and conditions and is considered a major predictor of fertility behavior (Domermuth et al. 2015; Li, 2021). According to data from the China Statistical Yearbook (National Bureau of Statistics, 2020) and previous fertility studies (Jing et al. 2022; Zeng and Hesketh, 2016), fertility policies have a very strong impact on China's demographic trends. Therefore, unlike previous studies, this study aims to explore fertility intentions without considering policy intervention.

Research on fertility intentions has become a central focus of discussion on low fertility in recent years (Hashemzadeh et al. 2021; Luo and Mao, 2014), and fertility intentions have been found to be related to micro and macro factors such as individual characteristics, family factors, socioeconomic status, and the socio-cultural environment (Preis et al. 2020). A large number of studies have also interpreted fertility intentions from many aspects such as housing (Atalay et al. 2021), religious beliefs (Buber-Ennsner and Berghammer, 2021), socioeconomic factors (Liu and Gong, 2020), fertility policies (Zhang et al. 2022), and employment (Gatta et al. 2022). Some theoretical perspectives have also been provided to explain the reasons for low fertility intentions, such as the second demographic transition theory (Zaidi and Morgan, 2017) and the gender revolution theory (Raybould and Sear, 2021). However, few studies have focused on the impact of social capital on fertility intentions.

Social capital has been shown to be a predictor of academic achievement, physical and mental health, children's intellectual development, sources of employment, and economic development (Coleman, 1988; Ellison et al. 2007). In recent years, social capital has also played an important role in explaining various phenomena in public health (Gilbert et al. 2022; Rotenberg et al. 2020), but research into social capital's influence on fertility is lacking. Nonetheless, a few empirical studies have shown that social capital, as an important informal guarantee mechanism, has a significant impact on individuals' perceptions and values and is one of the most important factors that influence fertility intentions (Balbo and Mills, 2011; Buhler and Fraczak, 2007).

The concept of social capital refers to characteristics of social organizations such as trust, norms, and networks that enhance social efficiency by facilitating coordination and action and act as social resources nested in social networks (Bourdieu, 1986; Putnam, 1995). Social capital is a multidimensional and complex concept, but can be broadly categorized into cognitive social capital and structural social capital, where cognitive social capital includes social trust and social reciprocity, which refers to the degree of trust in the "outside" world. Structural social capital, which includes social participation and social networks, refers to the degree of collection of resources and communication with the objective outside world (Uphoff, 2000). Williams (2006) classified social capital into offline and online social capital based on social interactions on the Internet. An individual's offline social capital is usually measured through both social trust and social networks

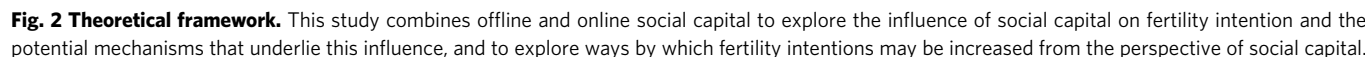
(Bühler and Philipov, 2005; Song and Jiang, 2022). According to social capital theory, many researchers consider the use of social networking sites (SNSs), which are web-based services that allow users to create personal profiles and view or create content that can be shared with other users through connections on the site (Boyd and Ellison, 2007), and their impact on social networks as a measure of online social capital (Johnston et al. 2013; Nguyen et al. 2022). Offline and online social capital together influence human and social development (Silva et al. 2020; Song and Jiang, 2022), and we therefore argue that there is an urgent need to combine online and offline social capital to explore the impact of social capital on fertility intentions.

Most previous empirical studies on social capital and fertility intentions were conducted in Eastern European countries facing demographic crises in the early 20th century, and they focused on the impact of social networks (mainly a single dimension of offline social capital) on fertility intentions and lacked analyses of the mechanisms involved. Therefore, this study combines offline and online social capital to explore their influence on fertility intentions, as well as the potential mechanisms of this influence, in the hopes of providing empirical evidence in support of methods to increase fertility intentions by means of changing social capital.

Theoretical framework, literature review, and research hypotheses

The concept of "social capital" was first applied in the field of political science in 1916 when Hanifan (Hanifan, 1916) used the term to describe "the most important intangible substance in people's daily lives", referring to the elements of goodwill, companionship, sympathy, and social interaction that exist among individuals and families. Coleman (Coleman, 1988) believed from a social function perspective that social capital facilitated the actions of individuals within a social structure. Putnam (Putnam, 1993) later argued from a macro perspective that social capital refers to certain characteristics of social organizations that can enhance social efficiency by facilitating cooperation, such as trust, norms, and networks. Following this, Nan Lin (Lin, 2002) argued that social capital consists of the resources embedded in social networks that actors acquire and use. Taking all of these notions together, we define social capital as any capability, resource, or norm embedded in actors' social network relationships that can influence the actors' actions. An individual's offline social capital is usually measured through both social trust and social networks (Bühler and Philipov, 2005; Song and Jiang, 2022). Many researchers consider the use of SNSs and their impact on social networks as a measure of online social capital (Johnston et al. 2013; Nguyen et al. 2022) (Fig. 2).

