



Does Internet Connectedness Disconnect Marriage? A Micro Empirical Analysis

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Abstract

This study explores the relationship between internet use during non-working hours and marriage well-being and channels through which internet use operates on marital satisfaction. With a 2-year nationwide micro panel data, our main results reveal negative effects of internet experience on overall marriage satisfaction, satisfaction towards spousal contribution in housework and marital stability. Empirically, we adopt linear as well as non-linear models, use propensity score matching approach, and implement parametric as well as semiparametric analyses. Evidence further show that active internet users can use the internet to chat with strangers and easily access potential romantic partners. Its social function leads to a substantial reduction in search cost and raised reservation value of partner contribute to a lower level of spousal satisfaction. Moreover, it was also found that internet use partially weakens traditional Chinese views of family gender roles. And gender ideology changes through internet's educational function has increased spousal dissatisfaction in China. In addition, it is found that internet use crowds out time spent on housework as well as other investment in current marriage, and hence increases spousal dissatisfaction.

Keywords Internet usage · Marital satisfaction · Crowd-out effect · Gender role attitudes · China

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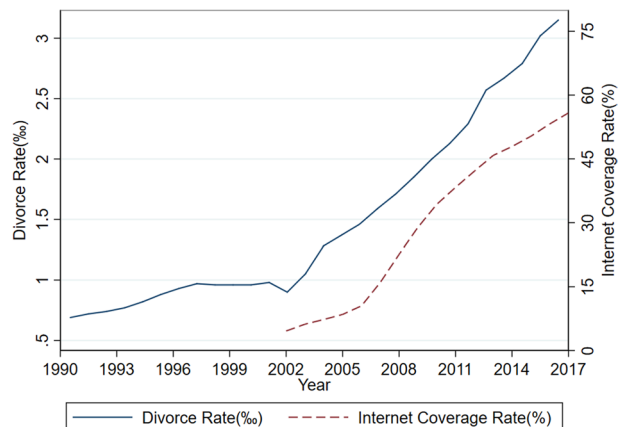
1 Introduction

The past several decades have witnessed a dramatic increase in global divorce rates (Wang & Schofer, 2018). As shown in Fig. 1, the divorce rate in China has also substantially increased, almost tripling in the past 15 years. Current studies attribute this societal shift to rapid urbanization, human capital development, economic growth, women's empowerment, cultural changes, and globalization (Mu & Xie, 2014; Wang & Zhou, 2010). At the same time, internet use has spread widely, and online engagement has become an important part of individual daily life for the past 20 years. As of June 2019, the number of Chinese internet users had reached 854 million, with a coverage rate of 61.2%. This advancement in information communication technologies (ICTs) potentially plays an important role in individual marital decisions as well, but associated studies are still rare. Our paper aims to contribute to the literature in this area.

As has been widely documented, internet generalization has profoundly influenced modern society in many aspects, for example, in communication, social connections, leisure activities, happiness, and economic growth (Castellacci & Tveito, 2018; Chavula, 2013; Correa et al. 2010; Meijers, 2014; Njoh, 2018; Zhou & Peng, 2018). The psychological effects of individual internet usage have also been studied, with significant results being found regarding generation of loneliness, influence on subjective well-being, and lowered political trust, among others (Kim et al. 2009; Weiser, 2001; Zhao & Hu, 2017). To the best of our knowledge, however, little is known about its influence on marriage. Kendall (2011) could not find evidence to support the rise of internet usage increasing divorce in the U.S., however, Valenzuela et al. (2014) found that internet access is positively associated with divorce as well as negatively associated with marital satisfaction in the U.S. In the Chinese context, using provincial data, Zheng et al. (2019) found that broadband internet access is positively related to divorce.

Marital satisfaction is a prime predictor for marital stability. It is not only important because of its centrality to individual well-being but also to family and social development. Most directly, the lower levels of marital satisfaction cause lower quality of marriage life and is a risking factor for individual depression. Unpleasant marriages can cause a decrease in frequency of sexual intercourse and may lead couples to use more effective methods

Fig. 1 The divorce rate and the internet coverage rate in China. Data sources: China National Bureau of Statistics



Data sources: China National Bureau of Statistics

of contraception or even abortion to avoid unwanted pregnancies (Thornton, 1977). Thus, marital satisfaction potentially influences the decision to have children, which leads to a lower fertility rate and a decreased labor population. Further, in recent years, the aging population crisis in China has grown, causing severe economic and social problems. The importance of marital satisfaction to individual well-being and social development motivates us to focus on internet usage's influence on overall marital satisfaction and segmented satisfaction with one's spouse.

Compared with Western societies, the national divorce rate in China is relatively low, and self-reported marital satisfaction is relatively high (Ortiz-Ospina & Roser, 2020). One important reason is the deeply rooted cultural and gender norms that require women to be obedient and forgiving in marriage and that stigmatize divorce (Zheng et al. 2019). Outside options or the availability of potential dating partners is limited, and empowering women in such an environment is difficult. Internet use plausibly influences social norms, offers women more outside options for romantic partners as well as labor market opportunities, and contributes to gender identity modernization (Dettling, 2017; Zhou et al. 2019). Castellacci and Tveito (2018) argue that internet use leads to less agreement with traditional views and thus more independent, modern women. Further, changes in gender role attitudes and a reduction in search costs to find romantic partners are likely to affect one's expectations in marriage (Becker, 1973; Becker et al., 1977; Bellou, 2015; Kendall, 2011; Zhou et al., 2019); the changes could plausibly raise dissatisfaction toward the current spouse and marriage. This study also empirically explored the potential channels linking marital satisfaction and internet use.

Thus, this study evaluated the effect of internet use on marital stability with a nationwide representative two-waves panel data in China, aiming to empirically identify a direct link between internet use and marital satisfaction. Specifically, we used the 2014 and 2018 waves of the Chinese Family Panel Studies (CFPS) to examine the impact of internet use on marital satisfaction and marital status after four years. First, we investigated overall marital satisfaction as well as satisfaction with spousal economic and housework contributions. Second, we considered different dimensions of respondents' internet use, for example, whether they used the internet or not, time spent online, and the utility and gratification from internet usage, including social interaction, entertainment, and online education. Third, in addition to standard linear models, we also considered nonlinear probability models in order to properly handle the discrete dependent variable. We further used the semi-parametric approach, which allows for highly and/or locally nonlinear marginal effects, to examine the robustness of the main parametric results. We found evidence supporting the existence of the internet's negative impacts on overall marital satisfaction and satisfaction toward housework contributions. In addition, we found that gender role attitude changes and lowered search costs are important mediators.

The rest of this paper is organized as follows: Sect. 2 reviews the existing literature and provides the theoretical framework; Sect. 3 presents the data, measures, and statistical analysis methods; Sect. 4 presents the results; and Sect. 5 summarizes the results and draws conclusions.

2 Literature Review and Hypotheses

Marital satisfaction refers to the level of happiness that a person feels in their marriage relationship; it is the primary predictor of divorce. Existing literature has documented many factors that can affect marital satisfaction. External environments, for example macroeconomic conditions and social culture, can directly and indirectly influence micro-households and marital relationships (Gudmunson, Beutler, Israelsen, McCoy, and Hill, 2007; Wang & Schofer, 2018). Within household environments, spousal interactions and socioeconomic performance profoundly affect spousal relationships (Amato, 2010; Phillips et al. 2009). Healthy communication and shared leisure time are beneficial to marital happiness (Borae & Peña, 2010; Sharaievska, Kim, and Stodolska, 2013). Decisions regarding having children and division of housework also affect marital satisfaction (Gana & Jakubowska, 2016; Oshio et al. 2013).

The Internet, as one of the most important ICT developments of all time, has been proven to help accelerate economic development and social transformations (Castellacci & Tveito, 2018; Meijers, 2014). While it generates far-reaching effects on diverse perspectives of individual lives, the internet has also expanded people's social networks and influenced marital relationships (Manago et al., 2012). However, most existing studies have shown that the internet does not seem to play a positive role in marital satisfaction and family cohesion.

According to the classical model of the marriage market, marriage is a repetitive searching and matching process with the search cost, time and associated resources spent on partner searching playing a crucial role (Becker, 1973; Becker et al., 1977). This idea can be applied to relationship-related internet activity. As internet users dramatically increase and social media connects different communities, the internet has allowed people to communicate at almost no cost. Internet applications can substantially reduce search costs and increase the probability of receiving an offer to date. Stevenson and Wolfers (2007) argue that the internet provides a more convenient channel for online partner choice. With the popularity of online dating, internet use helps people find romantic partners more quickly and increases the marriage rate among single people (Bellou, 2015). Hall (2014) found that 21% of couples know each other through online dating in the United States.

