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Does Mobile Phone Penetration Affect Divorce Rate? Evidence from China

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Abstract: Marital happiness is an important symbol of social harmony and can help promote sustainable economic and social development. In recent years, the rapid rise of the divorce rate in China, a country where the divorce rate had previously been low, has attracted wide attention. However, few articles have focused on the popularization of information and communication technology's impact on China's rising divorce rate in recent years. As a first attempt, the provincial panel data during the period 2001–2016 is applied to study quantitatively the relationship between mobile phone penetration and the divorce rate. In order to get more reliable estimation results, this paper uses two indicators to measure the divorce rate, and quantile regression is applied for further analysis. Additionally, one-year to five-year lag times of the mobile phone penetration are used as the core explanatory variables in order to analyse the lagging effect of mobile phone penetration on divorce rate. The result shows that the correlation between the mobile phone penetration and the divorce rate was statistically positive significant in China during the period 2001–2016. Furthermore, the paper also finds that mobile phone penetration had the greatest impact on divorce rate in central China, followed by eastern China, but it was not obvious in western China during this period. From a technological perspective, this paper provides some possible explanations for the rising divorce rate in China in recent years, and further enriches the relevant research on the impact of the development of information and communication technology on societal changes.

Keywords: mobile phone penetration; divorce rate; marital happiness; well-being

1. Introduction

The quality of marriage is an important guarantee of well-being [1–5]. In China's traditional marriage culture, "a woman follows her husband no matter what his lot is" is a commonly held belief, and divorce is often seen as a stigma [6]. However, China's divorce rates have appreciably risen in the 21st century. As shown in Figure 1, since 2001 the crude divorce rate (the number of divorces per 1000 population) increased from 0.98‰ to 3.02‰ in 2016 [7]. The increasing divorce rate in China, a country that has been heavily influenced by traditional marriage concepts, has attracted extensive attention from scholars in recent years [8–10].

Some scholars attribute the rising divorce rate in China to the rapid urbanization, marketization, industrialization, modern education development, and economic growth, etc., during the past 40 years, and those factors may contribute to changes in people's attitudes and beliefs, which can lead to shifts in family structure, functioning, and relationships [11,12]. However, these factors do not explain why China's divorce rate remained low and did not change much in the 1990s (as shown in the Figure 1).
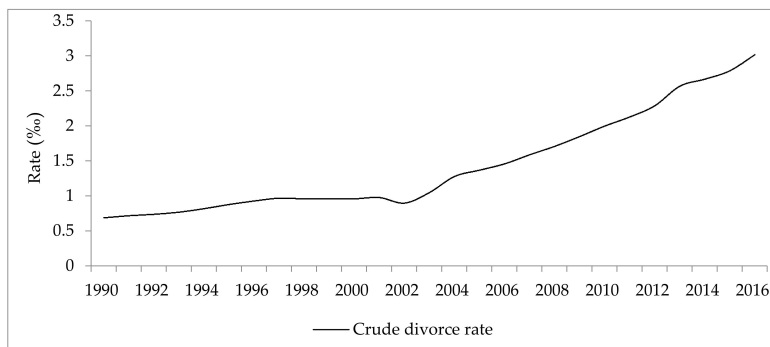
Figure 1. The crude divorce rate in China between 1990 and 2016. Data sources: China National Bureau of Statistics.

The main purpose of this paper is to explain the rising divorce rate in China from the perspective of the increasing mobile phone penetration in recent years. With the development of information and communication technology (ICT) in recent decades, the mobile phone has become a major communication tool [13]. Since 2005, the global mobile-cellular telephone penetration grew from 33.9% to 103.5% in 2017 [14]. The rapid spread of mobile phones has brought the world into a digital era, which has had a profound impact on economy, culture, and politics [15,16], and has greatly expanded the scope of interpersonal communication [17]. The rise in the mobile phone penetration may have the following effects on China's divorce rate:

(1) The popularity of mobile phone, whether for unmarried or married people, can greatly reduce the cost of searching for romantic partners. With the development of smart phones, mobile phone functions have become more and more diverse, which has had a significant impact on people's dating behaviours. Various social platforms and mobile phone applications, such as WeChat (Tencent, Shenzhen, China) and QQ (Tencent, Shenzhen, China), can closely connect individuals with common interests, offer a convenient condition for extramarital affairs, and increase the possibility of divorce. (2) The popularity of mobile phones has affected people's interpersonal relationships and the relationship between couples. (3) The spread of mobile phones has accelerated the spread of modern marriage concepts in China. Nowadays, especially for young people, mobile phones have become one of the most important tools for connecting to the Internet in order to find whatever information is needed. More and more people use mobile Internet to search for laws and regulations related to marriage, especially for couples experiencing marriage crises who may use mobile Internet to communicate with more people in common situations. As a result, people may be more daring to say goodbye to a failed marriage than to think that divorce is a shameful act.

The main contribution of this paper is embodied in the following three aspects. First of all, previous studies have tended to ignore the impact of advances in information technology on divorce rate, and the few relevant studies that have previously been published have mainly been based in developed countries. As a first attempt, this paper examines the explicit relationship between mobile phone penetration and divorce rate based on China's macro data at the provincial level, thus expanding on previous established research. Secondly, China is committed to the construction of a "harmonious society", and marital happiness is considered to be an important embodiment of a "harmonious society". Simultaneously, divorce may potentially result in negative effects on both health and well-being [18]. Therefore, this paper has many implications for Chinese public policy in the future. Furthermore, many countries in the world regard ICT as an important driving force for the promotion of the sustainable development of economy and society and the improvement of people's welfare [19]. Given the increasingly prominent role of mobile phones in people's daily lives, understanding their influence on individuals and families is crucial [20–22]. Thirdly, in this paper, the robustness and endogeneity of the model are considered rigorously and fully, which makes the conclusion more reliable.

The remainder of this paper is organised as follows. Section 2 briefly reviews the existing theory and literature. Section 3 presents the econometric model and data description. Section 4 provides the empirical results and relevant discussions. Finally, the Section 5 summarizes the conclusions drawn from this research.

2. Brief Review of the Literature and Theoretical Analysis

2.1. Theory Related to Marriage and Divorce

Unlike traditional marriages, divorce rates are high in modern marriages [23], which has led many scholars to become interested in the reasons why people choose to divorce after a period of marriage. Becker [24] was an early researcher on marriage and family behaviour. In considering mainly an economics perspective, Becker thought that each person tries to find the best mate available to them in the marriage market. Becker believed that when the expected utility of marriage is greater than that of being single, people will get married. When the expected utility of being single or remarrying is greater than the loss of utility from divorcing (including the separation from family, the separation of family property, legal expenses, and other losses), the married person will terminate their marriage. Similar to this theory, Weiss and Willis [25] considered that a marriage would end when the other partner meets a better match, whereafter Becker et al. [26] stressed the important role of "search costs" both before and after the marriage. In this theory, the individual selects firstly or sets the retention value (or threshold value, which is a minimum acceptable quality level) for a future matcher, and then restores the search within the accessible crowd. When an individual finds an individual that exceeds the retention value, she or he will get married. When the search cost is high, the retention value of the individual will generally be lower. Otherwise, the individual will give up the benefit of marriage for an unacceptably long period.

Many other studies also focused on the explanation factors for divorce from other perspectives. Societal transition was widely regarded as an important factor for the rise of divorce rates. Over the past two decades, egalitarian beliefs have been spread worldwide, which has profoundly influenced the nature of family relationships. Especially with the improvement of the status for women and children, the traditional patriarchal system based on blood and hierarchy has been greatly challenged, and family relations are constantly changing [27–30].

Economic factors are also cited as important reasons for divorce. Amato and Beattie [31] studied how unemployment affects divorce rates by studying data from the United States during the period from 1960 to 2005. They found that the relationships between unemployment rate and divorce rate changed over time. Rainer and Smith [32], Battu et al. [33], and Klein [34] all found a close relationship between house prices and divorce rate.

The social-economic growth hypothesis theory emphasizes that urban society will first exhibit low marital stability, such as that commonly observed in the middle class, which typically lives in a more affluent environment [35–38]. For example, Sandström [39] found that the divorce rate in rural, single-provider family, low-income households was significantly lower than that in urban, dual-provider family, high-income households through an analysis of the divorce behaviour in Swedish from 1911 to 1974.