Previous research has shown that offline social capital promotes individuals' willingness to have children. Groups with high levels of social trust are more likely to rely on social services and security institutions to support fertility, childcare, and education, and to help women balance work and childbearing (Gross et al. 2004). A panel of data from 24 OECD countries suggests that trust underpins the ideal environment for childcare in developed countries, and that fertility can be increased by strengthening social trust (Yamamura and Antonio, 2011). Aassve et al. (2016) found that because women's increased education leads to an increased need to combine work and family life, pervasive social trust facilitates work-family balance through the outsourcing of child-rearing activities, thereby increasing fertility. Social networks are also an important influence on fertility intentions, as people expand their new values and become familiar with new perspectives on fertility through the communication channels of social networks, and these new perspectives influence their



sampling method to collect data systematically and comprehensively at multiple levels of society, community, family, and individual, to summarize trends in social change, to explore topics of great scientific and practical significance, to promote the openness and sharing of scientific research in China, to provide data and information for international comparative research, and to act as a multidisciplinary platform for economic and social data collection. The datasets generated and/or analyzed during the current study are available in at <http://cgss.ruc.edu.cn/> and in the Supplementary Information document.

The data from the CGSS 2017 which included questions related to individual social capital and fertility intentions. Considering the more and more common postponement of the age of childbearing, the development of artificially assisted reproductive technology (ART) and surgical methods to preserve fertility (Kasaven et al. 2022), and the increasing number of old-husband and young-wife combinations in China (Chen, 2019), we limited the age of the sample to between 18 and 60 years old. After removing missing values and outliers, a final sample of 7,518 individuals was obtained.

Variable selection

Dependent variable. The dependent variable of this study is an individual's policy-free fertility intention, expressed by the number of children he wants to have. The data come from responses to the question, "How many children do you want to have if there are no policy restrictions?" in the CGSS2017 questionnaire. The responses of "0", "1", "2" and "3 or more" were assigned as "0", "1", "2" and "3" respectively.

Independent variables. The core independent variable is social capital. Based on the original questionnaire and referring to the existing literature (Song and Jiang, 2022), we measure individual social capital in two aspects: offline social capital and online social capital.

Offline social capital: According to a previous study (Xu and Wang, 2021), social trust (referred to as "trust" in the table) and social network (abbreviated to as "network" in the table) were both used as a measure of offline social capital. Social trust represents cognitive social capital and social networks represent structural social capital, so this is a relatively complete measure of offline social capital. For social trust, the specific question referenced was, "In general, do you agree that most people in this society can be trusted?". Responses came in the form of any one of five choices of "strongly disagree", "relatively disagree", "I cannot say whether I agree or disagree", "relatively agree", and "strongly agree". Since the response of "I cannot say whether I agree or disagree" does not reflect a tendency to trust, we assigned it a value of 0 along with those who answered "strongly disagree" and "relatively disagree" and a value of 1 for "relatively agree" and "strongly agree". The specific question referenced for social network information was, "In the past year, did you often socialize/visit people in your free time?" The answer to this question measures the overall social interaction of the individual, and we assigned a value of 0 to "never" and "rarely"; the other choices of "sometimes", "often", and "always" were assigned a value of 1.

Online social capital: We measured online social capital (referred to as "online" in the table) using the frequency of Internet access (Chen et al. 2022a), including the frequency of using cell phones and computers to access the Internet. In response to the question, "In the past year, how often did you use the Internet?", we assigned 0 to the answers "never" and "rarely" and 1 to the remaining answers of "sometimes", "often", and "always".

Control variables. In order to reduce possible bias due to missing variables and possible bias in the statistical model due to omitted variables, the following four categories of variables were controlled in the empirical analysis: personal characteristic variables including gender, age, education, hukou, marital status, health, and working hours (abbreviated as "work" in the table and used as its logarithmic value in the regression); social insurance features including whether to participate in medical insurance and whether to participate in pension insurance; household characteristic variables include the presence or absence of children (referred to as "children" in the table), the proportion of sons (referred to as "son ratio" in the table), and annual family income (abbreviated as "family income" in the table and used as its logarithmic value in the regression as logarithm in the regression); and regional characteristics, where the regions were West China, Central China, East China, and Northeast China. West China was used as the benchmark regression group in the regression analysis. The main variable descriptions and their descriptive statistics are shown in Table 1. The mean value of fertility intention of the sample was 1.85, which is lower than the replacement level of 2.1.

Empirical Model. The effects of social capital on individual fertility intentions can be determined as follows:

$$\text{Fertility}_i = \beta_0 + \beta_1 \text{offline} + \beta_2 \text{online} + \beta_3 \text{CV}_i + \varepsilon_i$$

Where, Fertility_i denotes the fertility intention of individual i , offline denotes offline social capital, online denotes online social capital, CV_i are control variables, and ε_i is a random error term. Since the dependent variable fertility intention is an ordered categorical variable, an ordered probit (oprobit) model regression was used for parameter estimation.

