Internet Use and Fertility Intention in China

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Abstract

China's fertility rate has been on a downward trend since the adoption of the one-child policy in 1979. Internet use is among the promising technological changes that may solve low fertility issue by income effect and improving work-life balance which promotes fertility intention. However, Internet use may also reduce fertility intention by cultivating modern value of fertility and substitution effect. Therefore, whether Internet use improve or hinder fertility intentions must be empirically tested. As no studies have examined impact of Internet use on fertility intention addressing unobserved heterogeneity, this study uses panel data and instrumental variables method to fill the gap in the literature. Using two-wave panel data from the 2014 and 2018 China Family Panel Studies, this study investigates the impact of Internet use on fertility intention. This study finds that Internet use improves fertility intention. Moreover, while the frequency of Internet use does not improve fertility intention, attitude toward the Internet does. Furthermore, there are significant differences by age, marital status, gender, hukou, and educational background. Finally, Internet use affects fertility intention through higher household income.

Keywords: Internet use; Fertility intention; China; Panel data
JEL Classification Codes: C23; J13

1. Introduction

China's fertility rate has been on a downward trend since the adoption of the one-child policy in 1979. For nearly two decades, China's fertility has been below the level that

allows the population to replace itself in the long run[1] (Zheng, Cai, Wang, & Gu, 2009). Total fertility rate (TFR) has decreased from 6.385 in 1965 to 2.309 in 1990, and further to 1.665 in 2015. According to the latest data from the Seventh National Census, TFR reached 1.3 in 2020, already at a low level. China has already fallen into the low fertility trap (Yan et al., 2021). Low fertility rate is considered to be a major contributor to the decline in the working-age population and population aging (Liu, Xing, & Zhang, 2020). Despite the gradual relaxation of the birth control policy in recent years[2], the expected increase in the fertility rate has not yet been observed (Chen, 2016; Mu, 2017; Song, 2016; Zhong, 2016). After the issue of the "universal two-child" policy, the fertility rate increased by 12.95‰ and 12.43‰ in 2016 and 2017, respectively. However, the follow-up impetus of the policy was insufficient and played a limited role in boosting fertility behavior. The birth rates in 2018 and 2019 decreased by 1.17‰ and 1.63‰, compared with the 2011–2015 period.

China's low fertility issue could be due to low fertility intention. The soaring education costs, uncertainty about the future, and inadequate child-rearing environments could hinder the desire to give birth. As a preliminary step to increasing the number of births and birth rate, it is necessary to create a society in which people actively want to have and raise children. Moreover, fertility intention has long been regarded as a predictor of fertility behavior (Schoen et al., 1999; Jiang et al., 2016). Unlike fertility behavior, fertility intention is observable for not only women of reproductive age but also men, middle or advanced age class, and singles. Fertility behavior may be affected by fertility intention of surrounding people and society. Therefore, it is essential for China to investigate the factors that promote or inhibit fertility intention as China has joined the group of below-replacement-fertility countries in the world.

Internet use is among the promising technological changes that may solve this low fertility issue improving work-life balance and increasing household income (income effect). However, Internet use may also reduce fertility intention cultivating more modern

[1] Under modern low-mortality conditions, which typify China, replacement-level fertility is conventionally defined as a total fertility rate (TFR) of 2.1 births per woman.
[2] The Chinese government passed the "selective two-child" policy and the "universal two-child" policy, respectively, in 2013 and 2015.

value of fertility and increasing opportunity costs of having children (substitution effect). Therefore, in this study, the impact of Internet use on fertility intention is to be empirically tested. This study finds that Internet use has a significantly positive impact on fertility intention. This study contributes to the existing literature in four ways. First, using two-wave longitudinal data, this study addresses heterogeneity and other endogeneity problems together in the context of China for the first time. Second, this study compares the effects of Internet use by gender, age groups, marital status, urban and rural household registers (hukou), and educational background heterogeneous groups. Third, while macro approach to the effects of Internet use on fertility intention appears in the literature, micro and a combination of both, as in this study, are few[3]. Fourth, this study investigates the effects of Internet use on fertility intention through the mediation effect model and four mediators (household income, working hours, values regarding education attainment, getting married, and housework hours) to improve understanding of the mechanism of the examined relationship.

2. Literature review

Although there are several studies regarding influential factors of fertility intention, these studies mainly focus on particular population such as urban residents (e.g., Liu & Gong, 2020), women (e.g., Zheng et al., 2016; Liu et al., 2020), women attending outpatient gynecology clinics (e.g., Lau et al., 2018), and within one province (e.g., Liu & Lummaa, 2019; Wei et al., 2018; Zheng et al., 2009). Moreover, studies that focus on fertility intention among Chinese women in the general population at the national level are still limited (e.g., Liu et al., 2020; Yan et al., 2021). Although Liu et al. (2020) and Wang et al. (2021) investigate the influential factors of fertility intention using nationally representative survey project cross-sectional data, to the best of our knowledge, there are no studies on the influential factors of fertility intention in China using panel data to address unobserved heterogeneity. Therefore, this study uses nationally representative micro panel data.