Some scholars have begun to pay attention to the impact of population mobility on marriage. Glenn and Supancic [40], Landale and Ogena [41], Frank and Wildsmith [42], and Gautier et al. [43] all found that the divorce rate is usually high in areas with high migratory and floating populations. Caarls and Mazzucato [44] found that the likelihood of divorcing is higher when a wife (without her husband's escort) works abroad, but lower when the husband (without his wife's escort) works abroad.

2.2. Mobile Phone and Mobile Internet

With the rapid development of mobile communication, especially smartphones, and Internet technology, the number of mobile Internet (MI) users has increased rapidly [45]. In the past, the main

function of mobile phones was communication (i.e., voice calls and text messages). However, more and more mobile phone users have conducted information searches, online shopping, social entertainment, and other activities through the mobile Internet in the last few years [46]. According to the 41st China Internet Development Statistics Report, as of December 2017, the number of mobile Internet users in China reached 753 million, and the proportion of netizens using mobile phones to surf the Internet increased from 95.1% in 2016 to 97.5% [47]. Mobile phones have become the main channel for residents to access the Internet. The tremendous impact of mobile phones and mobile Internet on people's life has attracted wide attention from scholars [48]. On the one hand, the relevant studies examine the impact of mobile phones and/or mobile Internet on the economy or personal income and employment from both micro and macro perspectives. For example, at the micro level, Bertschek and Niebel [49] analysed date from a German firm and found that mobile Internet access was able to significantly improve labour productivity. Islam et al. [22] found that mobile phone use had a significant promoting effect on performance of a microenterprises in Bangladesh. At the macro level, there is a broad range of literature showing a significant positive relationship between mobile phone and/or mobile Internet use and the economic growth in a region or country [50–53].

On the other hand, the impact of mobile phones or mobile Internet on social development or individual well-being has also received extensive attention from scholars [19]. There is quite an extensive amount of literature showing that mobile phone and/or mobile Internet use can reduce corruption [54,55], improve institutional quality [56], affect individual social networks [57], increase search convenience [46,58], etc. However, other studies have also found that excessive use of mobile phones can cause "technostress", which has negative effects on users' mental and physical health and work efficiency [59–61].

As can be seen from the above literature review, although existing literature has conducted research on the impact of mobile phones and mobile Internet on economic growth and social development, there is a lack of studies that discuss the impact of mobile phone penetration on family interpersonal relationships, such as marriage stability. However, from the perspective of personal well-being, sustainable economic development, and social harmony, it is of great practical significance to discuss the impact of mobile phone penetration on divorce rate. This article attempts to fill this gap.

2.3. Theoretical Analysis of the Possible Impact of the Mobile Phone Penetration on the Divorce Rate in China

In traditional Chinese society, marriage usually follows the principle of "arrange a match by parents' order and on the matchmaker's word". The right of young men and women to freely choose their spouses is greatly restricted. Freedom to marry or divorce between men and women was frowned upon by public opinion. Moreover, in traditional Chinese society, interpersonal communication is often based on blood relationship, which greatly reduces the chance of finding a suitable partner for both men and women. Although China has achieved great economic and social development in recent decades, the traditional marriage concept still has far-reaching influence, which is an important reason why the divorce rate in China has remained low [6].

However, the emergence of new media tools, such as the Internet and mobile phones, are changing the way that people produce and live, and people's attitudes and beliefs are changing drastically. These changes can also affect the traditional forms of interpersonal communication between men and women, and people's social networks, all of which can ultimately affect the stability of marriage. Scholars and institutions have previously considered the impact of new media on marital stability. Merkle and Richardson [62] and Rosen et al. [63] all found that online dating is a unique way to pursue romance. Valenzuela et al. [64] found that the use of social networks sites has negative effects on marriage quality, and is positively associated with individuals thinking about divorce. The spread of mobile phones may have a positive effect on divorce rate for the following reasons:

Firstly, mobile phone use can affect people's social networks [65] and reduce the cost of a married person searching for a "third party" after marriage [6]. Nowadays, social media networks or apps, such as WeChat (Tencent, Shenzhen, China), QQ (Tencent, Shenzhen, China), and Microblog (Sina,

Beijing, China), have become the main ways for Chinese residents to engage in social activities [63]. The use of mobile phones can reduce the cost of searching for partners, expand the range of people seeking the opposite sex, and increase the substitution of spouses [57,66–69], all of which can reduce the stability of marriage [70]. Furthermore, if a married person thinks that it will be easy to find a more suitable partner after marriage, he or she may reduce his/her investment in his/her existing marriage, such as by choosing to not have children [71], which may ultimately increase the divorce rate.