Results

Basic results. The results of the baseline regression of fertility intention and social capital are shown in Table 2. Model 1 reveals that social trust is significantly and positively related to fertility intention at the 1% level with a regression coefficient of 0.075. Model 2 examine the relationship between social networks and fertility intentions, and reveals that social networks positively influence fertility intentions, with a coefficient of 0.057. Model 3 attempts to capture the relationship between social trust and social networks (i.e., offline social capital) and fertility intentions and is a direct test of Hypothesis 1. These results indicate that fertility intentions are positively influenced by offline social capital. Model 4 is also a direct test of Hypothesis 2 and shows that the frequency of Internet access (i.e., online social capital) is negatively related to fertility intentions, with a regression coefficient of -0.079 . Finally, Model 5 examines the effects of both offline and online social capital on fertility intentions, and the results still indicate that fertility intentions are positively influenced by offline social capital but negatively influenced by online social capital.

Marginal effects. Since the regression results of the oprobit model give only limited information in terms of statistical significance and sign, the marginal effect of social capital on fertility intention needs to be examined as well. The marginal effect is the change in the probability of the dependent variable fertility intention taking values of 0, 1, 2, or 3, when all variables but the one of interest remain unchanged at their mean values and the variable of interest changes by one unit (the results are shown in Table 3). Table 3 presents the marginal effects for Model 3, Model 4, and Model 5 in the baseline regression,

Table 1 Descriptive statistics.

Variables	Mean	S.D.	Min	Max	Description
Fertility intention	1.851	0.617	0	3	No children = 0, one child = 1, two children = 2, three or more children = 3
Trust	0.621	0.485	0	1	Strongly disagree, relatively disagree, neutral = 0, relatively agree, strongly agree = 1
Network	0.576	0.494	0	1	Never, rarely = 0, sometimes, often, always = 1
Online	0.683	0.465	0	1	Never, rarely, = 0, sometimes, often, always = 1
Gender	0.468	0.499	0	1	Male = 1, female = 0
Age	42.273	11.465	18	60	Age of respondents in 2017
Education	1.854	1.1	1	4	Junior high school and below = 1, senior high school = 2, junior college = 3, university degree or above = 4
Hukou	0.555	0.497	0	1	Urban = 0, rural = 1
Marital status	0.817	0.387	0	1	Unmarried, separated without divorce, divorced, and widowed = 0, cohabitation, married with a spouse = 1
Health	3.69	1.035	1	5	Very unhealthy = 1, relatively unhealthy = 2, general = 3, relatively healthy = 4, very healthy = 5
Work	32.212	28.079	0	100	Continuous variable
Medical insurance	0.933	0.25	0	1	No = 0, yes = 1
Pension insurance	0.699	0.459	0	1	No = 0, yes = 1
Children	0.838	0.369	0	1	No = 0, yes = 1
Son ratio	0.465	0.43	0	1	Continuous variable
Family income	86025.654	108548.809	0	700000	Continuous variable
Middle	0.222	0.416	0	1	Dummy variable
East	0.405	0.491	0	1	Dummy variable
Northeast	0.129	0.336	0	1	Dummy variable

Table 2 Ordered probit estimation of the effects of offline and online social capital on fertility intentions.

Variables	(1)	(2)	(3)	(4)	(5)
Trust	0.075*** (0.028)		0.074*** (0.028)		0.073*** (0.028)
Network		0.057** (0.027)	0.055** (0.027)		0.059** (0.027)
Online				-0.079** (0.036)	-0.082** (0.036)
Gender	0.022 (0.028)	0.024 (0.028)	0.023 (0.028)	0.024 (0.028)	0.025 (0.028)
Age	0.009*** (0.002)	0.009*** (0.002)	0.009*** (0.002)	0.007*** (0.002)	0.007*** (0.002)
Education	0.014 (0.017)	0.016 (0.017)	0.013 (0.017)	0.021 (0.017)	0.018 (0.017)
Hukou	0.313*** (0.033)	0.314*** (0.033)	0.311*** (0.033)	0.302*** (0.033)	0.298*** (0.033)
Marital status	0.169*** (0.049)	0.168*** (0.049)	0.167*** (0.049)	0.175*** (0.049)	0.171*** (0.049)
Health	0.011 (0.015)	0.012 (0.015)	0.010 (0.015)	0.016 (0.015)	0.012 (0.015)
Work	0.002 (0.008)	0.002 (0.008)	0.002 (0.008)	0.002 (0.008)	0.003 (0.008)
Medical insurance	0.137** (0.057)	0.135** (0.057)	0.133** (0.057)	0.141** (0.057)	0.135** (0.057)
Pension insurance	-0.051 (0.034)	-0.049 (0.034)	-0.052 (0.034)	-0.048 (0.034)	-0.052 (0.034)
Children	0.189*** (0.065)	0.187*** (0.064)	0.189*** (0.065)	0.194*** (0.065)	0.197*** (0.065)
Son ratio	-0.203*** (0.035)	-0.202*** (0.035)	-0.203*** (0.035)	-0.203*** (0.035)	-0.204*** (0.035)
Family income	0.007 (0.009)	0.006 (0.009)	0.007 (0.009)	0.009 (0.009)	0.008 (0.009)
Middle	0.010 (0.038)	0.008 (0.038)	0.008 (0.038)	0.012 (0.038)	0.010 (0.038)
East	-0.264*** (0.037)	-0.267*** (0.037)	-0.264*** (0.037)	-0.261*** (0.037)	-0.258*** (0.037)
Northeast	-0.456*** (0.047)	-0.456*** (0.047)	-0.455*** (0.047)	-0.454*** (0.047)	-0.451*** (0.047)
Pseudo-R ²	0.0375	0.0373	0.0378	0.0374	0.0382
Observations	7518	7518	7518	7518	7518