For the married, the internet's anonymity and online social networks are likely to enlarge the set of partner options outside marriage through a reduction in search cost. Whitty (2003) emphasizes that the internet allows people to pursue online interactions outside of marriage, which could lead to acts of infidelity. From these perspectives, internet usage is likely to lower current marital satisfaction levels and raise the propensity for divorce in married population. Moreover, the reduction in search cost is likely to raise reservation values (that is a minimum acceptable quality level) for one's spouse (Becker et al., 1977). It implies a decline in the probability that a marriage offer will be accepted as well as a decline in marital satisfaction toward the current spouse because of higher expectations of the spouse when more offers are available in the marriage market. Idealized images of a better partner behind the screen are likely to lower satisfaction in the current marriage and increase the divorce rate (Kendall, 2011). Furthermore, dissatisfaction is likely to lead to a decline in marital investment. For example, interacting with a fictitious mate could be more attractive than mundane interactions within a family. A marriage could end when lack of marital investment occurs or when a partner meets a better match (Weiss & Willis, 1997). With its anonymity and convenience, the internet has reduced the cost of derailment as well as facilitated infidelity, which has heavily affected marriages (McDaniel et al.,

2017; Valenzuela et al., 2014; Whitty, 2003). The above discussion gives rise to the following hypotheses:

Hypothesis 1 Overall, Internet usage is likely to negatively influence marital satisfaction and marital stability among married population.

According to the media dependency theory (DeFleur & Ball-Rokeach, 1975), the public increasingly relies on media because the acceleration of social changes and uncertainties cause media to play a multi-functioning role in current society. Self-control deficiencies and internet addiction problems are often observed in internet users (Beard, 2005; Larose, 2009). Since time endowment and vigor are limited, one's time with family or on housework becomes less when one spends more time online (Nie & Erbring, 2000). Higher satisfaction is reported with shared leisure time, healthy communication, and quality accompaniment with partners (Gottman, 1998; Phillips et al., 2009; Sharaievska et al., 2013). Internet usage for social as well as entertainment functions can distract attention and interest from one's partner, increase social anxiety, and reduce communication efficiency between couples. Existing empirical evidence has already shown that online social experience or online game addictions can harm spousal intimacy and affect marital quality in Western society (Hand et al., 2013; Kerkhof et al., 2011). Mesch (2006) found that online time is positively related to family conflicts, especially when the internet is used for social purposes. Clayton et al. (2013) state that people who regularly use Facebook are more likely to have negative interpersonal relationship outcomes such as breakups, divorces, or romantic cheating. Online pornography also can threaten a stable and healthy marriage (Manning, 2006). Nevertheless, when a couple has problems in their relationship, they can choose to escape from reality by surfing the internet, which is not conducive to solving problems (Kerkhof et al. 2011). Frequent internet usage for entertainment or social functions occupies casual time and crowds out time spent on housework or sharing leisure activities with spouses. This crowd-out effect on current marital investments for better partnerships undoubtedly leads to marital dissatisfaction. The above discussion gives rise to the following hypothesis:

Hypothesis 2 Social internet interaction and entertainment activities will generate significantly negative influences on marital satisfaction, especially for those who overuse it.

In 2019, there were 854 million internet users accounting for 61.2% of the total population in China. Among internet users, 96.5% of the total use it as an important tool for social interaction or communication, 88.8% use it for entertainment (65.1% of these enjoy playing online games), and 27.2% use it for online education (China Internet Network Information Center, 2019). Undoubtedly, the internet has generated profound influences on marriages in China. In the past, traditional marriages could not be separated from so-called "parents or match-maker's orders." In other words, the entire marriage was under the command of others. Currently, free love and the free marriage market are the main trend in China. Internet proliferation has expanded the space and freedom of partner selection. Search costs for the marriage market have been substantially reduced and the reservation value of partners has also risen. Lu et al. (2015) found that internet usage occupies the time for partners to communicate with each other and the rise of the virtual community lowers costs to search for alternative romantic partners. Online entertainment is more likely to isolate people from their partners and decrease family leisure sharing. In this way, conflicts within families

have increased (Dong, 2004; Li, 2014). Thus, as proposed in hypotheses 1 and 2 above, individual internet usage also generates an overall significantly negative effect on marital satisfaction for the married population in China.

Online education is another important function of the internet. Cultural, social, and individual variables in the marriage can change through partners' use of the internet for educational purposes. In other words, the internet's educational function helps reshape marital concepts and spousal relationships. Heaton (2002) believes that improvements in education, which enable couples to make more mature decisions about marital commitments as well as enhance communication ability, can enhance marital stability. As online education has a positive impact on social modernization, internet usage can change people's perceptions and cognition (Farman, 2015) and improve their self-awareness as well as conception of life (Manago et al., 2012). This also implies that the internet can affect marital stability and marital satisfaction through attitudes regarding gender identity (Davis & Greenstein, 2009). Whether couples share common values is strongly associated with higher marital satisfaction and marital stability (Zvonkovic et al., 1994). Meanwhile, online discussions about gender issues and female-centered media programs are continuously changing people's attitudes toward gender roles and contributing to female empowerment. Influenced by egalitarian gender norms over the past several decades, women are more economically independent and more likely to expect a marriage in which both partners have equal rights (Sayer et al., 2011; Yodanis, 2010). This gender role awareness is found to be negatively associated with marital satisfaction (Cherlin, 2004; Wong & Goodwin, 2009). In short, conclusions on the relationship between online education and marital satisfaction are inconsistent. The discordance leaves it as an empirical question, and different cultural and social environments might have different answers.

In Chinese society, ingrained Confucian social norms emphasize that wives should take on more housework as well as the majority of the responsibility for the stability of their marriages (Warner, 2005). For example, the traditional values of gender roles within the family support that "Men should be career-oriented, while women should be family-oriented," "For women, a good marriage is better than a good career," "Women should have children to be complete," "Women should be responsible for all the housework," and so on. These traditional values concerning marriage and family seem to conflict with modernity and individualism (Ye et al., 2014). As the Chinese economy grows, labor force participation as well as educational attainment have been significantly enhanced for females, signaling huge progress in women empowerment and gender equality in China (Inglehart & Norris, 2003). Demands for individuality and independence are increasing for Chinese women with the rapid growth of China (Zhang, 2010), and more widespread internet usage has accelerated this process. A recent study suggests that the internet can affect traditional gender norms and cultivate equal gender ideology through its educational and informative functions (Zhou et al., 2019). The shift in gender role attitudes has made women aware of the inequalities that exist within families and at work (Yu & Lee, 2013).

Since time endowment and vigor are limited, one's time with family or on housework becomes less when one spends more time online (Nie & Erbring, 2000). Time use online and offline are substitutes, especially for women who tend to engage in fewer online activities (Ren & Kwan, 2009; Ren et al., 2013). Schwanen et al. (2014) also show that those who spent more time on internet spent less time on household labor. The previous research has suggested that internet use may occupy the time spent on household labor. Similarly, internet use certainly occupies time spent on housework in China. According to data reported by the Chinese Network and Information Center and Zhou and Peng (2018), citizens have increasingly used internet off work and males use internet more than females.

Under the influence of traditional gender attitudes, males have already seldom done housework and now situation is likely to be worse.

On one hand, Oshio et al. (2013) have shown that inequitable division of housework significantly affects marital satisfaction. Unbalanced household labor division raised marital dissatisfaction. On the other hand, modernization of the traditional gender role attitudes in China has been developing with the increased demands for individuality and independence as well as being aware of the inequalities between men and women. Therefore, it is reasonable to expect that people's use of the internet could generate critical changes in gender role attitudes and increase dissatisfaction toward current housework division or traditional gender identities within the family. Also, internet usage is likely to crowd out time spent on housework and create marital dissatisfaction in China.

The above discussion leads to the following hypotheses:

Hypothesis 3 Internet usage is likely to affect gender role attitudes in China; Changes in gender role attitudes from internet usage are likely to create marital dissatisfaction among married people in Chinese society.

Hypothesis 4 Internet usage is likely to crowd out time spent on housework, create dissatisfaction toward current housework load within families, and create marital dissatisfaction in China.

Several existing studies have already shown that internet access is positively related to the national divorce rate in China (Wang & Li, 2012; Zhang et al., 2018; Zheng et al., 2019). Still, there is a lack of evidence at the individual level, and there has been relatively little research on the association between internet use and the decision to divorce. Our study attempts to fill this gap by focusing on the relationship between the internet user experience and marital satisfaction using household survey data to explain the increase in China's divorce rate. We also examine the mediating roles played by the reduction in search cost, changes in gender role attitudes, and crowding-out effects on housework sharing in the relationship between internet use and marital satisfaction.

3 Data, Measures, and Statistics

3.1 Data and Measures

This study utilized the 2014 and 2018 waves of the CFPS. This is a large-scale, nationally representative survey covering more than 162 counties from 29 provinces in China and provides comprehensive information on a range of topics. Of interest to this study, is that it surveys respondents' overall marital satisfaction, satisfaction with spousal economic and housework contributions, internet use experiences, self-reported health conditions, educational attainment levels, gender, residential information, and so on. To answer the primary research questions on the relationship between internet usage and marital satisfaction, our main empirical sample included married respondents born between 1960 and 1990 surveyed in the 2014 and 2018 waves of population average effect estimations. We

also followed the marital status of respondents who reported that they were married in the period 2014 to 2018.¹

3.1.1 Dependent Variables

First, we estimated the average population effect with pooled regressions and the causal impact on the decision to marry by regressing marital status in 2018 with internet utilization in 2014. The dependent variable of *marital stability* equals 1 if the individual stayed married. Second, we examined influence of internet usage on marital satisfaction, which is the primary manner in which the internet is relevant in marriage. We focused on three survey questions: “*On the whole, are you satisfied with your marriage?*”; “*Are you satisfied with your spouse’s economic contribution to the family?*”; and “*Are you satisfied with your spouse’ contribution in terms of sharing housework?*” Respondents chose an answer from 1 to 5, where 5 was “very satisfied,” 3 was “not satisfied but not unsatisfied,” and 1 was “very unsatisfied.” While our study adopted the questions regarding overall marital satisfaction as the benchmark, the other two were also analyzed to show different perspectives of the respondents’ feelings about their married lives.