Secondly, the use of mobile phones can affect people's interpersonal relationships [72]. There is a broad range of literature indicating that the excessive use of mobile phones can lead to "dependency", "compulsion", and "mobile phone addiction", all of which may have negative effects on the health, psychology, study, and work of individuals [73–75]. Furthermore, for young people today, mobile phones represent the most common way to access the Internet. However, the "digital world" has created a virtual environment that may cause couples to distrust each other, thereby potentially undermining the quality and stability of their marriages. Both of these can ultimately have negative effects on the relationships of married couples [76–82]. Clayton et al. [83] found that people who regularly use Facebook are more likely to have negative interpersonal relationship outcomes such as breakups, divorces, or romantic cheating.

Thirdly, according to the societal transition theory, the increase in the mobile phone penetration has promoted the spread of democracy and freedom ideology [20,84], which could accelerate the spread of modern marriage concepts and affect the stability of family and marriage. In addition, the spread of mobile phones and mobile Internet has also accelerated the spread and improvement of modern marriage laws and regulations [6]. As a result, more and more Chinese are daring to say goodbye to failed marriages for the pursuit of happiness. Last but not least, the use of social media tools, such as mobile phones and the internet, has boosted women's access to the labour market, raising the status of women in their families [85–87]. The studies of Spitze and South [88] and Kalmijn and Poortman [89] found that women's participation in the labour market increased divorce rates.

From the above analysis, mobile phones reduce the cost of searching for romantic partners, change people's marriage concepts, and deeply affect people's interpersonal communications. Therefore, there may be a significant positive relationship between mobile phone penetration and divorce rate in China. Consequently, the Chinese provincial panel data has been used to examine potential relationships between mobile phone penetration rates and divorce rates for the rest of this paper.

3. Research Methods and Data

3.1. Estimation Model and Methods

In previous studies on divorce, scholars mostly used individual micro data. However, individual data are prone to problems in that certain (or unobservable) characteristics of a spouse can affect both divorce and mobile phone use simultaneously. Fortunately, China's provincial panel data can solve this problem by adding the provincial fixed effects to control other unobservable variables that may affect divorce rate. From a few relevant studies using macro panel data, scholars usually use regression analysis [31,71]. Likewise, this study uses econometric regression models to examine the explicit relationship between mobile phone penetration and divorce rate. Since data for mobile phone use at the provincial level in China started in 2001, the dataset uses 496 observations from China's 31 mainland provinces between 2001 and 2016.

In order to examine the impact of China's mobile phone penetration on divorce rate, this paper uses a province effects panel model, which controls for the unobserved heterogeneity among provinces. Specifically, this research study formulates the following regression model:

$$\text{Divorce}_{it} = a_0 + a_1 \text{Mobile}_{it} + C X_{it} + \lambda_i + \varepsilon_{it} \qquad (1)$$

where the subscripts i = 1,2,...,31 index each of the 31 provinces; the subscripts t = 1,2,...,16 index each of the specific year during the sample period from 2001–2016; and Divorce_{it} is the dependent variable

in province i in year t. Among the regressions, Moblile$_{it}$ is the core explanatory variable of province i in the year t. The vector X is defined as a set of controls commonly used in divorce rate literature. λ$_i$ represents province dummies, and the ε$_{it}$ represents the error term.

3.2. Variable Settings and Data Source Description

Considering the purpose of this paper is to analyse the impacts of mobile phone penetration on divorce rate, the dependent variable is the divorce rate, and this study uses the mobile phone penetration rate as the core explanatory variable. Additionally, the control variables X mainly include: the urbanization level, the average educational year, the total of elderly adult and child dependency ratio, and a policy dummy variable. More specifically, all the above variables are set as follows:

The divorce rate is denoted by "Divorce". For ease of calculation, scholars generally use crude divorce rates to measure divorce rate levels [31]. This paper also adopts this index; the calculation method is as follows:

$$\text{Divorce} = \frac{\text{The number of divorces in a given year}}{\text{The total population}} \times 1000 \tag{2}$$

For more supplementary analyses (discussed later), this study uses another index to measure the divorce rate (denoted by Divorce1), which uses the following formula:

$$\text{Divorce1} = \frac{\text{The number of divorces in a given year}}{\text{The total population between 15 and 64 years old}} \times 1000 \tag{3}$$

This index can accurately measure the divorce rate for marriage-age populations.