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, where the p-value is the probability that the estimated coefficient falls outside the standard error. Robust standard error in parentheses.

where Model 3 estimates the effect of offline social capital, Model 4 the effects of online social capital, and Model 5 the joint effects of online and offline social capital. The results for Model 5 show that for each unit increase in social trust, the probability that an individual's fertility intention is 0 or 1 decreases by 0.004 and 0.018, respectively and that the probabilities of individual fertility intention of 2 or 3 or above increase by 0.009 and 0.013, respectively. Thus, the probability of having more than one child increases as the level of social trust increases. Analogous explanations can be made for the other variables of interest. These results again show that fertility intentions are positively correlated with offline social capital and negatively correlated with online social capital, which agrees with Hypotheses 1 and 2.

Endogeneity testing. Given that social capital and individual fertility intentions may interact and that there may be variables that affect both social capital and fertility intentions, which can lead to measurement error, there may be endogeneity problems caused by omitted variables or mutual causality. To test for whether this is the case, we elected to implement instrumental variables into the regressions to compare the results. Valid instrumental variables must be independent of random confounding factors as well as highly correlated with endogenous variables. For offline social capital, we chose the variables of “self-rated social class (hereinafter referred to as “social level 1”)” and “self-rated socioeconomic status (hereinafter referred to as “social level 2”)” as instruments for social trust and social network, respectively. The logarithm of “first online age” (hereinafter

(1)	(2)	(3)	(4)	Model (4)			Model (5)			(11)	(12)
				(5)	(6)	(7)	(8)	(9)	(10)		
Model (3)	Y = 1	Y = 2	Y = 3	Y = 0	Y = 1	Y = 2	Y = 3	Y = 0	Y = 1	Y = 2	Y = 3
Variables											
Trust	-0.004*** (0.001)	-0.018*** (0.007)	0.013*** (0.005)					-0.004** (0.001)	-0.018*** (0.007)	0.009** (0.003)	0.013*** (0.005)
Network	-0.003*** (0.001)	-0.013** (0.007)	0.010** (0.005)					-0.003** (0.001)	-0.014** (0.007)	0.007** (0.003)	0.010*** (0.005)
Online								0.004** (0.002)	0.020** (0.009)	-0.010** (0.004)	-0.014** (0.006)
Sender	-0.001 (0.001)	-0.006 (0.007)	0.003 (0.003)	0.004** (0.005)	0.019** (0.009)	-0.009** (0.004)	-0.014** (0.006)	-0.001 (0.001)	-0.006 (0.007)	0.003 (0.003)	0.004 (0.005)
Age	-0.000*** (0.000)	-0.002*** (0.000)	0.001*** (0.000)	0.002*** (0.000)	-0.002*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	-0.000*** (0.000)	-0.002*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
Education	-0.001 (0.001)	-0.002*** (0.000)	0.002 (0.002)	0.004*** (0.006)	-0.001 (0.001)	0.003 (0.003)	0.004 (0.003)	-0.001 (0.001)	-0.004 (0.004)	0.002 (0.002)	0.003 (0.003)
Gender	-0.015*** (0.002)	-0.076*** (0.008)	0.035*** (0.006)	-0.015*** (0.002)	-0.005 (0.004)	0.035*** (0.004)	0.053*** (0.006)	-0.014*** (0.002)	-0.073*** (0.008)	0.035*** (0.004)	0.052*** (0.006)
Ukuku	-0.008*** (0.002)	-0.041*** (0.012)	0.019*** (0.006)	-0.008*** (0.002)	-0.074*** (0.008)	0.020*** (0.012)	0.031*** (0.009)	-0.008*** (0.002)	-0.042*** (0.012)	0.020*** (0.006)	0.030*** (0.009)
Marriage	-0.001 (0.001)	-0.002 (0.004)	0.002 (0.003)	-0.001 (0.001)	-0.004 (0.004)	0.003 (0.003)	0.003 (0.003)	-0.001 (0.001)	-0.003 (0.004)	0.001 (0.002)	0.002 (0.003)
Health	-0.000 (0.000)	-0.000 (0.002)	0.000 (0.001)	-0.000 (0.000)	-0.001 (0.002)	0.000 (0.002)	0.000 (0.001)	-0.000 (0.000)	-0.001 (0.002)	0.000 (0.001)	0.000 (0.001)
Log(work)	-0.000 (0.000)	-0.000 (0.002)	0.000 (0.001)	-0.000 (0.000)	-0.001 (0.002)	0.000 (0.002)	0.000 (0.001)	-0.000 (0.000)	-0.001 (0.002)	0.000 (0.001)	0.000 (0.001)
Log(work)	-0.006*** (0.003)	-0.032*** (0.014)	0.016** (0.007)	0.023** (0.010)	-0.034** (0.003)	0.017** (0.007)	0.025** (0.010)	-0.007** (0.003)	-0.033** (0.014)	0.016** (0.007)	0.024** (0.010)
Insurance											
Pension	0.003 (0.002)	0.013 (0.008)	-0.006 (0.004)	-0.009 (0.006)	0.012 (0.002)	-0.006 (0.008)	-0.008 (0.006)	0.002 (0.002)	0.013 (0.008)	-0.006 (0.004)	-0.009 (0.006)
Insurance											
Children	-0.009*** (0.003)	-0.046*** (0.016)	0.022*** (0.008)	0.033*** (0.011)	-0.047*** (0.016)	0.023*** (0.008)	0.034*** (0.011)	-0.010*** (0.003)	-0.048*** (0.016)	0.023*** (0.008)	0.035*** (0.011)
Ratio	-0.010*** (0.002)	-0.049*** (0.009)	-0.024*** (0.004)	-0.035*** (0.006)	0.050*** (0.002)	-0.024*** (0.009)	-0.036*** (0.006)	0.010*** (0.002)	0.050*** (0.002)	-0.024*** (0.009)	-0.036*** (0.006)
Log (family income)	-0.000 (0.000)	-0.002 (0.002)	0.001 (0.001)	0.001 (0.002)	-0.002 (0.002)	0.001 (0.001)	0.002 (0.002)	-0.000 (0.000)	-0.002 (0.002)	0.001 (0.001)	0.001 (0.002)
Middle	-0.000 (0.001)	-0.002 (0.009)	0.000 (0.002)	0.002 (0.008)	-0.003 (0.009)	0.001 (0.002)	0.003 (0.008)	-0.000 (0.001)	-0.002 (0.009)	0.000 (0.002)	0.002 (0.008)
East	0.011*** (0.002)	0.065*** (0.009)	-0.028*** (0.004)	-0.048*** (0.007)	0.064*** (0.002)	-0.028*** (0.009)	-0.047*** (0.007)	0.011*** (0.002)	0.063*** (0.002)	-0.028*** (0.009)	-0.046*** (0.007)
Northeast	0.024*** (0.003)	0.116*** (0.012)	-0.066*** (0.009)	-0.073*** (0.007)	0.115*** (0.012)	-0.067*** (0.009)	-0.073*** (0.007)	0.024*** (0.003)	0.115*** (0.012)	-0.066*** (0.009)	-0.072*** (0.007)