[3] A macro approach examines Internet use as a whole and a micro approach focuses on specific online activities (Nie et al., 2017).

Although policy, institutional, cultural, socioeconomic, and demographic variables are all important factors that influence fertility outcome (Zheng et al., 2009), many scholars have focused on the effects of income and social security on fertility intentions (Liu & Gong, 2020) and those of general socioeconomic factors such as household income, hukou, and education attainment. Moreover, while there are some studies on the impact of Internet use on fertility decisions in developed countries (e.g., Billari et al., 2019), with some exceptions, related studies in the Chinese context are few. Using German panel data, Billari et al. (2019) find positive effects of broadband Internet on the fertility of highly educated women aged 25–45. Using Chinese cross-sectional data, Li et al. (2021) examine the relations between Internet use and fertility behavior from the perspective of digital economy and find that Internet use has a significant negative impact on fertility behavior as opportunity costs of having children (substitution effect) are more significant than positive effects by increasing labor income (income effect). A more specific description follows. They find that Internet use increases labor income, suggesting income effect; Internet use decreases working hours, suggesting that Internet use helps workers to be more productive and gives them more time to choose their “work-family” allocation. Although Internet use has no significant effect on the availability of work, workers who use the Internet frequently are more likely to be self-employed and flexibly employed. Internet use reduces women’s physical disadvantage in the labor market and increases women's employment opportunities and income, which increases women’s opportunity cost of having children and reduces fertility through the substitution effect. Thus, both income and substitution effects are present, but the substitution effect is more significant. Closely related to this study, using Chinese cross-sectional data, Wang et al. (2021) investigate the impact of Internet use on fertility intention and find that individuals who use the Internet and the more frequently they use it have lower fertility intention. Further research finds that reproductive experience and intergenerational digital divide proxied by difference in average educational attainment between individuals and their parents have negative moderating effects. However, they use cross-sectional data, which cannot fully control for unobserved characteristics. Therefore, this study can provide new and rich evidence using panel data.

2.1 Channels of influence of Internet use on fertility intention

It can be assumed that Internet use has both positive and negative effects on fertility intention. As a related study, Billari et al. (2019) discuss three potential mechanisms of the Internet on fertility: information, marriage, and work–family balance. Although they focus on fertility behavior, the potential mechanisms can also be applied to fertility intention. Regarding first mechanism, the Internet provides access to information about contraceptive behaviors and about the possible life course consequences of the choice to become a parent. Regarding second mechanism, the Internet has been described as 'the new social intermediary in the search for mates' (Rosenfeld & Thomas, 2012). As Bellou (2015) states, the Internet may decrease search costs and increase the rate of partnership offers. Regarding third mechanism, high-speed Internet may affect labor force participation and work-family balance (Wajcman, 2015; Dettling, 2017), thereby enabling individuals to balance work and parenting more easily. Moreover, several studies have investigated the impact of Internet use (access) on household income (earnings) and find that Internet use increases household income (e.g., DiMaggio & Bonikowski, 2008; Chang & Just, 2009; Chang, Lambert, & Mishra, 2008; Ma, Nie, Zhang, & Renwick, 2020). Therefore, it is implied that there is income effect. Moreover, Wang et al. (2021) discuss three potential mechanisms of the Internet on fertility intention: information cost, childbearing history, and Intergenerational "digital divide". Regarding first mechanism which can further exacerbate individual feelings of anxiety and trust in others. Regarding second mechanism, extreme discussion on the Internet reflects the general anxiety about having a child and heightens the anxiety about having another child. Regarding third mechanism, large intergenerational "digital divide" leads to more family relationship conflicts for individuals who use the Internet frequently, which in turn may inhibit their fertility intention. Other than income and information effects, Li et al. (2021) find substitution effect through increases in opportunity costs of having children. Based on the above arguments, this study discusses following five potential mechanisms of Internet use on fertility intention: information, marriage, work-family balance, income, and substitution effects.

Regarding positive effects, marriage, work-family balance, and income effects

can be described as follows.

Transition to marriage effect. The arrival of the Internet has partly displaced traditional pathways of forming partnership, thus Internet use may affect the transition to marriage, and more generally, the likelihood of finding a partner to become the parent of a joint child (Rosenfeld & Thomas, 2012). Bellou (2015) states that the Internet has the potential to reduce search frictions allowing individuals to identify faster more available options and finds that the Internet has contributed to more marriages. It is implied that transition to marriage increases fertility intention.