The mobile phone penetration is denoted by "Mobile". This paper uses the number of mobile phone users per 100 people to measure the mobile phone penetration rate level. The corresponding calculation formula is as follows:

$$\text{Moblie} = \frac{\text{The number of mobile phone users}}{\text{The total population}} \times 100 \tag{4}$$

The urbanization level is denoted by "Urban". In accordance with a large number of previous studies, urbanization level has an important relationship with divorce rate. Urbanization is a trend that accompanies economic and social development, frequent population movements, and advanced human civilization. Urban areas, where modern industrial agglomeration occurs and industrial civilizations are developed, may have higher divorce rates than rural areas [8,43,90]. Therefore, it is necessary to add urbanization level as a control variable for the divorce rate in China. For ease of calculation, this study used the proportion of urban residents within the total population to measure the level of urbanization.

The average educational year is denoted by "Education". With the improvement of human civilization, people have more freedom to pursue a high quality marriage or dissolve their marriage, especially women [91,92]. Many previous studies have found that education has a positive relationship with divorce rates [93]. In this paper, education level is measured by education years per capita for people six years old or above. The formula is: Education = (population for primary school education × 6 + population for junior high school education × 9 + population for high school education × 12 + population for college degree or above × 16)/population for age 6 or above.

The total dependency ratio is denoted by "Dependency". The age structure of a population has an important influence on its divorce rate [94,95]. In recent years, China has fully liberalized the two-child policy, and China's aging population has become an increasingly serious issue. Therefore demographic changes may have had an important impact on the divorce rate. In order to measure the dependency ratio, the population below the age of 14 and over the age of 65 was divided by the population between age 15 to 64.

The policy dummy variable is denoted by "Policy". The "Marriage Registration Ordinance" of China, amended in 2003, simplifies marriage and divorce proceedings and may also have an important impact on the divorce rate [96,97]. For this reason, this paper sets up a dummy variable for marriage policy. Therefore, the policy dummy variable is measured as follows:

$$\text{Policy} = \begin{cases} 0 \ if \ year < 2003 \\ 1 \ if \ year \geq 2003 \end{cases} \tag{5}$$

China's provincial panel data during the period between 2001 and 2016 is utilized in this study. The data for divorce rate and the mobile phone penetration rate were cited from China Statistical Yearbooks. The data for the control variables, including Urban, Education, and Dependency, were all collected from China Demographic Yearbooks.