referred to as “first online age”) was used as an instrument for the frequency of Internet access. Since the dependent variable in this paper is an ordered categorical variable, the model with the instruments was re-estimated using the conditional mixed process approach (CMP) (Roodman, 2011), with the probit model used in the first stage, and the oprobit model used in the second stage.

The endogeneity test parameter atanhrho_{12} is significantly different from 0 at the 1% level, implying that trust, network, and online are endogenous variables, and the estimation results obtained by the CMP method the most accurate, further confirming that offline social capital represented by social trust and social networks significantly and positively affects fertility intentions and that online social capital represented by Internet frequency significantly and negatively affects fertility intentions, in agreement with Hypotheses 1 and 2.

Heterogeneity analysis. We now turn to subgroup analysis in an effort to discern if there was any heterogeneity among the fertility intentions of different types of individuals. First, there were significant differences between men and women (columns (1) and (2) of Table 6). These regression results show that social capital primarily affects women, with more offline social capital accumulation leading to stronger fertility intentions but that online social capital negatively affects their fertility intentions.

Second, we looked at regional heterogeneity. Since the level of economic development, clan identity, fertility culture, and other local cultural factors have a certain impact on social capital and fertility intentions, we divided the sample into two groups, Eastern and Midwestern and regressed separately. The results in columns (3) and (4) of Table 6 indicate that offline social capital positively affects fertility intentions in the Eastern group but does so negatively in the Midwestern group.

Third, we examined age heterogeneity. Decades of research has shown that women's fertility varies at different ages; it starts to decline in a woman's 30 s, and most women face infertility in their early-to-mid 40 s (Opinion, 2014; Pfeifer et al. 2017). We therefore divided the overall sample into three age groups according to these different levels of female fertility. Columns (5) to (7) of Table 6 show that the group aged 30–60 is more influenced by offline capital, and as their level of social trust increases, their fertility intentions increase. Online social capital

Table 4 Endogeneity test results.						
	(1)	(2)	(3)	(4)	(5)	(6)
	IV method					
Variables	M (3)	M (3)	M (4)	M (5)	M (5)	M (5)
Trust	0.506** (0.221)	0.061** (0.025)		0.507** (0.221)	0.061** (0.025)	0.070*** (0.027)
Network	0.051* (0.027)	0.870*** (0.129)		0.054** (0.027)	0.879*** (0.129)	0.055** (0.027)
Online			−0.398*** (0.087)	−0.080** (0.035)	−0.077** (0.033)	−0.392*** (0.088)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Atanhrho_12	−0.276* (0.148)	−0.571*** (0.109)	0.229*** (0.059)	−0.278* (0.148)	−0.574*** (0.108)	0.222*** (0.059)
N	7518	7518	7518	7518	7518	7518
	First stage					
	Dep: Trust		Dep: Network		Dep: Online	
Social level 1	0.069*** (0.023)		0.092*** (0.021)			
Social level 2	0.036 (0.023)		0.070*** (0.021)			
First online age					−1.291*** (0.190)	
Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, where the p-value is the probability that the estimated coefficient falls outside the standard error. Robust standard error in parentheses.						