Work–family balance effect. High-speed Internet use leads to increase in labor force participation and it is suggested that home Internet facilitates work-family balance (Dettling, 2017), thereby allowing individuals to reconcile work and parenthood more easily (Billari et al., 2019). Billari et al. (2019) state that by allowing individuals to work remotely, access to high-speed Internet can reduce commuting times, reduce absenteeism, and increase productivity and find that the Internet increases the likelihood of working from home, encourages part-time work, and reduces working hours. Dettling (2017) and Billari et al. (2019) state that telework (the Internet) can also reduce childcare costs and allow individuals to spend more time with their families, reducing the nonpecuniary costs of working. It is implied that work-family balance through telework increases fertility intention.

Income effect. Several studies have investigated the impact of Internet use (access) on household income (earnings) (e.g., DiMaggio & Bonikowski, 2008; Chang & Just, 2009; Chang, Lambert, & Mishra, 2008; Ma, Nie, Zhang, & Renwick, 2019). Internet use increases human capital, which improves productivity, which leads to higher income. Moreover, as Bloom et al. (2015) provide experimental evidence that telework can improve worker productivity, telework might also increase wages. Internet use may also intervene in the earnings determination process by promoting the expansion and use of social networks (Lin, 2001). According to Butz and Ward (1979), higher male wages raise household income and increase demand for children. As increase in the female wage rate also brings about an increase in income, if the income effect (the effect of an increase in the number of births due to an increase in the income level through an increase in wages)

exceeds the substitution effect (the effect of a decrease in the number of births due to an increase in the cost of raising children), the number of births will rather increase (Adachi & Nakazato, 2017). This income effect on fertility is observed in existing studies (e.g., Takayama et al., 2000). It is implied that household income increase fertility intention.

Regarding negative effect, substitution and information effects can be described as follows.

Substitution effect. Substitution effect is the effect of an increase in the wage rate on childbearing through an increase in the cost of raising children. According to Butz and Ward (1979), substitution effect is the negative effect of higher wages for married women on the demand for children. Internet use reduces fertility through the substitution effect. According to time allocation theory, individuals allocate their time rationally among paid labor, unpaid household work, and leisure to maximize utility. Internet use reduces women's physical disadvantage in the labor market and increases women's employment opportunities and income, which makes the opportunity cost of having children higher for women, and women devote more time to paid work, such as part-time work, while squeezing out time for having children, reducing fertility through the substitution effect (Li et al., 2021).

Information effect. The Internet provides unprecedented access to information about contraceptive behavior and the possible life-course consequences of the choice to become a parent. Moreover, the Internet may increase the quality and quantity of information available on childcare costs and benefits, as well as on health and sexual practices. (Billari et al., 2019). Similarly, Li et al. (2021) state that the Internet provides general knowledge about contraception and what life might be like after becoming a parent, and it can also spread the cost of parenting through interactive communication, which may cause "fertility panic" among urban population who worry about whether they have enough budget and energy to have children. Moreover, the Internet may weaken traditional values held towards childbearing such as 'bringing up children for the old age', 'predominance of men over women', and 'more children, more happiness' to some extent through the above information channels. Therefore, it is implied that information obtained through the Internet changes value of fertility to less traditional one, and thus decreases fertility

intention. Furthermore, Wang et al. (2021) state that the Internet brings information costs through information overload, information conflict, and information narrowing, which can further exacerbate individual feelings of anxiety and trust in others, reduce fertility utility, and thus affect individual fertility intention negatively. On the other hand, Guldi and Herbst (2017) state that increased availability of information affects the teen birth rate, but in a potentially ambiguous direction. They find that the Internet has decreasing effect on fertility at younger ages possibly through information mechanism: changes in sexual activity, contraception use, abortion, or some combination. However, this decreasing effect may be reversed at older ages, if information seeking and social learning are tied to the proactive achievement of higher desired fertility at later ages (Billari et al., 2019).

3. Methodology

3.1 Model

This study uses a fixed effects (FE) model, a fixed effects ordered logit model, and a random effects ordered logit model to address the heterogeneity problem. Moreover, this study also uses a fixed-effects Poisson model. The fixed effects Poisson model is a fixed-effects model used when the explained variable is not a continuous quantity but a variable that takes discrete values and is not a negative number (count data). Cluster-robust standard errors[4] are used to determine the correlation of individual errors. The model is expressed by Eq. (1):

$$FI_{it} = a + \beta INT_{it} + \gamma X_{it} + v_i + u_{it}, \quad (1)$$

where *i* denotes the individual; *t* denotes year; FI is the indicator of fertility intention. INT is the indicator of Internet use, which is a key independent variable; X is a set of control variables; β and γ are the coefficient of variables; v_i denotes an individual-specific time-invariant factor, and u_{it} denotes an idiosyncratic error.