3.1.2 Important Explanatory Variables

For a more comprehensive and robust study, we measured internet usage experience from different perspectives with the rich information provided by this dataset. Questions adopted here include: 1. “*How many hours on average per week do you spend on the internet (including mobile internet) in your off-hours?*”; 2. “*Do you ever use the internet (including mobile internet)?*”; 3. “*In general, how frequently do you use the internet for studying (such as searching for learning materials and taking online courses)?*”; 4. “*In general, how frequently do you use the internet for entertainment (such as watching videos and downloading music)?*”; 5. “*In general, how frequently do you use the internet for social interaction (such as chatting online and using Facebook or micro-blogs)?*” Respondents’ answers to questions 3–6 were categorized as follows: *never use the internet, use the internet but not for this function, use monthly, 1–2 times per week, 3–4 times per week, and every day*. Note that we used the numerical variable, *hours online per week*, as the key measure of interest.

We further used a very specific internet use experience associated with a decrease in search costs related to dating, *chatting with strangers online*. Respondents were asked to indicate the extent to which they use the internet to interact with others. The categories were as follows: *never use the internet, use the internet but never chat with others, chat sporadically, and chat often*. Responses revealed whether one’s pool of potential romantic partners was expanded, whether one’s opportunity for finding potential new partners was increased (outside options), and whether one’s search costs decreased. Another investigated

¹ First, CFPS is a longitudinal survey dataset. The 2018 wave is the latest available wave. However, questions in the survey significantly change year by year. For example, marital satisfaction questions as well as internet questions were not included in 2016; questions related to gender role attitudes and self-reported household status were not surveyed in 2018. The 2014 and 2018 waves are relatively more consistent than the other waves, which lack important information. Second, we also examined alternative age spans, for example, individuals aged 20 to 60 and 30 to 50. Consistent results were found, and results are available upon request.

factor was *hours spent on housework*. If more time was spent on the internet, it would replace time on housework and lower willingness to share housework.

In addition, the respondents were asked to choose, on a five-point scale, their degree of agreement with given gender role attitudes. Low numbers indicated disagreement, whereas high numbers indicated agreement. The midpoint (3) indicated indifference or undecided. Statements included: “*Men are career-oriented, while women are family-oriented*”; “*For women, a good marriage is better than a good career*”; “*Women should have children to be complete*”; “*Men should be responsible for half of the housework.*” The last statement reflects a relatively modern view toward sharing housework. In general, women’s empowerment occurs through respondents’ changes in attitudes toward traditional gender roles, and respondents’ gender ideologies are important mediators of satisfaction toward their spouses. The current study utilized these statements to test whether internet usage affected marital satisfaction regarding changing gender role attitudes and the empowerment of women.

3.1.3 Other Control Variables

For a better *ceteris paribus* effect estimation, we partialled out confounding factors, including self-evaluated household social status (only for 2014), job types, personal annual income, having children or not (only for 2014), self-reported health conditions, educational attainment, gender, survey year fixed effect, birth year cohort effects, time trend (age), and regional heterogeneity. Regional heterogeneity was controlled for by an urban dummy and provincial indicator. Birth year cohort effects were controlled for by a group of birth year indicators. Household social status was measured by categorical indicators, which revealed important information on family revenue-associated status.

3.2 Main Statistics

The main descriptive statistics are reported in Table 1. On average, the marital satisfaction score was 4.464 on the five-point scale, while satisfaction toward spousal economic and housework contribution were 4.288 and 4.123, respectively. Overall, the mean scores for all satisfaction measurements were higher in 2018 than in 2014. Note that those who married in 2014 but became single in 2018 were not surveyed for marital satisfaction levels. Group differences in overall marital satisfaction and satisfaction with spousal housework and economic contributions were statistically significant. In traditional Chinese households, the wife is responsible for daily chores, therefore women had much lower scores regarding satisfaction with their spouses’ housework contribution. Mean satisfaction scores for this measure were slightly higher for internet users compared with non-internet users (4.4693 vs. 4.4598, respectively), but were not significant. The same was true for satisfaction with spousal economic contribution, while mean satisfaction scores for spousal housework contribution were significantly lower for internet users than non-internet users. Finally, regarding the marital status of respondents from 2014 to 2018, around 2.2% changed to single, cohabitation, or divorce after four years.

With respect to internet usage, 44.7% of the respondents were internet users, and the average amount of off-work hours per week spent online was 5.09. Both increased from 2014 to 2018. Approximately 53.3% were females, and approximately 48.2% were urban residents. Females on average reported 0.25 on 5-point scale lower marital satisfaction than male sample (females 4.347 vs males 4.593). This finding is consistent with the literature

Table 1 Descriptive statistics (2014 and 2018 CFPS)

Variable	Obs	Mean	Std. Dev	Min	Max
Marital Satisfaction	28,703	4.464	0.885	1	5
Satisfaction towards spousal economic contribution	28,687	4.288	0.984	1	5
Satisfaction towards spousal housework contribution	28,691	4.123	1.145	1	5
Hours online per week	28,703	5.089	9.184	0	84
Internet Utilization	28,703	0.447	0.497	0	1
Whether chat with strangers online					
<i>Not use internet</i>	28,703	0.553	0.497	0	1
<i>Use internet but Never</i>	28,703	0.367	0.482	0	1
<i>Sporadic Chat</i>	28,703	0.075	0.263	0	1
<i>Often Chat</i>	28,703	0.005	0.069	0	1
Frequency of internet utilization for social interaction					
<i>Not internet user</i>	28,703	0.554	0.497	0	1
<i>Internet user but not this function</i>	28,703	0.060	0.238	0	1
<i>Monthly use</i>	28,703	0.008	0.090	0	1
<i>1–2 times per week</i>	28,703	0.009	0.094	0	1
<i>3–4 times per week</i>	28,703	0.141	0.348	0	1
<i>Every day</i>	28,703	0.228	0.420	0	1
Frequency of internet utilization for entertainment					
<i>Not internet user</i>	28,703	0.553	0.497	0	1
<i>Internet user but not this function</i>	28,703	0.056	0.231	0	1
<i>Monthly use</i>	28,703	0.011	0.103	0	1
<i>1–2 Times per Week</i>	28,703	0.014	0.119	0	1
<i>3–4 Times per Week</i>	28,703	0.184	0.388	0	1
<i>Every day</i>	28,703	0.181	0.385	0	1
Frequency of internet utilization for education					
<i>Not internet user</i>	28,703	0.553	0.497	0	1
<i>Internet user but not this function</i>	28,703	0.203	0.402	0	1
<i>Monthly use</i>	28,703	0.019	0.138	0	1
<i>1–2 times per week</i>	28,703	0.020	0.140	0	1
<i>3–4 times per week</i>	28,703	0.127	0.333	0	1
<i>Every day</i>	28,703	0.077	0.267	0	1
Ln (total annual income)	27,906	4.491	5.052	0	13.641
Job types					
0 Unemployed	28,703	0.102	0.303	0	1
1 self-employed agricultural production	28,703	0.350	0.477	0	1
2 self-employed private sectors as well as enterprises	28,703	0.122	0.327	0	1
3 employed in Agricultural Industry	28,703	0.006	0.076	0	1
4 employed in non-farm sectors	28,703	0.393	0.488	0	1
5 casual works	28,703	0.028	0.164	0	1
Education levels					
Illiterate	28,703	0.173	0.378	0	1
Primary	28,703	0.221	0.415	0	1

Table 1 (continued)

Variable	Obs	Mean	Std. Dev	Min	Max
<i>Junior</i>	28,703	0.321	0.467	0	1
<i>Senior</i>	28,703	0.135	0.342	0	1
<i>College and above</i>	28,703	0.150	0.357	0	1
Self-reported health condition from very healthy to unhealthy 1–5					
1	28,703	0.149	0.356	0	1
2	28,703	0.189	0.392	0	1
3	28,703	0.398	0.490	0	1
4	28,703	0.141	0.348	0	1
5	28,703	0.123	0.328	0	1
Female	28,703	0.533	0.499	0	1
Age	28,702	42.123	8.965	24	58
Urban	28,441	0.482	0.500	0	1
Whether has kids or not	16,162	0.946	0.225	0	1
Household social status the lowest to the highest 1–5					
1	16,132	0.059	0.236	0	1
2	16,132	0.130	0.336	0	1
3	16,132	0.539	0.499	0	1
4	16,132	0.199	0.399	0	1
5	16,132	0.073	0.260	0	1
Hours spent on housework					
	16,115	2.023	1.834	0	10
Gender role attitude 1	16,154	3.987	1.174	1	5
Gender role attitude 2	16,127	3.534	1.329	1	5
Gender role attitude 3	16,143	4.182	1.125	1	5
Gender role attitude 4	16,154	4.071	1.090	1	5

Empirical sample includes married respondents born between 1960 and 1990. Since the survey questions are not perfectly consistent, we only have variables, *whether has kids or not*, *household social status for 2014*, *hours spent on housework and gender role attitudes* in 2014, but not for 2018. That is why the observation number changes. Gender role attitude 1: Men are career oriented while women are family oriented; Gender role attitude 2: Women marry better than do well; Gender role attitude 3: Women should have children to be complete; Gender role attitude 4: Men should take up half of the housework

(Elmslie & Tebaldi, 2014; Jackson et al., 2014; Liu et al., 2013; Qian & Sayer, 2016). Average age was around 42.123 years. The younger, the higher the likelihood of using the internet and there exists a time trend over time. Based on our empirical sample, differences in overall marital satisfaction across birth cohorts (age) are insignificant, while statistics shows that satisfaction towards spousal economic as well as housework contribution is statistically higher for the older. Relatively more males use the internet slightly more than females and the ratio is 1.113. The frequency of internet use for education is quite low compared with usage for entertainment and social functions. And there exists increasing time trends for all the online activities from the old cohorts to the young cohorts. Among the 12,818 internet users, 2,290 had chatted online with strangers, 11,084 used the internet for social interaction, 6,989 used the internet for education, and 11,201 regularly used the internet for entertainment.