Table 5 Robustness test results.						
	(1)	(2)	(3)	(4)	(5)	(6)
	Change method			Change dependent variable		
Variables						
Trust	0.137*** (0.051)		0.135*** (0.051)	0.021** (0.009)		0.021** (0.009)
Network	0.103** (0.049)		0.110** (0.050)	0.018** (0.008)		0.019** (0.008)
Online		−0.144** (0.066)	−0.150** (0.066)		−0.021* (0.011)	−0.022* (0.011)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo- R ² / R ²	0.039	0.038	0.039	0.065	0.064	0.066
Observations	7518	7518	7518	7518	7518	7518
Note: ***p < 0.01, **p < 0.05, *p < 0.1, where the p-value is the probability that the estimated coefficient falls outside the standard error. Robust standard error in parentheses.						

mostly affects the group aged 18–29, and as their online frequency increases, their fertility intentions decrease.

Mechanism analysis. Mechanism 1: the changing concept of pensions. Respondents’ recognition of the idea that “the pension of the elderly with children is mainly borne by their children” in the CGSS2017 questionnaire was used to measure the traditional concept of relying on children for pensions. Here, the higher the recognition, the more an individual prefers this traditional concept of a pension. Taking the response to the above questionnaire statement 1 for “yes” and 0 for “no” as the dependent variable, the results in columns (1) to (3) of Table 7 show that offline social capital promotes individuals’ identification with the traditional concept of pension but that online social capital weakens the concept, and these estimates are statistically significant at the 1% level. Offline social capital promotes the concept of relying on children for pensions, which makes individuals more inclined to choose to have children. However, online social capital decreases the concept of relying on children for a pension, and as the frequency of Internet access increases willingness to have children decreases.

Mechanism 2: the changing concept of filial piety. The seven filial piety options in the questionnaire were factor analyzed to obtain filial piety scores as a dependent variable, where the more the concept of filial piety was recognized, the higher an individual’s score. The results are shown in columns (4) to (6) of Table 7, where we can see that offline social capital promotes individuals’ recognition of the traditional filial piety concept but that once again online social capital weakens it, and these estimates are also statistically significant at the 1% level. The traditional Chinese concept of filial piety holds that “passing on the family line” is the greatest filial piety, adherence to the which

necessarily increases an individuals’ fertility intentions to have children. By contrast online social capital weakens this traditional concept of filial piety, thus reducing fertility intentions.

Mechanism 3, the changing perception of social justice. Considering that social capital may influence an individual’s recognition of social justice, we used people’s evaluation of social justice (1–5, the higher the value, the fairer the perception) as the dependent variable and estimated similar regressions to the above. The results are shown in columns (7) to (9) of Table 7, where we see that offline social capital promotes people’s evaluation of social justice but that online social capital once again does the opposite.

Discussion

Here we report on the effects and mechanisms of online and offline social capital on fertility intentions, based on data from CGSS2017. The empirical results show that the mean value of all fertility intentions in our sample was 1.85, which is lower than the replacement level of 2.1. We found that individuals’ fertility intentions are positively influenced by offline social capital but negatively influenced by online social capital. The role of social capital in shaping individuals’ fertility intentions also varies by gender, region, and age. Women, Eastern groups, and those 30–60 years old are more influenced by offline social capital, and their intentions become stronger as offline social capital accumulates. Contrarily, online social capital negatively affects the fertility intentions of women, Midwesterners, and 18–29 year olds. Furthermore, our mechanism analysis revealed that online and offline social capital mainly influence fertility intentions by affecting their perceptions of pensions, filial piety, and social justice.

District differences

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, where the p-value is the probability that the estimated coefficient falls outside the standard error. Robust standard error in parentheses.

(4) (5) (6) (7) (8)

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, where the p-value is the probability that the estimated coefficient falls outside the standard error. Robust standard error in parentheses.

Low fertility has become a serious social problem in China, but research on the correlation between social capital and fertility intentions in the Chinese context is relatively scarce. Our results show that as offline social capital accumulates, an individual's intention to have multiple children increases. For each additional unit of social trust, the probability that an individual wants to have 2, or 3 or more children, increases by 0.009 and 0.013, respectively, and for each additional unit of social network, this probability increases by 0.007 and 0.010, respectively. This finding is similar to that of Xu et al. (Xu and Wang, 2021), who suggest that more universal social trust and wider social interaction can enhance fertility intentions of women of childbearing age. As an informal guarantee mechanism for childbirth, offline capital can play an effective complementary role to traditional fertility policies and guarantee mechanisms, not only helping childbearing age groups to bear the costs of childbirth but also sharing the risks that childbirth brings to the employment and family stability. In contrast, as an individual's online social capital increases, the probability of an individual's willingness to have 2 or 3 or more children decreases by 0.010 and 0.014, respectively. This is consistent with previous studies that show that the Internet reduces individuals' intentions to have children (Qiu et al. 2022; Liu et al. 2021). The collision of various new concepts and ideas available on the Internet can implicitly influence the fertility concepts and attitudes of Internet users. As a result, it may be possible to take advantage of offline social capital to promote fertility intentions by utilizing the information exchange and communication roles of online social capital to guide people toward higher fertility intentions.