Second, although the FE model can address the heterogeneity problem, there may also exist other endogeneity problems, such as the inverse causality problem (e.g., an individual who has higher fertility intention is likely to use the Internet). Individuals

[4] The standard errors are clustered at individual level.

who use the Internet may have systematically different characteristics from non-Internet users, i.e., there may be self-selection. If those differences are unobserved but correlated to the outcome variable of fertility intention, then Internet use dummy is endogenous. Some previous literature (e.g., Chang & Just, 2009; Hübler & Hartje, 2016) state that the Internet use variable is potentially endogenous because a household decides whether to use the broadband Internet service. Based on the above, this study uses the instrumental variables (IV) method to address this endogeneity problem, as expressed by Eqs. (3)–(5):

$$INT_{it} = a + \beta_z Z_{it} + \gamma X_{it} + \mu_{it}, \quad (3)$$

$$FI_{it} = a + \beta_{INT} \widehat{INT}_{it} + \gamma X_{it} + \varepsilon_{it}, \quad (4)$$

$$corr(Z, \varepsilon) = 0, \text{ and } corr(Z, \mu) \neq 0, \quad (5)$$

where INT is the probability of Internet use and Z represents the IV.

This study also estimates an interaction term to focus on the group difference (e.g., marital status, gender, hukou) in the effect of Internet use on fertility intention, as shown in Eq. (6) –(9):

$$INT_{it} = a + \beta_z Z_{it} + \gamma X_{it} + \mu_{it}, \quad (6)$$

$$INT * Group_{it} = a + \beta_z Z_{it} + \beta_z Z * Group_{it} + \gamma X_{it} + \mu_{it}, \quad (7)$$

$$FI_{it} = a + \beta_1 INT_{it} + \beta_2 Group_{it} + \beta_3 INT_{it} \times Group_{it} + \gamma X_{it} + v_i + u_{it}, \quad (8)$$

$$corr(Z, \varepsilon) = 0, \text{ and } corr(Z, \mu) \neq 0, \quad (9)$$

β_3 denotes the coefficient of the interaction term Internet use × group variables, which indicates group differences in the impact of Internet use on an individual's fertility intention. In heterogeneous analysis, we especially focus on the coefficient of β_3.

Finally, this study uses the mediation model to investigate the channels of the influence of Internet use on fertility intention, as expressed by Eqs. (10)–(12).

$$FI_{it} = \beta_0 + \beta_1 INT_{it} + \beta_2 X_{it} + \varepsilon_i, \quad (10)$$

$$Me_{it} = \beta_0' + \beta_1' INT_{it} + \beta_2' X_{it} + \varepsilon_i', \text{ and} \quad (11)$$

$$FI_{it} = \beta_0'' + \beta_1'' INT_i + \beta_2'' X_i + \beta_3 Me_i + \varepsilon_i'', \quad (12)$$

where Me represents mediator variables. When β_1' and β_3 are statistically significant, as well as β_1'' changes (e.g., become smaller) compared with β_1, we can say that Internet use affects fertility intention, possibly through mediator Me. The indirect effect is $\beta_2' \times \beta_3$.

3.2 Data and variables

This study uses data from the China Family Panel Studies (CFPS), a national longitudinal survey project that collects data at the individual, family, and community levels launched

in 2010 by the Institute of Social Science Survey of Peking University, China. The baseline national survey was launched in the 25 provinces/municipalities/autonomous regions, and it successfully interviewed members of 14,960 households. A total of 33,600 adults and 8,990 youths were interviewed (Xie & Hu, 2014). The CFPS has five waves from 2010 to 2018; this study uses the two-wave longitudinal survey data (2014 and 2018) because only these two waves have questionnaire items on fertility intention. The samples of CFPS are 37,147 (2014) and 37,354 (2018). This study selects samples aged 16 years and over and exclude missing values.

3.2.1 Dependent variable

The dependent variable is the fertility intention. Arnocky et al. (2012) define individual fertility intention as the desire to have or not to have children, or the desire for a specific number of children over the lifespan. As with existing studies (e.g., Liu et al., 2020; Meng & Lyu, 2021; Zheng et al., 2016; Zhu & Hong, 2021), this study uses ideal number of children as an indicator of fertility intention. Ideal number of children is based on the question "What's your ideal number of child."

3.2.2 Key independent variable

The key independent variable is (i) the dummy variable for Internet use (1 = "used" and 0 = "did not use") based on the question "Do you use Internet," and (ii) hours of Internet use. Moreover, attitude toward the Internet captured by asking respondents the degree of importance of the Internet for collecting information (5 = "very important" and 1 = "very unimportant").