With respect to gender role attitudes, the mean score for “*Men are career-oriented, while women are family-oriented*” was 3.987; the mean score for “*For women, a good marriage is better than a good career*” was the lowest at 3.534; the mean score for “*Women should have children to be complete*” was the highest at 4.182; and the mean score for “*Men should be responsible for half of the housework*” was 4.071. Each of these scores decreased from 2014 to 2018. Finally, internet users spent less time on housework than non-internet users (2.31 vs. 1.45).

4 Empirical Findings

4.1 Effects of Internet Usage on Marital Satisfaction and Instability

Based on the literature, the population average effect estimation model is as follows:

$$MS_{ijot} = \beta_0 + \beta_1 \text{Hours on line per week}_{ijot} + \beta_2 \text{Female} + \beta_3 \text{Urban}_{iot} + \Omega X_{ijot} + \gamma_0 + \delta_t + \tau_j + \varepsilon_{ijot} + \gamma_0 + \delta_t + \tau_j + \varepsilon_{ijot} \quad (1)$$

where i represents individual i , j represents birth year, t represents survey year, and o indicates province. MS_{ijot} is the extent to which an individual i born in birth year j and province o and interviewed in survey year t is satisfied with his or her current marriage. $\text{Hours on line per week}_{ijot}$ refers to how many hours the respondent uses the internet (including mobile internet) outside of work per week. Female equals 1 if individual i is female (0 otherwise) and urban equals 1 if an individual i lives in an urban area (0 otherwise). X_{ijot} is the vector of control variables. Empirically, we have tried to control for less variables first and then introduce more for robustness checks. δ_t is the survey year fixed effect, indicates provincial fixed effects, and τ_j represents birth year cohort effects. We implemented linear probability and nonlinear probability models (ordered logit), but we take linear probability estimates as the benchmark because OLS estimates are self-evident and can be interpreted directly as well as intuitively.

Main outcomes are presented in Table 2. All regressions were simultaneously controlled for respondents' gender, annual income, job types, educational attainment, health conditions, time trends, an urban dummy, survey year fixed effects, birth year cohorts, and provincial fixed effects. Note that we not only evaluated the effects on overall marital satisfaction in panel A but also on satisfaction with spousal economic and housework contribution as well. We consistently found that there were negative marginal effects of internet usage experience on marital satisfaction and satisfaction with spousal housework contribution. However, our findings do not support a negative effect of internet usage on satisfaction toward spousal economic contribution. As indicated, one more hour online per week can significantly decrease marital satisfaction by 0.0024 points and satisfaction with spousal housework contribution by 0.0044 points. Given our empirical sample, an internet user on average spends 11.4 h on the internet every week and exhibits a mean marital satisfaction level of 4.464. Compared with the non-internet user group, the average user's satisfaction level decreased by 1.422 on the five-point scale ($11.4 * 0.0024 * 52$) in a year. Considering that nationwide, internet users spent on average 28 h online per week in 2018, their

Table 2 Internet Use, Marital Satisfaction and Marital Stability

Panel A		(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables		Marital Satisfaction		Satisfaction towards spouse's		Satisfaction towards spouse's	
		Marital Satisfaction		Economic contribution		Housework contribution	
Estimation method	OLS	Order Logit	Order Logit	OLS	Order Logit	OLS	Order Logit
Sample	2014 and 2018	2014 and 2018	2014 and 2018	2014 and 2018	2014 and 2018	2014 and 2018	2014 and 2018
Hours online per week	- 0.0024*** (0.001)	- 0.0062*** (0.002)	- 0.0006 (0.001)	- 0.0062*** (0.002)	- 0.0044*** (0.001)	- 0.0070*** (0.002)	- 0.0070*** (0.002)
Ln (annual income)	0.0028 (0.002)	0.0084* (0.004)	- 0.0009 (0.002)	0.0084* (0.004)	0.0063*** (0.002)	0.0111*** (0.004)	0.0111*** (0.004)
Education attainment	Base: ILITERATE						
Primary	0.0036 (0.020)	- 0.0156 (0.047)	- 0.0113 (0.021)	- 0.0156 (0.047)	- 0.0351 (0.023)	- 0.0760* (0.044)	- 0.0760* (0.044)
Junior high	- 0.0122 (0.020)	- 0.1284*** (0.046)	- 0.0238 (0.021)	- 0.1284*** (0.046)	- 0.0955*** (0.023)	- 0.2281*** (0.044)	- 0.2281*** (0.044)
Senior high	- 0.0381 (0.024)	- 0.2317*** (0.056)	- 0.0589** (0.026)	- 0.2317*** (0.056)	- 0.1709*** (0.029)	- 0.3761*** (0.053)	- 0.3761*** (0.053)
College and Above	- 0.0039 (0.023)	- 0.1713*** (0.056)	- 0.0356 (0.026)	- 0.1713*** (0.056)	- 0.1338*** (0.030)	- 0.3230*** (0.054)	- 0.3230*** (0.054)
Female	- 0.2237*** (0.012)	- 0.6038*** (0.029)	- 0.1873*** (0.013)	- 0.6038*** (0.029)	- 0.6485*** (0.015)	- 1.1696*** (0.027)	- 1.1696*** (0.027)
Observations	27,654	27,654	27,643	27,643	27,647	27,647	27,647
R-squared/Wald chi2	0.054	1651.75	0.037	1204.18	0.121	3575.59	3575.59

Table 2 (continued)

Panel B	(7)	(8)	(9)	(10)	(11)	(12)
Dependent variables	Marital stability					2018 Stability
Logit regression and sample	2014 and 2018	2014 and 2018	2014 and 2018	2014	2018	with 2014 controls
Hours online per week	- 0.016*** (0.002)		- 0.007 (0.007)	- 0.015*** (0.003)	- 0.017*** (0.003)	- 0.017*** (0.003)
Average marginal effect	- 0.0011***		- 0.00003	- 0.0011***	- 0.0010***	- 0.0004***
Marital satisfaction		0.363*** (0.076)	0.362*** (0.077)			
Average marginal effect		0.0019***	0.0019***			
Observations	31,259	24,800	24,753	18,852	12,384	12,541
Pseudo R-squared	0.174	0.113	0.114	0.204	0.116	0.038

Full regressions control for personal annual income, education attainment, self-reported health status, job types, gender, urban dummy, constant, age, survey year fixed effect, birth year fixed effects and provincial fixed effects. Robust standard errors adjusted for clusters in personal id are reported in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The main empirical sample includes married respondents born between 1960 and 1990 in panel A. In panel B, all marital status excluding being widowed from 2014 and 2018 waves are considered in regression (7). In regression (8) and (9), we control for marital satisfaction and note that those who divorce or is single will not report marital satisfaction. Therefore, the sample changes. In regression (10) and (11), we consider 2014 and 2018 wave respectively, but we don't control for marital satisfaction. Meanwhile, in regression (12), we follow the initially married population in 2014 over time and examine the effect of internet use on their marital status in 2018. Around 12,541 observations born between 1960 and 1990 that married with spouse in 2014 are followed and re-surveyed in 2018

satisfaction level was 3.494 ($28 \times 52 \times 0.0024$) lower compared with the group not using the internet.²

We have presented estimates of interest in Table 2.³ Personal annual income was only significantly positively related to satisfaction with spousal housework. One interpretation for this is that it is common for the partner who earns less to take on most of the housework within a family so that the other with the higher income is more likely to satisfy with his or her spousal housework contribution. Estimates of educational attainment were insignificant when marital satisfaction was the dependent variable. We also found that respondents with a higher education level were more likely to be dissatisfied with their spouse's housework contribution. The consistent negative estimates for gender dummies indicate that women were less satisfied overall with their marriage and spouses' contributions than men by 0.224 points, and they were much less satisfied regarding spouses' housework contribution. After controlling for the socio-economic conditions and demographic variables of respondents, age and age squared as controlled variables becomes insignificant. Additionally, health conditions were positively correlated with marital satisfaction. Most estimates for job types were statistically insignificant; in general, employed respondents were more satisfied. The positive estimate for the urban dummy indicates that urban residents were, on average, more satisfied with their marriages than rural residents.