Gender differences in fertility intentions suggest that women are more influenced by social capital, with offline social capital significantly enhancing their fertility intentions and online social capital negatively affecting it. This may be due to the fact that the more pervasive social trust and wider social interactions in offline life favorably enhance women's social support and thus reduce their parenting stress (Rossier and Bernardi, 2009). However, the Internet not only spreads fertility anxiety but also exposes women to a variety of new ideas and concepts that increase their self-awareness and thus weaken traditional Chinese fertility concepts such as "more children, more happiness" and "passing on the family line". This leads to a decrease in their fertility intentions (Liu et al. 2021). Furthermore, the traditional Chinese gender concept of "men dominate the outside, and women dominate the inside" confines women to household chores and child rearing, and fathers' involvement in the child rearing process is almost nonexistent (also known as "widowhood parenting" in China) (Xu, 2020). This can make women's lack of social support in child rearing and the stress of child rearing very high, thus reducing their willingness to have children (Xu, 2020).

The popularity of the Internet has brought about changes in women's values and promoted women's self-awakening, causing them to pay more attention to their own development and needs and to consider childbearing based on their own happiness and inner feelings, thus reducing their individual fertility intentions (Chen et al. 2022a). In the process of building a childbirth-friendly environment in this context necessitates balancing the division of family roles between men and women and encouraging men to take on more family responsibilities. Moreover, safeguarding the career development opportunities and rights of women of childbearing age, so that women can better balance work and family, is also important in this regard. We also recommend that the Chinese government provide high-quality information services on childbirth in an effort to alleviate women's anxiety about it.

Our study of regional differences showed that offline social capital has a significant positive effect on the fertility intentions of

the Eastern region group but has a significant negative effect on the fertility intention of the Midwestern group. In the Eastern region, the economy is more developed, the pace of life is fast, and there is less time to communicate with family and friends in real life, so the accumulation of offline social capital is weaker and has led to later marriage and later childbearing becoming more prominent (Nie et al. 2020). In contrast, the sparsely populated Central and Western regions (Midwestern group), with large mixed and small clustered settlement patterns that make social ties between people that much closer, leading to higher social trust and more frequent interactions with each other, people's agreement with the traditional concepts of "passing on the family name", "raising children for old age", and a "preference for boys", and other fertility concepts are deeply rooted in terms of offline social capital (Du et al. 2019). Furthermore, Internet development in these regions is slow, and online social capital is weaker compared to the East. Even so, researchers have found that willingness to have children gradually decreases as the frequency of Internet access increases even in the West and Central parts of China (Li et al. 2021; Zhang et al. 2023). Therefore, we recommend much the same approach to encouraging people in Western and Central regions to have children as we do for the Eastern regions concomitant with increased Internet usage as these parts of the country continue to develop.

In addition, our study of age differences shows that 30–60 year olds are more influenced by offline (mainly social trust) than online capital, and as social trust increases, fertility intention increase. Online social capital mainly affects those 18–29 years old: as their online frequency increases, their fertility intention decreases. 30–60 year olds are predominantly already married, and their social relationships are more stable. Social support from relatives and friends is higher as well, as is their level of social trust. Xu et al. (Xu and Wang, 2021) also showed that high social trust promotes fertility intentions. The fertility of women varies by age, with 18–29 being the optimal age for women to have children, but many young people are afraid of marriage and childbirth due to the increasing negative publicity about marriage and childbirth in the current mass media (Lei, 2022). Women's fertility begins to decline in their 30s, thus timely efforts to change young unmarried people's fertility attitudes may have an important impact on future fertility levels.

With regard to other factors that affect fertility intentions, as in previous studies fertility intentions are higher among those who are rural-domiciled and married (Yu and Liang, 2022). However, individuals with children have higher fertility intentions relative to those without children and that individuals with a higher proportion of sons have lower fertility intentions. Possible reasons for this are the existence of a preference for boys in Chinese fertility attitudes (Zeng and Hesketh, 2016) and the strong desire to have a boy even after having a girl, which decreases as more boys are born. With regard to family income, some studies have shown that the higher the family income, the higher the fertility intentions (Xiang et al. 2023), though others have shown a negative correlation between family income and fertility intentions (Dribe et al. 2014). Unlike these previous studies, however, family income had no effect on fertility intentions in this study. This may be due to the fact that people are trying to strike a balance between economic prosperity and quality of life and are therefore more cautious about childbearing. According to Leibenstein's theory of "the cost-effectiveness of children", with the development of the "social economy" and increases in family income, people pay more and more attention to improving their social status, which causes the number of children they have to decrease (Min, 2016). Low-income families in relatively economically developed areas generally choose to have one child because of the high cost of having children, but those in less-

developed areas have a higher number of children due to their more traditional views of childbearing and the fact that economic improvement greatly depends on a large labor force.