3.2.3 Control variables

Referring to previous studies, this study employed the following control variables: (1) education attainment (years of schooling); (2) age and age squared term; (3) sex (male dummy); (4) self-reported health status dummy variables (excellent, very good, good, fair, and poor); (5) marital status (having married dummy); (6) hukou (urban hukou dummy); (7) employment status (working dummy); (8) residence (urban area dummy); (9) number of family members; (10) absolute income (household income and its squared term); (11) public pension enrollment, (12) public medical insurance enrollment, (13) the provincial dummy, and (14) year dummy variables.

3.2.4 Instrument variable

Two types of IVs have been used in previous studies on Internet use and fertility: (i) Internet penetration rate in a province (Li et al., 2021; Wang et al., 2021); (ii) distance of a household residence from the main distribution frame (MDF) (Billari et al., 2019). This study performed a set of tests to select an appropriate IV. As the test results of endogenous variables and weak identification show that the number of base stations of mobile phones is a more appropriate IV, this study uses it in the analysis. This study also uses the Internet penetration rate in a province as an IV, but this instrument did not pass a weak identification test. The second condition for a valid IV, the exclusion restriction, is difficult to test. To address this problem, this study adopts the recent Conley et al. (2012) bounds approach. Although our IV plausibly satisfies the exclusion restrictions, we report results from the Conley et al. (2012) bounds approach, under the assumption that the instruments may violate the exclusion restrictions. It specifies a support of possible values for $\theta_j \in [-\delta, +\delta]$, where $\delta > 0$ can be arbitrarily small. Under this assumption, we estimate the lower and upper bounds for the estimation of β_1. Data on the number of base stations of mobile phones in a province are obtained from the *China Statistical Yearbook*. Tables 1 provides the summary statistics of the variables included in the analysis.

Table 1 Near here

4. Results

4.1 The impact of Internet use on fertility intention

Table 2 presents the results estimated using a FE model, a fixed effects ordered logit model, a random effects ordered logit model, a fixed-effects Poisson model, and a FE-IV model. While columns (1), (3), (5), (7), and (9) do not control for family-level variables, columns (2), (4), (6), (8), and (10) do.

Table 2 Near here

The coefficient of Internet use is statistically significant and positive based on a FE model, a fixed effects ordered logit model, a random effects ordered logit model, and a fixed effects Poisson model. The results are robust in a FE-IV model. Using Conley et al. (2012) approach, even under the condition that our IV violates the exclusion restriction,

our results are still robust[5]. These results suggest that addressing both individual heterogeneity and endogeneity problems together, Internet use statistically significant positively affects fertility intention. In other words, these results imply that Internet use significantly increases ideal number of children. Calculating the marginal effects of fixed effects ordered logit model and those of random effects ordered logit model, the results show that those who use the Internet increases their fertility intention to have three children by 0.005-0.006 and 0.003-0.004 units, respectively. The results are consistent with Billari et al. (2019) which find that broadband Internet has a positive impact on fertility behavior in Germany. On the other hand, the results are different from Wang et al. (2021), which is the only study on the impact of Internet use on fertility intention in the Chinese context. However, it is not surprising as Wang et al. (2021) do not address individual heterogeneity problem using different data source: cross-sectional data from Chinese General Social Survey.

Next, this study examines the impact of the frequency of Internet use and attitude toward the Internet for further enrichment of the findings. While the frequency of Internet use is non-significant[6], attitude toward the Internet is statistically significant and positive in all models. Therefore, it is implied that those who think that information gathering via the Internet is more important will substantially increase the number of ideal children. The results are shown in Table 3.

Table 3 Near here

4.2 Heterogeneity analysis

Third, this study explores the heterogeneous effects of Internet use using subsample analysis. Regarding the heterogeneous group, there are significant differences by age, marital status, gender, hukou, and educational background. The results are shown in Table 4 (age and gender), Table 5 (hukou), and Table 6 (education and marital status).

[5] The estimated bounds are reported for 95 percent confidence intervals in Table 9, with $\delta = 0.0001$, 0.0005, 0.001, 0.005, and 0.01. The reported results are from FE-IV estimators. The results show that the estimated bounds do not vary significantly with the value of δ. Moreover, none of the 95 percent confidence intervals contain zero.

[6] These results are not listed in the paper owing to the limited space; they are, however, available upon request.