In panel B, we evaluated the average population effects of internet usage and marital satisfaction on current marital status as well as ex post facto decisions to divorce. Consistent with the literature, we found that a high level of marital satisfaction contributes to marital stability and is a strong predictor of divorce. The key estimates in regressions (7) to (11) indicate a significantly negative association between internet use and marital stability. The result of regression (12) shows that married internet users in 2014 were more likely to be divorced in 2018. We ran regressions (9) while simultaneously controlling for *hours online per week* and marital satisfaction. The estimate of *hours online per week* was insignificant, which implies that internet usage influences marital stability mostly by lowering respondents' marital satisfaction, which is the primary determinant of divorce. Another possibility is that the insignificance is because those divorced had not been surveyed the question of marital satisfaction and were not included in the samples of regression (8) and (9). Overall, our research found that use of the internet was likely to lower levels of marital satisfaction, which corresponds to the positive association of internet utilization and later marital instability. Our results provide micro-level evidence for the positive association between the provincial internet coverage rate and divorce rate found by existing literature (Li, 2014).

According to the above results, our common hypothesis that there exists a strongly negative ceteris paribus effect of internet usage on marital satisfaction is supported. Table 3 further presents results for alternative measures for internet usage and different estimation methods for robustness checks. The regressions were run with the 2014 and 2018 waves in panel A, respectively. The negative effects were slightly stronger in 2018. Statistically, compared with those who never use the internet, internet users on average scored 0.027 points lower for marital satisfaction and 0.098 points lower for satisfaction with spousal housework-sharing (panel B). The relation between internet use and satisfaction with spousal economic contribution was insignificant, as in Table 2.

² According to China Internet Development Reports, weekly time online of internet users climbed from 25.9 hours in 2014 to 28 in 2018. Source: <http://www.cnnic.net.cn/>.

³ Because of space limitations, we haven't presented all estimates and full results are available upon request.

Table 3 Marital satisfaction and internet use: alternative measures and different functions

Panel A									
Dependent variables	Marital satisfaction			Spouse's economic contribution			Spouse's housework contribution		
	2014	2018	2014	2014	2018	2014	2014	2018	2018
OLS/sample									
Hours online per week	- 0.002* (0.001)	- 0.003*** (0.001)	0.0001 (0.001)	- 0.0015 (0.001)	- 0.0015 (0.001)	- 0.004*** (0.001)	- 0.005*** (0.001)		
Female	- 0.161*** (0.015)	- 0.311*** (0.016)	- 0.103*** (0.016)	- 0.308*** (0.020)	- 0.308*** (0.020)	- 0.569*** (0.018)	- 0.755*** (0.021)		
Observations	16,006	11,648	16,002	11,641	11,641	16,003	11,644		
R-squared	0.052	0.072	0.034	0.054	0.054	0.107	0.149		
Panel B									
Dependent variables	Marital satisfaction			Spouse's economic contribution			Spouse's housework contribution		
	2014 and 2018			2014 and 2018			2014 and 2018		
	OLS	Order Logit	Order Logit	OLS	Order Logit	Order Logit	OLS	Order Logit	Order Logit
Internet	- 0.027* (0.014)	- 0.108*** (0.034)	0.0143 (0.016)	0.0081 (0.032)	- 0.098*** (0.017)	- 0.171*** (0.032)			
Observations	27,711	27,711	27,700	27,700	27,704	27,704			
R-squared/wald chi2	0.053	1649.54	0.037	1210.26	0.122	3628.04			
Panel C									
Dependent variable marital satisfaction									
Diverse online experiences	Education	Social interaction	Entertainment	Education	Social interaction	Entertainment	Education	Social interaction	Entertainment
Not internet user	OLS estimation with empirical sample from 2014 and 2018						Base group		
							Not in sample		

Table 3 (continued)

Panel C						
Dependent variable marital satisfaction						
Diverse online experiences	Education	Social interaction	Entertainment	Education	Social interaction	Entertainment
<i>Internet user but not for this Function</i>	- 0.024 (0.016)	0.034 (0.021)	0.021 (0.023)	Base group		
<i>Monthly use</i>	- 0.088** (0.037)	- 0.129** (0.058)	- 0.047 (0.047)	- 0.068* (0.037)	- 0.170*** (0.061)	- 0.075 (0.051)
<i>1-2 times per week</i>	- 0.065* (0.038)	- 0.110* (0.057)	- 0.072* (0.042)	- 0.046 (0.037)	- 0.148** (0.059)	- 0.101** (0.046)
<i>3-4 times per week</i>	- 0.026 (0.018)	- 0.036** (0.017)	- 0.038** (0.016)	- 0.007 (0.019)	- 0.070*** (0.024)	- 0.071*** (0.024)
<i>Every day</i>	- 0.003 (0.022)	- 0.033* (0.017)	- 0.025 (0.017)	0.010 (0.022)	- 0.072*** (0.024)	- 0.058** (0.025)
Observations	27,931	27,931	27,931	12,448	12,445	12,448
R-squared	0.054	0.054	0.054	0.071	0.072	0.071

Full regressions control for personal annual income, education attainment, self-reported health status, job types, gender, urban dummy, constant, age, survey year fixed effect, birth year fixed effects and provincial fixed effects. Robust standard errors adjusted for clusters in personal id are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The main empirical sample includes married respondents born between 1960 and 1990

In panel C of Table 3, we examined specific functions of the internet usage experience, which can shed light on the specific channel through which internet usage affects marital satisfaction. Empirically, instead of hours spent online, we used different explanatory variables depicting respondents' frequency of internet use for social interaction, entertainment, and education. The regression model is as follows:

$$MS_{ijot} = \beta_0 + \beta_1 \text{Internet_Using_Functions}_{ijot} + \beta_2 \text{Female} \\ + \beta_3 \text{Urban}_{iot} + \Omega X_{ijot} + \gamma_0 + \delta_t + \tau_j + \varepsilon_{ijot} \quad (2)$$

For education-related internet usage, we found that the effects were stronger for people who used the internet monthly or once or twice a week compared with other frequencies. No differences were found between the daily-educational-use internet group and the no-usage internet group. For social interaction-related use, in general, the more frequently a respondent used the internet, the less he or she was satisfied in his/her marriage. For entertainment-related use, we found that the negative effects were stronger for those who used the internet once or twice and three to four times per week compared with other groups. We also evaluated the effects of these distinct internet usages on satisfaction with spousal economic and housework contribution. Using marital satisfaction and satisfaction with spousal housework contribution as dependent variables, we found significantly negative impacts of the different internet usages, while the impact was insignificant in the case of satisfaction with spousal economic contribution. These findings are consistent with those presented in Tables 2 and 3.

To summarize, empirical evidence supports the idea that married people's internet usage negatively influences marital stability and spousal satisfaction with housework contribution. The influence of distinctive internet usages on marital satisfaction could differ. To sum up, evidence supports hypothesis 2 that online social interaction and entertainment generate significantly negative influences on marital satisfaction, especially for those who use the internet more frequently.

4.2 Mediators: Chatting with Strangers Online and Lowered Search Costs

Social communication is one of the internet's critical functions. It connects social networks, lowers communication costs, and increases communication speed. It has also reduced the search costs of the marriage market and enlarged the available dating pool/set (outside options). For married couples, the lower search cost means more outside options, higher expectations of current partners, and smaller opportunity costs for divorce. Table 3 shows that, in general, the more frequently a person uses the internet for social interaction, the less she or he is satisfied with the current marriage. Table 4 focuses on a specific online social activity, online chatting with strangers, as a proxy for lower search costs. In other words, it reports directly measured lowered search costs and increased outside options in the marriage market for respondents. Results of *whether you have chatted with strangers online* with the sample of internet users are reported in panel A, and those including the entire empirical sample are reported in panel B. On the whole, key estimates of internet usage are consistently significantly negative, indicating the negative marginal effects of online chatting on marital satisfaction. In panel A, compared with those who have never chatted with strangers online, other internet users, on average, showed a decrease of 0.165 points for marital satisfaction, 0.158 for satisfaction with spousal housework-sharing, and 0.146 for satisfaction with spousal economic contribution. Similar results were also found

Table 4 Decrease in searching cost: online chatting with strangers and marital satisfaction

Dependent variables	Marital satisfaction			
	2014 and 2018		2018	
	2014	2018	2014 and 2018	2018
OLS estimation			Economic	Housework
Panel A	Spousal contribution			
<i>Whether has chatted with strangers online</i>				
Observations	Comparison within internet users	-0.156*** (0.031)	-0.146*** (0.024)	-0.158*** (0.027)
R-squared		5.417	12,441	12,446
Panel B	Comparison within full empirical sample	0.071	0.052	0.16
<i>Whether has chatted with strangers online</i>				
Observations		-0.025* (0.014)	0.019 (0.016)	-0.090*** (0.017)
R-squared		16,092	27,913	27,916
Panel C	Comparison among groups	0.052	0.037	0.121
<i>Based group</i>	Never use internet			
<i>1 Never chat but using internet</i>		-0.009 (0.020)	-0.047*** (0.016)	-0.063*** (0.018)
<i>2 Sporadic chat with Strangers online</i>		-0.147*** (0.023)	-0.099*** (0.025)	-0.214*** (0.028)
<i>3 often chat with Strangers online</i>		-0.158* (0.085)	-0.053 (0.091)	-0.032 (0.092)
Observations		27,924	27,924	27,913
R-squared		0.056	0.056	0.038

Full regressions control for personal annual income, education attainment, self-reported health status, job types, gender, urban dummy, constant, age, survey year fixed effect, birth year fixed effects and provincial fixed effects. Robust standard errors adjusted for clusters in personal id are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Panel A only considers internet users that married respondents born between 1960 and 1990 and panel B as well as C examine all the married respondents born between 1960 and 1990

for the full sample in panel B. In panel C, we used alternative categorical measures for online chatting with strangers, also finding a negative impact on marital satisfaction: the more frequently a respondent chatted with strangers, the more likely he or she was dissatisfied. For overall marital satisfaction, results for those who never use the internet were similar to those for internet users who never use it to chat with strangers. Regarding satisfaction with spousal economic and housework contribution as dependent variables, evidence shows that no differences were found between those who often chat with strangers online and those who never use the internet.