Our results also show that online and offline social capital affect individuals' fertility intentions mainly through their perceptions of pensions, filial piety, and social justice. Chinese culture has a long history, and traditional concepts filial piety, such as "bring up sons to support parents in their old age", "more children, more happiness", and "there are three kinds of unfiliality, and the absence of offspring is the most unfilial", have been passed down from generation to generation. These concepts have a profound and lasting impact on people in offline interactions (Wang and Peng, 2015). However, with the development of the Internet, people can now exchange new ideas and concepts online, and these traditional concepts have begun to be abandoned. The dissemination of avant-garde information on the Internet, such as "DINKs", contraception, and abortion, has changed the traditional concepts of fertility and filial piety of Chinese Internet users causing them to focus more on their own development and needs and to consider fertility more based on their own happiness and inner feelings compared to traditional concepts, thus reducing their willingness to have children (Qiu et al. 2022). Social progress and technological development have brought the Internet to millions of households, which has led to a greater diversity of media usage. However, because of the broad reach of Internet media, the content disseminated by the Internet media has a certain inherent lag, and people often rate the information they encounter as "good and bad" and "hard to distinguish the true from the false". The more online media is used, the lower the sense of social justice is (Bai, 2022). In offline life, everyone is in contact with people from the same economic level as themselves, but online interactions cross such divides as economic class, exacerbating some people's sense of unfairness, and the lower the perception of the fairness of their society, the lower these individuals' willingness to have children (Lu et al. 2018). With this in mind, we recommend that the Chinese government formulate relevant policies to encourage all sectors of society to develop diversified elderly care models and encourage social capital to enter the elderly care service industry. In addition, elderly care services can benefit from a "smart" elderly care service platform based on Internet+ and other technologies in order to transform from a single-family elderly care model to a diversified elderly care model. Furthermore, from the perspective of policy design, we also recommend the government to focus on distributional, procedural, and interactive equity and to provide precise public policies to improve the overall perception of equity among the child-bearing population, which may impact their decisions to have children.

The innovation of this study is that it assessed the influential factors and mechanisms of offline and online social capital on fertility intentions under the guidance of social capital theory, and improves the theoretical framework of fertility decision-making by incorporating social capital factors explicitly. Moreover, we offer several recommendations for enhancing the fertility intentions of Chinese people (women in particular) of childbearing age. However, the study is not without limitations. First, an individual's offline social capital though can obviously be influenced by restrictive family planning policies and may not return to previous levels immediately after the gradual relaxation or elimination of these policies. However, due to the absence of relevant questions or entries in the CGSS database used, we were unable to obtain information on fertility intentions and online and offline social capital in the context of restrictive family planning policy interventions specifically. Therefore, future studies should take full account of the inertial effects of fertility and the historical impact of restrictive family planning policies in

China. If more comprehensive data become available, we suggest that future studies should compare the effects of different years and policies on fertility intentions. Additionally, future research should also consider the issue of fertility within the framework of global population sustainability issues. As the global population continues to grow, many people are faced with challenges such as resource shortages and environmental pressures. Therefore, focus should be placed not only on how to increase fertility but also on how to achieve sustainable population development.

Second, due to the limitations of the survey data used, our measurements of offline and online social capital are not comprehensive. Only two entries, social trust and social networks, were used for offline social capital, and only frequency of Internet access was used for online social capital. In future research it may be necessary to use a variety of methods and indicators in order to measure social capital more accurately, and to synthesize information from multiple dimensions in order to capture the notion of social capital more accurately. A combination of qualitative and quantitative research, as well as interdisciplinary perspectives and methods can be used to explore the concept social capital further. Third, this study is cross-sectional, so further longitudinal evidence is needed to make causal inferences about social capital and fertility intentions. However, the CGSS is a national survey, so its sample is representative, and the resulting conclusions should thus be relatively reliable. There is thus a need to collect larger-scale data that covers the entire population through longitudinal observations or quasi-experimental methods.

Conclusion

Our findings help to elucidate the relationship between offline and online social capital and individuals' fertility intentions. Fertility intentions are positively influenced by offline social capital but negatively influenced by online social capital. Online and offline social capital mainly influence individuals' fertility intentions by affecting their perceptions of pensions, filial piety, and social justice. Social capital, as one of the most important factors that influences fertility intentions, we recommend that Chinese government explicitly consider it in policy formulation. Specifically, we recommend that the government strengthen cultural leadership, work to create a favorable social atmosphere of universal trust, encourage social interaction, increase online information regulation, provide resources to help individuals establish positive views of fertility, and make an effort to improve the perception of equity among the Chinese reproductive-age population.

Data availability

The datasets generated and/or analyzed in the current study are available at <http://cgss.ruc.edu.cn/> and in the Supplementary Information document. The training, validation, and testing datasets are available from any of the corresponding authors upon reasonable request.

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Author contributions

Enjing Li, Yajing Dong, and Xiaoli Chen determined the research approach and managed the research process. Jing Zhao, Zhijie Zou, and Jianfei Chen assisted in defining research ideas, executing research plans, analyzing data, and writing the manuscript. Yujia Chen, Wanfa Lin, and Xianbo Pei helped analyze data and contributed to writing the manuscript. Jing Zhao and Zhijie Zou revised the manuscript. Xiaoli Chen approved the final version of the manuscript.

Ethical approval

Ethical approval was not required for this study as all data used came from existing publicly available sources. Personal information was kept confidential and medical data were not utilized.

Informed consent

Informed consent from the participants was not required for this study as all data used came from existing publicly available sources. Personal information was kept confidential, and medical data were not utilized.

Competing interests

The authors declare no competing interests.

Additional information

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