Based on a FE model, significant positive impact is observed among all age groups, male, those who are married, have rural hukou, and graduated from high school or below. Moreover, based on a FE-IV model, significant positive impact is observed among age group under 49 years old, female, those who are married, have rural hukou, and graduated from high school or below. It is implied that age group under 49 years old tend to use the Internet more frequently and get more information, thus significant positive impact is observed. Moreover, the significant positive impact of Internet use among those who are married indicates that childbirth and child rearing are perceived as more realistic options, and that the positive information effect of Internet use is more pronounced. Furthermore, significant positive impact of Internet use observed among those who have rural hukou or graduated from high school or below indicates that Internet use may reinforce traditional value of fertility such as 'more children, more happiness' for those who live in rural areas or less educated.

Furthermore, the results of heterogeneous analysis on the effects of Internet use on fertility intention are shown in Table 7. The regression coefficient of the interaction term of Internet use and hukou status is estimated to be negative (-0.066) and that of Internet use is estimated to be positive (0.047) based on a FE model. Although the regression coefficients of Internet use are positive in Column (1), given the urban hukou residents dummy, dFI/dINT = 0.047-0.066*1 = -0.019, Internet use impact on fertility intention of urban hukou residents is negative. However, the regression coefficient of the interaction term of Internet use and hukou status is estimated to be negative (-0.570) and that of Internet use is estimated to be positive (1.411) based on a FE-IV model. Therefore, while it is implied that Internet use decreases fertility intention of those who with urban hukou, addressing endogeneity issues, Internet use increases fertility intention of urban hukou residents. On the other hand, the coefficient of the interaction term of Internet use and marital status, gender, and educational background is non-significant, respectively.

4.3 Channels of the influence of Internet use on fertility intention

Finally, this study investigates the mechanism of the effect of Internet use on fertility intention based on the mediation effect model. The results are shown in Table 8. Five potential effects moderators (household income, working hours, values regarding

educational attainment, marital status, and housework hours) are used. One channel in the mechanism of relationship between Internet use and fertility intention—increases in household income—are found to be significant. The indirect effect coefficient of Internet use to increase household income to then promote fertility intention is 0.112×-0.008, which is approximately -0.001. It is implied that positive impact of Internet use on fertility intention decreases due to negative mediating impact of household income on fertility intention. The results are consistent with related existing studies showing positive effects of computer use, smartphone use, and Internet use on wage and household income (e.g., Krueger, 1993; Ma, Grafton, & Renwick, 2020; Mao, Zeng, & Hu, 2018; Chang & Just, 2009) and those of showing negative effects of household income on fertility intention (e.g., Pan & Ning, 2010; Liu & Gong, 2020).

5. Conclusions and policy implications

Using the data from the CFPS 2014 and 2018 to address individual heterogeneity and other endogeneity problems simultaneously, this study investigates the impact of Internet use on fertility intention and clarified the mechanisms. The main conclusions are as follows: First, the impact of Internet use on fertility intention is statistically significant and positive based on a FE model, fixed effects ordered logit model, a random effects ordered logit model, and a fixed-effects Poisson model. The results are robust as a FE–IV model show that, when addressing heterogeneity and other endogeneity problems, Internet use positively affects fertility intention. Robustness checks using attitude toward the Internet measured as the degree of importance of the Internet for collecting information confirm these conclusions. The results are consistent with Billari et al. (2019), but not with Wang et al. (2021), the only study using cross-sectional data, which shows that Internet use negatively affects fertility intention. The findings in this study indicate that there is an analysis bias when using cross-sectional data. In this study, we provide evidence on the causal association between Internet use and fertility intention based on two-wave panel data analyses.

Second, regarding the heterogeneous group, there is a significant difference by age cohort, marital status, hukou status, and educational attainment. There exists a

positive relationship between Internet use and fertility intention among the younger generation whose age are under 49, those who are married, those who have rural hukou, and those who graduated from high school or below.

Third, the influence of Internet use on fertility intention is mediated by household income effect channel. Internet use increases household income which negatively affects fertility intention. The results are consistent with existing studies showing that Internet use increases household income (e.g., Ma et al., 2020) and household income decreases fertility intention (e.g., Liu & Gong, 2020).

The policy implications from these empirical results can be considered as follows: It is found that Internet use positively affects fertility intention. Therefore, online media policies to control or decrease negative information on childcare (i.e., soaring education costs and fiercely competitive university entrance examinations) on the Internet platform should be discussed. It is also suggested that the Chinese government increases positive information on childcare (i.e., expansion of parental leave, child allowance) and advertisement (i.e., pronatalism[7]) on the Internet platform.

It is also found that although Internet use positively affects fertility intention, it also increases household income which decreases fertility intention. Policymakers must then develop strategies to support telework and working from home to improve fertility intention. It is also suggested for policymakers to expand education expenditure and establish more childcare facilities to reduce opportunity costs of having children. Given that Internet use is shown to greatly increase fertility intention of those who are married, have rural hukou, graduated from high school or below, expanding services to these groups may increase the overall fertility intention of nations. It should be noted that attitude toward Internet use has significant positive impact on fertility intention, indicating the need for better public awareness on the Internet as a useful source of information on childbirth and child care.