Thus, the groups who chat with strangers online are more likely to be dissatisfied with their spouses compared with those internet users who never chat online as well as those who never use the internet. This finding implies that the lowered search cost coupled with increased outside options is one of the most important mediators for the impact of internet use on marital well-being. Therefore, our hypothesis 1 is strongly supported. In addition, because the survey does not provide information on communication with current partners, we cannot do further analysis. Plausibly, the effects are different when the internet is used to communicate with one's spouse.

4.3 Mediators: Changed Gender Role Attitudes and Crowd-out Effects

Next, we consider whether beliefs about appropriate role-related behaviors for women and men within families play a mediating role in internet usage and marital satisfaction. In other words, we explore a specific channel, changes in gender role ideology, as the mechanism through which internet usage affects the marital relationship. The traditional view of gender roles supports that “Men should be career-oriented, while women should be family-oriented,” “For women, a good marriage is better than a good career,” “Women should have children to be complete,” “Women should be responsible for all the housework,” and so on. Are gender role attitudes changed by internet usage? Additionally, will the internet's influence on gender role attitudes further affect marriage satisfaction? The modernization of gender roles, to some extent, work to empower women; expectations toward spouses and marriage will be increased during this modernization and implicitly influence spousal relationships.

To study this possibility, we ran multiple multivariate regressions of gender role attitudes on internet utilization, regressions of marital satisfaction on gender role attitudes, and regressions of marital satisfaction on both gender role attitudes and internet utilization. The regressions are presented below; because only the 2014 wave of the CFPS provides gender role attitude information, there is no time dimension. The changes in estimates for internet utilization imply how internet utilization affects marital satisfaction through changing gender role ideology.

$$MS_{ij0} = \beta_0 + \beta_1 \text{Gender Role Attitude}_{ij0} + \beta_2 \text{Female} + \beta_3 \text{Urban} + \Omega X_{ij0} + \gamma_0 + \tau_j + \varepsilon_{ij0} \quad (3)$$

$$MS_{ij0} = \beta_0 + \beta_1 \text{Gender Role Attitude}_{ij0} + \beta_2 \text{Internet}_{\text{Utilization}_{ij0}} + \beta_3 \text{Female} + \beta_4 \text{Urban} + \Omega X_{ij0} + \gamma_0 + \tau_j + \varepsilon_{ij0} \quad (4)$$

$$\text{Gender Role Attitude}_{ij0} = \beta_0 + \beta_1 \text{Internet}_{\text{Utilization}_{ij0}} + \beta_2 \text{Female} + \beta_3 \text{Urban} + \Omega X_{ij0} + \gamma_0 + \tau_j + \varepsilon_{ij0} \quad (5)$$

Table 5 Potential mechanism: changes in traditional gender identities and hours on housework

Panel A	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Dependent variable marital satisfaction</i>							
Internet Utilization	-0.054*** (0.018)	-0.038** (0.019)	-0.053*** (0.018)	-0.049*** (0.018)	-0.054*** (0.018)	-0.042** (0.018)	-0.043** (0.018)
Attitude 1		0.056*** (0.007)				0.050*** (0.007)	0.052*** (0.007)
Attitude 2			0.010* (0.006)			-0.026*** (0.006)	-0.027*** (0.006)
Attitude 3				0.055*** (0.007)		0.038*** (0.007)	0.038*** (0.007)
Attitude 4					0.073*** (0.007)	0.064*** (0.007)	0.064*** (0.007)
Hours spent on house works					-0.011**		
Whether has Kids or not	-0.058** (0.029)	-0.059** (0.029)	-0.058** (0.029)	-0.063** (0.029)	-0.061** (0.029)	-0.064** (0.029)	-0.066** (0.028)
Self-Evaluated Household Status							
2 <i>Relatively Low</i>	-0.044 (0.042)	-0.038 (0.042)	-0.043 (0.042)	-0.037 (0.042)	-0.038 (0.042)	-0.029 (0.042)	-0.030 (0.042)
3 <i>Middle</i>	0.122*** (0.038)	0.123*** (0.038)	0.123*** (0.038)	0.124*** (0.038)	0.124*** (0.037)	0.127*** (0.037)	0.128*** (0.037)
4 <i>Relatively High</i>	0.227*** (0.039)	0.220*** (0.039)	0.226*** (0.039)	0.225*** (0.039)	0.224*** (0.039)	0.221*** (0.039)	0.222*** (0.039)
5 <i>High</i>	0.347*** (0.046)	0.328*** (0.045)	0.343*** (0.046)	0.334*** (0.046)	0.328*** (0.045)	0.316*** (0.045)	0.317*** (0.045)
Observations	16,106	16,101	16,078	16,088	16,100	16,060	16,015

Table 5 (continued)

Panel A							
OLS	(1)	(2)	(3)	(4)	(5)	(7)	
R-squared	0.065	0.069	0.065	0.069	0.072	0.078	
Panel B							
OLS	(1)	(2)	(3)	(4)	(5)	(7)	
Dependent variables	Attitude 1	Attitude 2	Attitude 3	Attitude 4	Index 1	Index 2	
Internet UTILIZATION	-0.303*** (0.025)	-0.191*** (0.028)	-0.099*** (0.025)	-0.003 (0.024)	-0.149*** (0.017)	-0.024*** (0.005)	-0.160*** (0.031)
Observations	16,107	16,084	16,094	16,105	16,065	16,112	16,066
R-squared	0.135	0.087	0.052	0.037	0.121	0.399	0.257
PSM estimates							
Difference	-0.346*** (0.047)	-0.158* (0.053)	-0.123** (0.045)	0.026 (0.044)	-0.157*** (0.032)	-0.039*** (0.011)	-0.119* (0.068)
Observations	16,107	16,084	16,094	16,105	16,065	16,112	16,066

Full regressions control for whether has kids or not, self-evaluated household status, personal annual income, education attainment, self-reported health status, job types, gender, urban dummy, constant, age, survey year fixed effect, birth year fixed effects and provincial fixed effects. Robust standard errors are reported in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The main empirical sample includes married respondents born between 1960 and 1990 in 2014 since the channel variables are not surveyed in 2018. Index 1 is measured by the average score of all the attitudes, while Index 2 is measured by the average score of all the attitudes over gender, province, and birth cohort

The estimation results are presented in Table 5. As shown in panel B, compared with respondents who never access the internet, internet users, on average, were less likely to agree with the statements representing the traditional view of gender roles: “*Men are career-oriented, while women are family-oriented,*” “*For women, a good marriage is better than a good career,*” and “*Women should have children to be complete.*” However, a relatively modern gender role attitude, “*Men should be responsible for half of the housework,*” was not significantly affected by internet use. We also took the mean value of the four statements to index respondents’ overall gender role ideology (see Index 1) as well as the mean value of the four statements over birth cohort, gender, and province (see Index 2). Consistent conclusions were found. For causality checks, we further used propensity score matching (PSM) and found that PSM estimates consistently showed the same results. The effect of “*Men are career-oriented, while women are family-oriented*” was relatively large, -0.346 . Overall, we can conclude that internet usage contributes to more modern gender role attitudes and this is a way to empower women (Riquelme et al. 2018).

Further, the estimates in panel A (Table 5) show the correlations between gender role attitudes and marital satisfaction. The higher the level of agreement with the four statements, the higher the respondents’ marriage satisfaction. This pattern implies that the traditional view of gender roles concerning careers, marriage, and children are positively associated with one’s marital satisfaction. Traditional attitudes of family gender roles in China generally promote obedient, easily contented wives and even unfair treatment. However, internet utilization can lead to less agreement with traditional views and more independent, modern women. By contrast, a progressive view of housework-sharing can help enhance marital satisfaction, but internet usage did not generate significant effects on this view. This might be related to time constraints: internet users spend more time online, which could limit their available time to share housework. After controlling for all the statement variables, we observed that estimates of internet utilization decreased from -0.054 to -0.043 . This change pattern implies that internet usage directly affects marital satisfaction and indirectly affects it through changing gender role ideology. The marginal effect of internet utilization on marital satisfaction also changed when we controlled for each attitude individually. Following previous covariate analyses (Jennison & Turnbull, 1997; Nunn, 2008), this implies that internet usage can change gender role attitudes and is relevant to marital satisfaction to some extent, accounting for 20.4% of the overall effect of internet usage on marital satisfaction.