3.3. Trends for Core Variables

Figure 2 depicts the changes to the crude divorce rate in 31 provinces. The figure reveals two major outliers. On the one hand, the crude divorce rate in Xinjiang province was extremely high during the period from 2001 to 2010 and then it had small drops in the substantially years. On the other hand, the crude divorce rate in the Tibet was the lowest during the whole period. The religious beliefs common to these areas can clearly explain the two outliers. The Tibetan area is mainly affected by Buddhist culture, which does not advocate divorce. The people of Xinjiang Uygur have long been deeply influenced by Islamic culture, which allows polygamy, and where men typically have absolute control over marriage. Due to the atypical pattern in Tibet and Xinjiang, this paper also carried out regression estimation on the samples excluding Xinjiang and Tibet. However, it found that the removal of Xinjiang and Tibet had no obvious influence on the estimation results, which may be due to our datasets being weighted by province population, as both Tibet and Xinjiang are underpopulated. The following regression results are based on samples including Xinjiang and Tibet. Obviously, the divorce rates in the remaining 29 provinces showed a highly consistent trend. While divorce rates vary widely among the 29 provinces, almost all provinces follow a similar trend, with divorce rates rising across all provinces from 2001 to 2016.
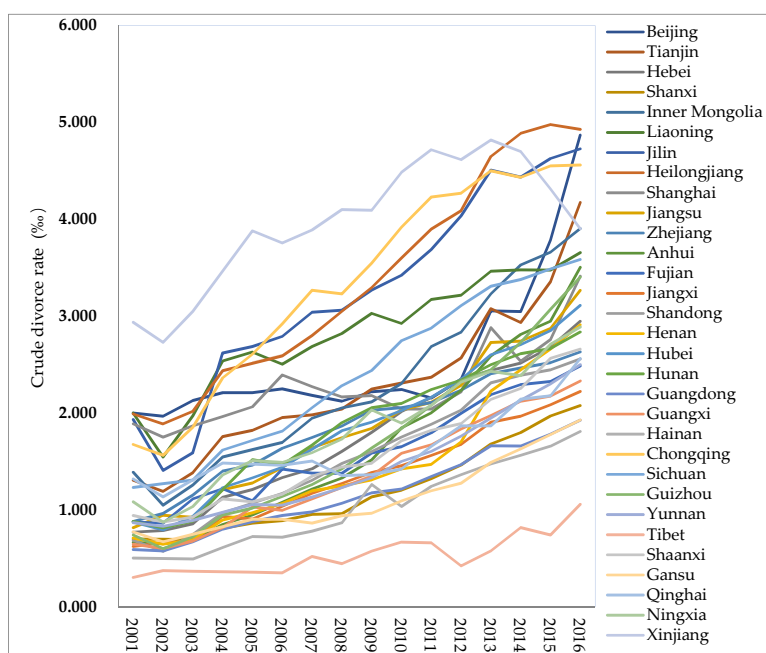

Figure 2. The crude divorce rates for 31 provinces of China: 2001–2016.

Figure 3 provides a scatter diagram between crude divorce rate and mobile phone penetration, demonstrating a significant positive correlation between the two factors. However, because other factors have not been considered, the relationship between divorce rate and mobile phone penetration needs to be further examination.
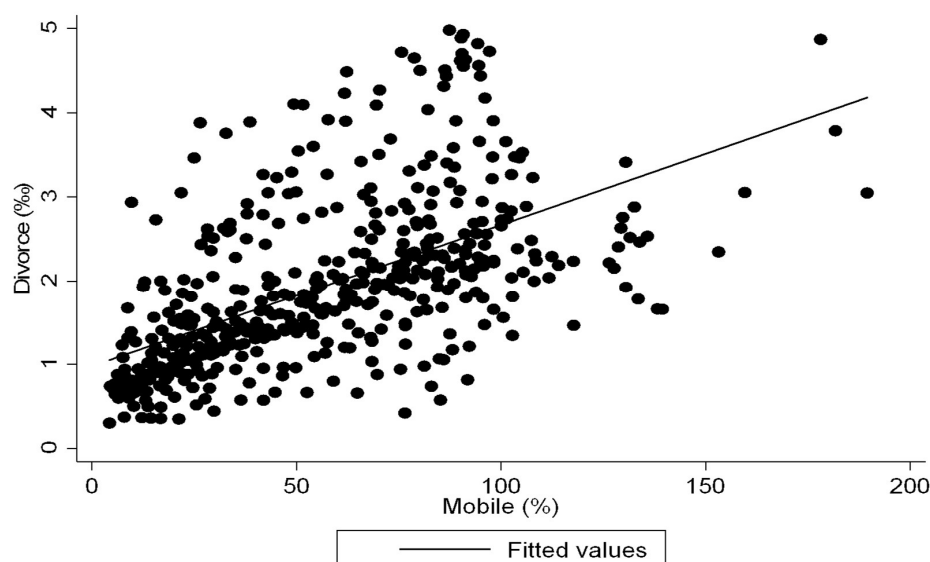

Figure 3. A scatter diagram of crude divorce rate against mobile phone penetration.

4. Empirical Results and Discussions

4.1. Statistical Analysis of Variables

In summary, the mean, standard deviation, maximum, and minimum values of key variables are shown in Table 1. Furthermore, this paper conducted multiple collinear tests on the main explanatory variables before the empirical analysis, and the highest variance inflation factor (VIF) is 4.73. Experience shows that when VIF is less than 10, multiple collinearity does not have much effect on regression analysis [98].