The limitations of this study are as follows. First, although this study used the FE and IV methods to address individual heterogeneity and other endogeneity problems

[7] In Yueyang city, Hunan, the statistical department has published recommendations for birth incentives.

that were not addressed simultaneously in previous studies, empirical studies of the causal relationship between Internet use and fertility intention based on other methods (e.g., the quasi-experiment method) are future issues to be addressed. Second, although this study investigated the mechanisms of Internet use on fertility intention using four mediators, we encourage more research on discovering and analyzing other possible mechanisms, once richer data is available.

Tables

Table 1 Summary statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Fertility intention	48,035	2.063	0.844	0	12
Internet use	48,232	0.384	0.486	0	1
Internet hours (hours)	19,590	12.387	11.891	0	168
Importance of Internet as communication path	48,161	2.398	1.605	1	5
Household income (RMB)	52,500	59273.840	80261.770	0	4270560
Household income per capita (RMB)	52,085	20393.140	42767.950	0	3300000
Individual income (RMB)	24,300	22333.530	31070.860	0	840000
Age	54,301	47.779	16.711	16	100
Gender	54,308	0.496	0.500	0	1
Urban hukou	50,735	0.255	0.436	0	1
Marital status	47,416	0.878	0.327	0	1
Health status	54,040	2.966	1.247	1	5
Education	54,221	2.221	1.348	0	8
Urban residence	51,352	0.471	0.499	0	1
Working	49,310	0.766	0.423	0	1
Public medical insurance	50,350	0.922	0.268	0	1

Public pension participation	39,058	0.630	0.483	0	1
Family size	53,821	4.289	1.992	1	21
The number of base stations of mobile phones	54,303	177639.6	125000.2	25000	559000

Table 2 Estimation results of the effect of Internet use on fertility intention

	FE		FEologit		REologit		FEpoisson		FE-IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Fertility intention		Fertility intention		Fertility intention		Fertility intention		Fertility intention	
Internet use	0.033**	0.034**	0.248***	0.253***	0.125***	0.152***	0.018**	0.018**	1.677***	1.697***
	(0.014)	(0.014)	(0.083)	(0.083)	(0.044)	(0.044)	(0.007)	(0.007)	(0.420)	(0.425)
Individual variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family variables	No	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.149***	1.135***								
	(0.230)	(0.231)								
Observations	31,651	31,651	9,244	9,244	31,651	31,651	24,690	24,690	31,651	31,651
Number of pid/panel id	19,294	19,294	3811	3811	19,294	19,294	12,345	12,345	19,294	19,294

Within R-squared	0.015	0.015								
Between R-squared	0.061	0.063							0.006	0.008
Overall R-squared	0.043	0.045							0.002	0.003
Log likelihood			-3065.054	-3063.326	-26483.509	-26297.405	-12505.132	-12504.987		
Pseudo R-squared			0.043	0.044						

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3 Estimation results of the effect of attitude toward the Internet on fertility intention

	FE		FEologit		REologit		FEpoisson		FE-IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Fertility intention		Fertility intention		Fertility intention		Fertility intention		Fertility intention	
Importance of Internet as communication path										
Very important	0.038**	0.038**	0.256**	0.259***	0.170***	0.187***	0.020**	0.020**		
	(0.019)	(0.019)	(0.100)	(0.100)	(0.054)	(0.054)	(0.009)	(0.009)		
Importance of Internet as communication path									0.648***	0.651***
									(0.189)	(0.189)
Individual variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family variables	No	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes

Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.178***	1.165***							0.029	0.010
	(0.229)	(0.230)							(0.492)	(0.494)
Observations	31,630	31,630	9,238	9,238	31,630	31,630	24,666	24,666	31,630	31,630
Number of pid	19,285	19,285			19,285	19,285	12,333	12,333	19,285	19,285
Within R-squared	0.015	0.015								
Between R-squared	0.061	0.063							0.002	0.002
Overall R-squared	0.042	0.044							0.002	0.002
Log likelihood			-3063.034	-3061.556	-26461.696	-26277.117	-12493.302	-12493.173		
Pseudo R-squared			0.043	0.044						

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4 Heterogeneous effects of Internet use on fertility intention (age and gender)

	age<=49		age>=50		female		male		age<=49		female	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	FE		FE		FE		FE		FE-IV		FE-IV	
Internet use	0.029*	0.030*	0.110***	0.109***	0.013	0.014	0.054**	0.054**	1.868***	1.895***	1.313***	1.345***