Worth mentioning, the 2014 wave provides more associated variables, fertility conditions, household status, and hours spent on housework. We found that respondents who reported higher levels of social status were more likely to feel satisfied in their current marriage. Marriages of respondents with children were more stable, although they were less satisfied with spousal contribution to housework and with marriage overall. Internet use can reduce one’s hours spent on housework and probably increase the partner’s time spent on it. However, spending more hours on housework does not contribute to higher levels of marriage satisfaction. On average, women spent 1.5 h more than men on housework and used the internet less, which explains why women reported lower satisfaction levels. More internet use leads to lower marital satisfaction and more housework load as well as lower marital satisfaction. From this respect, to some extent, if males share more housework, it can dilute the internet’s negative effect on marriage satisfaction with family. After controlling for hours spent on housework, the effect of internet utilization from regression (7) is slightly higher in absolute value than regression (6), even though the difference is insignificant. In practice, men use the internet more and perform household chores less than women, which widens the gender gap regarding marital satisfaction, especially as women’s attitudes toward traditional gender roles change.

Thus, according to the above evidence, we found that the effect of internet utilization on marital satisfaction occurred partially through changing gender role ideology and crowding out time spent on housework. Internet use has promoted modernization of gender role attitudes and strengthened women's demand for gender equality, which has in turn negatively affected marriage satisfaction in China. An increase in internet utilization leads to media dependency and reduces hours spent on housework.

Regardless, one's own satisfaction toward a partner or the marital satisfaction of the partner will be negatively affected. Therefore, our hypothesis 3 and 4 are supported.

Additionally, we recognize that mediators can be complex, and some relationships could potentially be bi-directional. To check robustness, we applied structural equation modeling with the maximum likelihood estimation method and tested the structural relationship among internet usage, gender role attitudes, and marital satisfaction, as well as using the alternative measure for internet usage of hours online per week. These differing methods produced consistent results strongly supporting that changes in gender role attitudes (an aspect of women's empowerment) link internet use and marital satisfaction.

4.4 Heterogeneous Effects

To estimate heterogeneous effects, we ran regressions after separating the sample according to respondents' educational attainment and household social status. The results are presented in panel A and B of Table 6, respectively. With respect to education levels, the estimates for hours spent online per week are significantly negative for the subsample with junior and senior high educational attainment. It is worth noting that significant negative impacts of internet use on satisfaction were not found in more educated respondents even though they use the internet more frequently, which could be because respondents with a college-level education are self-disciplined. However, further studies are required. With respect to household social status, the estimates for internet utilization were significantly negative for the subsamples reporting at the middle of the distribution; the groups who report 2, household income level is relatively low, and 3, household income level is around regional average. Meanwhile, these groups reported using the internet more frequently. Consistent with Table 2, marital satisfaction and satisfaction with spousal housework contribution were significantly affected but not the satisfaction with spousal economic contribution by internet use of the respondents.

In panel C, we ran subsample regressions by genders and different birth cohorts. Results show strong negative effects for the female subsample as well as subsamples of birth cohorts 1971–1980 and 1981–1990, but not for the male subsample and subsamples of birth cohorts 1960–1970. While females use the internet less than males, estimates of interest show a stronger negative marginal effect for females which implicitly points to the important role of changes in gender role awareness in the mechanism. According to descriptive statistics, the younger cohorts spend more average hours online than the older cohorts. Based on the main regressions in Table 2, we fail to find significant effects across birth cohorts, but we observe generational differences in influences of internet use on marital satisfaction when we classify the sample into three generations. The patterns or purposes of internet use experience should exist heterogeneity across generations and those differences working with individual socio-economic status and demographic background have generated diverse influences on their marital satisfaction.

Table 6 Heterogenous effects: education, household social status, and generations

Panel A					
Education levels	Illiterate	Primary	Junior high	Senior	Higher edu
Average hours online per week (empirical sample 2014 and 2018)					
	0.919	2.933	5.611	8.451	9.787
Proportion of internet users (empirical sample 2014 and 2018)					
	0.121	0.295	0.486	0.674	0.796
Marital satisfaction					
Hours online per week	- 0.006 (0.006)	- 0.003 (0.002)	- 0.002** (0.001)	- 0.003* (0.002)	- 0.001 (0.001)
Observation	4,823	6,175	8,904	3,709	4,247
Satisfaction towards spousal economic contribution					
Hours online per week	0.000 (0.005)	- 0.003 (0.002)	0.000 (0.001)	- 0.002 (0.002)	0.000 (0.001)
Satisfaction towards spousal housework contribution					
Hours online per week	- 0.002 (0.002)	- 0.005*** (0.001)	- 0.005** (0.002)	- 0.003* (0.002)	- 0.002 (0.002)
Panel B					
Household Social Status	The lowest = 1	2	Middle	4	The highest = 5
Average hours online per week (empirical sample 2014)					
	2.675	4.077	3.771	3.20	2.048
Proportion of internet users (empirical sample 2014)					
	0.283	0.364	0.368	0.320	0.176
Marital satisfaction					
Hours online per week	0.007 (0.005)	- 0.005* (0.003)	- 0.004*** (0.001)	0.001 (0.002)	0.001 (0.003)
Observations	950	2,084	8,628	3,198	1,172
Satisfaction towards spousal economic contribution					
Hours online per week	- 0.001 (0.006)	- 0.002 (0.004)	0.001 (0.001)	0.003 (0.002)	- 0.003 (0.003)
Satisfaction towards spousal housework contribution					
Hours online per week	- 0.008 (0.007)	- 0.000 (0.004)	- 0.006*** (0.002)	- 0.001 (0.003)	- 0.002 (0.003)
Panel C					
Marital satisfaction					
Subsamples	Female	Male	1960–1970	1971–1980	1981–1990
Average hours online per week (empirical sample 2014 and 2018)					
	4.928	5.287	2.382	4.929	9.713
Hours online per week	0.0032*** (0.001)	- 0.001 (0.001)	- 0.002 (0.001)	- 0.003** (0.001)	- 0.002** (0.001)
Observations	14,708	13,296	12,052	8501	7452

Full regressions control for whether has kids or not (only for panel b), self-evaluated household status (only for panel a), personal annual income, education attainment, self-reported health status, job types, gender, urban dummy, constant, age, survey year fixed effect (only for panel a), birth year fixed effects and provin-

Table 6 (continued)

cial fixed effects. Robust standard errors are reported in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 7 Marital satisfaction and internet use: test for correct parametric specification

Dependent variables	Marital satisfaction				Spousal contribution	
	2014 and 2018	2014 and 2018	2014	2018	2014 and 2018	2014 and 2018
SP-based F-statistic	0.146 [0.325]	0.210 [0.190]	0.605* [0.033]	0.775 [0.110]	0.237 [0.115]	0.310 [0.105]
Lnincome	No	Yes	Yes	Yes	Yes	Yes
Other controls	No	Yes	Yes	Yes	Yes	Yes
Hukou/age /gender	Yes	Yes	Yes	Yes	Yes	Yes
Birth cohorts fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Survey year fixed effects	Yes	Yes	No	No	Yes	Yes

SP-Based F statistic is 1000 times its real value; p value is obtained via 399 bootstrap replications and reported in square brackets *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Full regressions control for whether has kids or not (for 2014), household social status for 2014), education attainment, health status, job types, gender, urban hukou dummy, constant, age, survey year fixed effect, birth year fixed effects and provincial fixed effects

4.5 Functional Forms

To check the robustness of the main empirical results, we used a semiparametric model in which the nonparametric component is an unknown smooth function of a *continuous* variable of interest. This function is estimated by the B-spline approach: the variable of interest is first expanded as several cubic B-spline basis functions, and each of these is then multiplied by a coefficient. In other words, the unknown smooth function is approximated by a linear combination of cubic B-spline basis functions and can be estimated using OLS. A thorough introduction to B-spline is found in Ruppert et al. (2003). Our semiparametric model is illustrated by

$$MS_{ijot} = m(\text{Hours on line per week}_{ijot}) + \beta_2 \text{Female} + \beta_3 \text{Urban}_{iot} + \Omega X_{ijot} + \gamma_0 + \delta_t + \tau_j + \varepsilon_{ijot}, \tag{6}$$

where $m(\cdot)$ is an unknown smooth function and is estimated by the B-spline approach.

To examine whether empirical results from our parametric linear model are robust, the dynamic of marginal effects of hours online per week in the semiparametric model can be checked. If marginal effects are significantly negative and stable, we can conclude that the parametric results are reliable. However, visual examination is sometimes difficult, particularly when significant effects arise only in a small range, which makes it hard to decide which model is more suitable. As a result, we chose to test for correct parametric specifications. We employed the goodness-of-fit test proposed by Ullah (1985). This test is similar in essence to a standard F-test, which compares restricted and unrestricted residual sums of squares, and the

null hypothesis is that the parametric model is correctly specified versus the alternative hypothesis of a semiparametric specification; see Henderson and Parmeter (2015) for more details.

Table 7 reports our test results from some main parametric counterparts. In almost all cases, we failed to reject the null hypothesis that the parametric linear model correctly specified. The exception is the case of marital satisfaction in 2014. After further examination, we observed in the plot (available upon request) that for those who seldom or often use the internet, an increase in hours online per week had a significantly negative impact on marital satisfaction. In addition, significantly positive marginal effects were found somewhere in between these two, and this implies that an optimal number of hours that could be beneficial to marital satisfaction might exist. However, significantly negative effects were dominant on average. Therefore, based on the hypothesis testing, our empirical results from the parametric linear models are reliable.