Table 1. Summary statistics of the key variables.

Variables	N	Mean	Standard Deviation	Min	Max	Unit
Divorce	496	1.937	1.017	0.303	4.979	‰
Mobile	496	56.660	34.746	4.280	189.424	%
Urban	496	49.194	15.528	19.392	89.600	%
Education	496	8.423	1.239	3.738	12.546	Years/per capita
Dependency	496	37.441	7.029	19.267	57.579	%
Policy	496	0.875	0.331	0	1	–

4.2. Estimation Results of the Benchmark Model

Generally speaking, panel data estimation models include the ordinary least squares (OLS), fixed effects model (FE), and random effects model (RE); *F* test and the Hausman test were conducted to select the most appropriate model. Considering the possible heteroscedasticity and the autocorrelation of the panel model, this paper used the clustering robust standard deviation in all results. The regression results of the benchmark model are shown in Table 2.

Table 2. Regression results of the effect of mobile phone penetration on divorce rate.

Variables	Dependent Variable: Divorce					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Mobile		0.020 ***	0.011 ***	0.009 **	0.011 ***	0.011 ***
		(0.001)	(0.004)	(0.004)	(0.004)	(0.004)
Urban	0.054 ***		0.050 ***	0.045 ***	0.036 **	0.033 **
	(0.011)		(0.016)	(0.016)	(0.014)	(0.015)
Education	0.666 ***			0.187 *	0.356 ***	0.371 ***
	(0.149)			(0.099)	(0.095)	(0.094)
Dependency	0.042 ***				0.043 ***	0.048 ***
	(0.010)				(0.008)	(0.009)
Policy	0.158 **					0.133 **
	(0.074)					(0.059)
Constant	−8.036 ***	0.815 ***	−1.170 *	−2.344 **	−5.080 ***	−5.321 ***
	(1.128)	(0.099)	(0.611)	(0.968)	(0.953)	(0.910)
F	105.630	86.760	103.720	93.250	112.040	113.000
Hausman	52.750	2.120	22.360	24.950	24.720	22.630
	(0.000)	(0.347)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	496	496	496	496	496	496
Provinces	31	31	31	31	31	31
R^2	0.817	0.772	0.807	0.811	0.840	0.842
Model	FE	RE	FE	FE	FE	FE

Note: *, **, and *** represent 10%, 5%, and 1% levels of statistical significance, respectively. Robust standard errors are reported in parentheses. The *p* values shown are according to the Hausman test. FE stands for fixed effects model, RE stands for random effects model.

As shown in Table 2, Model (1) only considers the influence of control variables on the divorce rate. Model (2) simply investigates the direct relationship between mobile phone penetration and divorce rate. Models (3)–(6) add the control variables successively on the basis of Model (2). From the R^2 value of each model, Models (2)–(6) increase by degrees. At the same time, The R^2 value of Model (6) is also larger than that in Model (1), indicating that it is necessary to add the control variables and that the model is set appropriately. According to the estimation results, it can be seen that:

According to Model (2), the direct influence coefficient of mobile phone penetration on the divorce rate is 0.02 and is significant at the 1% level. This indicates that a 1% increase in the mobile phone penetration rate was associated with a 0.02‰ increase in the divorce rate. The regression coefficient for the mobile phone penetration in Model (6) reduces, but it is still statistically significant at 1% level. The result shows that a 1% increase in the mobile phone penetration rate was associated with a 0.011‰ increase in the divorce rate during this period. As shown in Figure 3, there was a significant positive correlation between mobile phone penetration and divorce rate.

For the control variables, Model (6) shows that both the urbanization level and the human capital level have significantly positive coefficients. This indicates that improvements to urbanization and education levels were important contributing factors for the increase in China's divorce rate in this period. As the largest developing country and the most populous country, China has seen rapid economic development since the late 1970s. However, China has not completed the urbanization process. China's urbanization rate was just 57.3% in 2016 according to China's National Bureau of Statistics (NBS). Therefore, with the advancement of China's urbanization process, China's public policy should pay more attention to the influence of the rising urbanization level on the concept of marriage across Chinese society. Additionally, the estimation results revealed that there was a significant positive correlation between dependency ratio and divorce rate. Perhaps the reason is that the growth of the dependency ratio significantly increased the cost of living and the stress of life, which have an impact on marriage. Furthermore, the policy change on divorce had an important

effect on divorce rate, which means that China's "Marriage Registration Ordinance", amended in 2003, contributed to the increase in divorce rate.