	(0.017)	(0.017)	(0.041)	(0.041)	(0.018)	(0.018)	(0.022)	(0.022)	(0.622)	(0.630)	(0.418)	(0.428)
Individual variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family variables	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	21,457	21,457	10,194	10,194	15,826	15,826	15,825	15,825	21,457	21,457	15,826	15,826
Number of pid	13,555	13,555	7,553	7,553	9,544	9,544	9,762	9,762	13,555	13,555	9,544	9,544
Within R-squared	0.012	0.014	0.042	0.042	0.026	0.026	0.012	0.012				
Between R-squared	0.021	0.030	0.001	0.001	0.081	0.084	0.027	0.028	0.015	0.013	0.037	0.041
Overall R-squared	0.017	0.025	0.002	0.002	0.057	0.059	0.017	0.017	0.010	0.008	0.019	0.022

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5 Heterogeneous effects of Internet use on fertility intention (hukou)

	Rural hukou		Urban hukou		Rural hukou	
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	FE		FE		FE-IV	
Internet use	0.032**	0.033**	0.038	0.039	0.733**	0.742**
	(0.015)	(0.015)	(0.040)	(0.040)	(0.344)	(0.347)
Individual variables	Yes	Yes	Yes	Yes	Yes	Yes
Family variables	No	Yes	No	Yes	No	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,646	24,646	7,005	7,005	24,646	24,646
Number of pid	15,284	15,284	4,508	4,508	15,284	15,284
Within R-squared	0.020	0.020	0.037	0.038		
Between R-squared	0.079	0.080	0.010	0.011	0.060	0.063
Overall R-squared	0.057	0.058	0.007	0.008	0.039	0.042

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6 Heterogeneous effects of Internet use on fertility intention (education and marital status)

	High school graduate or below		High school graduate above		High school graduate or below		not married		married		married	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	FE		FE		FE-IV		FE		FE		FE-IV	
Internet use	0.026*	0.027*	0.040	0.029	1.752***	1.778***	0.060	0.061	0.031**	0.031**	1.730***	1.755***
	(0.014)	(0.014)	(0.136)	(0.136)	(0.608)	(0.620)	(0.079)	(0.079)	(0.014)	(0.014)	(0.437)	(0.445)
Individual variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family variables	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	28,891	28,891	2,771	2,771	28,891	28,891	2,937	2,937	28,714	28,714	28,714	28,714
Number of pid	18,015	18,015	2,300	2,300	18,015	18,015	2,273	2,273	17,495	17,495	17,495	17,495
Within R-squared	0.013	0.013	0.122	0.126			0.080	0.080	0.017	0.017		
Between R-squared	0.049	0.051	0.010	0.014	0.013	0.015	0.006	0.007	0.036	0.037	0.008	0.011
Overall R-squared	0.035	0.036	0.011	0.014	0.006	0.007	0.011	0.011	0.023	0.024	0.003	0.005

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7 Estimation results of heterogeneous analysis on the effects of Internet use on fertility intention

	(1)	(2)
VARIABLES	FE	FE-IV
Internet use	0.047***	1.411***
	(0.015)	(0.386)
Internet use#urban hukou	-0.066**	-0.570***
	(0.032)	(0.122)
Urban hukou	0.069*	0.268***
	(0.035)	(0.099)
Individual variables	Yes	Yes
Family variables	Yes	Yes
Province fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Constant	1.111***	0.579*
	(0.232)	(0.301)
Observations	31,651	31,651
Number of pid	19,294	19,294
Within R-squared	0.016	
Between R-squared	0.063	0.024
Overall R-squared	0.044	0.012

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8 Channels of the influence of Internet use on fertility intention (household income)

	(1)	(2)	(3)
VARIABLES	ln(household income)	fertility intention	
Internet use	0.112***	0.034**	0.034**
	(0.029)	(0.014)	(0.014)
ln(household income)			-0.008*
			(0.005)
Individual variables	Yes	Yes	Yes
Family variables	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Constant	10.951***	1.077***	1.135***
	(0.435)	(0.223)	(0.231)
Observations	31,733	32,363	31,651
Number of pid	19,318	19,494	19,294
Within R-squared	0.053	0.014	0.015
Between R-squared	0.083	0.064	0.063
Overall R-squared	0.067	0.045	0.045

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 9 Bounds for the effect of Internet use on fertility intention

Internet use	95% confidence interval	
	Provincial Internet penetration rate	
Support for possible values of $\theta=\theta_1$	Lower	Upper
$\theta\in$[-0.0001, +0.0001]	0.957	2.549
$\theta\in$[-0.0005, +0.0005]	0.956	2.551
$\theta\in$[-0.001, +0.001]	0.954	2.554
$\theta\in$[-0.005, +0.005]	0.941	2.574
$\theta\in$[-0.01, +0.01]	0.925	2.600

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