5 Concluding Remarks

This paper contributes to the existing literature by providing evidence on how internet usage influences marital well-being in China at an individual level. Estimation results show that internet usage negatively affects marital satisfaction, which is a strong predictor of marital stability, and increases marital instability. We comprehensively measured internet usage and marital satisfaction from different perspectives, including time spent online and internet use to fulfill distinct needs. We consistently found robust negative impacts on overall marital satisfaction levels and satisfaction with spousal housework contribution but not on satisfaction with spousal economic contribution. Moreover, the semiparametric-based test results imply that our empirical findings are robust.

This study also contributes by providing evidence for the roles that reduction in search cost, time spent on social interaction and entertainment, changes in gender role attitudes, and crowd-out effects play on the internet-marriage relationship. Online education appears to influence marriage through changing gender role attitudes. Individual-level evidence supports that widespread internet utilization partially accounts for the recent rise in the divorce rate in China. Finally, although this paper provides consistent and strong evidence for population average effects of internet usage on marital well-being, partialling out various confounding factors, bi-directional association could exist, therefore to determine accurate estimates for causality, longer panel datasets and an advanced research design (e.g., an experimental design) are needed. In addition, culture, and social structure matter. Attention should be paid when attempting to generalize the above conclusions across countries.

Markus (1994) states that impacts from technology do not result from the technology itself but from the choices individuals make about how to use it. Helsper and Whitty (2010) have coined the term “netiquette,” which refers to rules of acceptable and unacceptable online behavior between partners. Later studies have confirmed that consensus and consistency between partners can improve marital satisfaction. Therefore, discipline and self-regulated online behaviors are key priorities that can contribute to a better marriage, which appears to be supported by our findings after analyzing the heterogeneous effects of education. With a more detailed internet use survey, we can further test for effects of specific functions and how particular internet use interacts with individual characteristics.

In China, internet usage indeed plays an increasingly important role in social development. The mode of love match has experienced a significant transition across generations and internet generalization has accelerated this process. Marriage, a foundation of social stability is significantly influenced and the public should pay more attention. According to

our findings, some regulations can be implemented. One is that social media applications or websites for dating should ask users to categorize their real status, for example “married” or “in love” to prevent online infidelity. Moreover, communities can promote residents using the internet for communication or sharing online entertainment with their own spouses. Appropriate internet utilization and self-controlled online behavior are encouraged. In addition, the government should create education programs or other measures to alleviate conflicts between traditional and modern social norms, especially regarding gender issues, to improve marital happiness and stability.

Appendix

Figures 2, 3, 4.
Tables 8, 9.

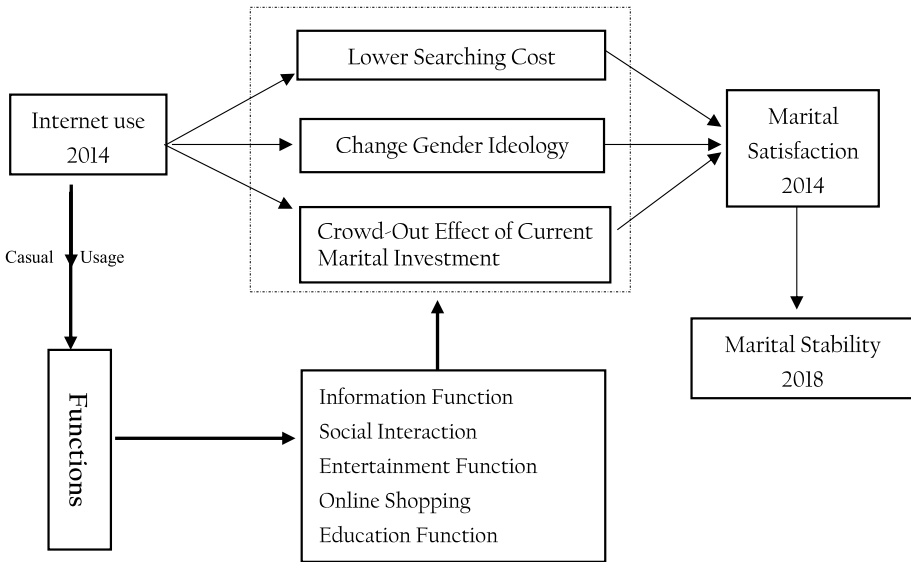


Fig. 2 Theoretical framework

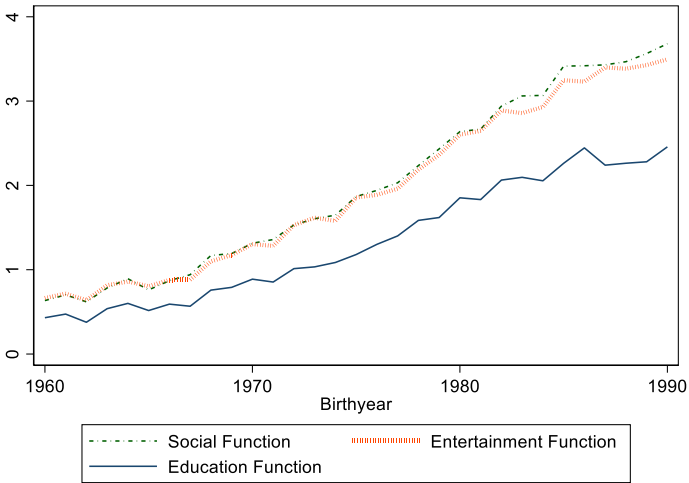


Fig. 3 Birth cohort difference in internet use (2014 and 2018 CFPS)

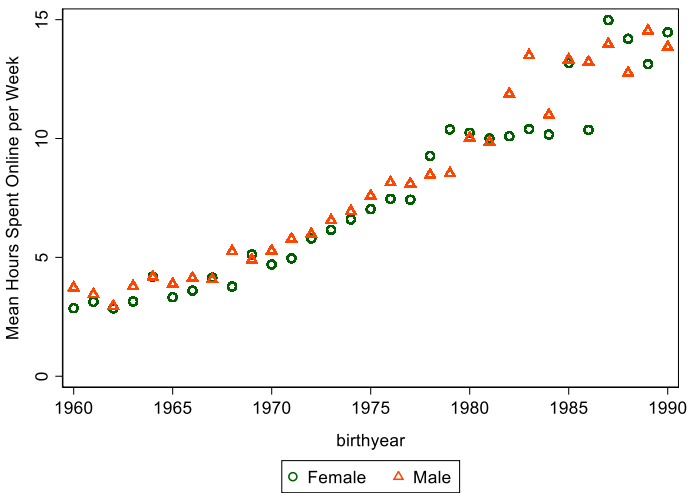


Fig. 4 Hours on spent online per week by gender and age Cohorts

Table 8 Internet use and marital stability

Population average effects logit estimations	2014 and 2018		2014 and 2018		2014		2018		2018 marital stability with 2014 controls initially Married Sample
Hours online per week	- 0.016*** (0.002)	- 0.007 (0.007)	- 0.015*** (0.003)	- 0.017*** (0.003)	- 0.015*** (0.003)	- 0.017*** (0.003)	- 0.017*** (0.003)	- 0.017*** (0.003)	- 0.017*** (0.003)
<i>Average Marginal Effect</i>	- 0.0011***	- 0.00003	- 0.0011***	- 0.0010***	- 0.0011***	- 0.0010***	- 0.0011***	- 0.0010***	- 0.0004***
Marital Satisfaction		0.362*** (0.077)							
<i>Average Marginal Effect</i>		0.0019***							
Observations	31,259	24,753	18,852	12,384	18,852	12,384	12,384	12,541	
Pseudo R-squared	0.174	0.114	0.204	0.116	0.204	0.116	0.116	0.038	
Population average effects with OLS regressions (2014&2018)									
Hours online per week			- 0.0008***	(0.0001)					
Panel data fixed-effects regression (differencing reg.)									
Hours online per week			- 0.0005***	(0.0001)					
Number of respondents			12,859						

Full pooled sectional regressions for population average effects control for personal annual income, education attainment, self-reported health status, job types, gender, urban dummy, constant, age (time trend), survey year fixed effect, birth year fixed effects and provincial fixed effects. Robust standard errors adjusted for clusters in personal id are reported in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The main empirical sample includes respondents born between 1960 and 1990 not including those widowed

Table 9 Gender heterogeneous effects in marital satisfaction regression

Dependent variable	Marital satisfaction		Satisfaction towards spouse's			
			Economic contribution		Housework contribution	
Sample	Female	Male	Female	Male	Female	Male
Hours online per week	- 0.003*** (0.001)	- 0.001 (0.001)	- 0.009*** (0.003)	- 0.011*** (0.004)	- 0.007*** (0.001)	- 0.001 (0.001)
Observations	14,633	13,225	15,038	13,797	14,631	13,219
R-squared	0.042	0.041	0.061	0.07	0.062	0.04
Panel B	Alternative measure					
Internet Utilization	- 0.050** (0.021)	0.005 (0.017)	0.045 (0.047)	0.025 (0.057)	- 0.155*** (0.028)	- 0.023 (0.019)
Observations	14,665	13,259	15,070	13,833	14,663	13,253
R-squared	0.042	0.041	0.06	0.07	0.062	0.04

Full regressions control for personal annual income, education attainment, self-reported health status, job types, gender, urban dummy, constant, age, survey year fixed effect, birth year fixed effects and provincial fixed effects.

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

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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