4.3. Mobile Phone Penetration and Divorce Rate: Regional Differences

Considering the big differences for divorce rates and mobile telephone penetrations among the 31 provinces in China, this study further divided the sample into three parts: the eastern, central, and western regions of China according to the usual methods. As shown in Table 3, Models (1) and (2) show the results of the eastern provinces. Models (3) and (4) show the results for the central provinces. Finally, Models (5) and (6) show the results for the western provinces.

Table 3. The effect of mobile phone penetration on divorce rate: regional differences.

Variables	Dependent Variable: Divorce					
	Eastern China		Central China		Western China	
	(1)	(2)	(3)	(4)	(5)	(6)
Mobile	0.016 *** (0.001)	0.006 * (0.003)	0.029 *** (0.003)	0.030 *** (0.005)	0.020 *** (0.003)	0.001 (0.004)
Constant	0.707 *** (0.133)	−6.554 *** (1.699)	0.703 *** (0.135)	−3.673 (2.110)	0.973 *** (0.207)	−3.289 ** (1.651)
F	52.180	76.480	108.910	82.240	119.010	137.020
Hausman	0.640 (0.724)	60.220 (0.000)	1.170 (0.557)	44.750 (0.000)	0.800 (0.670)	2.270 (0.810)
Control variables	NO	YES	NO	YES	NO	YES
Observations	176	176	128	128	192	192
Provinces	11	11	8	8	12	12
R^2	0.781	0.883	0.882	0.917	0.768	0.880
Model	RE	FE	RE	FE	RE	RE

Note: *, **, and *** represent 10%, 5%, and 1% levels of statistical significance, respectively. Robust standard errors are reported in parentheses. The *p* values shown are according to the Hausman test. FE stands for fixed effects model, RE stands for random effects model. Eastern China has 11 provinces, central China has 8 provinces, and western China has 12 provinces.

Specifically, from a regional perspective: Model (1) and Model (2) show that the association between the mobile phone penetration rate and divorce rate was positive and significant for eastern provinces. According to Model (2), a 1% increase in the mobile phone penetration rate was associated with a 0.006‰ increase in the divorce rate during this period. Model (3) and Model (4) reveal that the association between the mobile phone penetration rate and divorce rate was also positive and significant for central provinces, with a 1% increase in the mobile phone penetration rate associated with a 0.030‰ increase in the divorce rate. For the western region, the influence coefficient of mobile phone penetration on the divorce rate in Model (5) is significantly positive. However, after controlling for other variables, Model (6) shows that there is no direct relationship between mobile phone penetration and divorce rate.

By comparison, mobile phone penetration had the largest effect on the divorce rate in central China, followed by eastern China, but it was not obvious in western China during this period. Compared with the central and western regions of China, the eastern region of China has experienced a relatively fast economic development, a high degree of marketability, and higher average human capital. Therefore, the modern marriage concept is more popular and deeply ingrained in society. As a result, despite the high prevalence of mobile phones, the modern concept of marriage has not been impacted much. In the central regions, the economic development has been relatively slow, the industrialization degree is low, and the traditional culture and religious culture have a higher influence on marriage. Therefore, with the popularization of new media tools such as mobile phones, greater

effects on traditional concepts of marriage and interpersonal communication may be experienced in the central regions. For western China, there was no direct link between mobile phone penetration and divorce rates. That may be because, on the one hand, the mobile penetration in western China was still low. On the other hand, especially for the vast rural areas in western China, traditional marriage concepts still have a deep impact.

4.4. Robust Analysis

Additional analyses were conducted to assess the stability of our research conclusions. As discussed above, this paper used the Divorce1 variable (divorce rate for the marriage-age population) to replace the Divorce variable (crude divorce rate) for additional analyses. The results are shown in Table 4. It can be observed that the results are substantively identical to the results shown in Tables 2 and 3, which supports the conclusion that there was significant positive correlation between the mobile phone penetration rate and the divorce rate during the period 2001–2016. Furthermore, the mobile phone penetration rate had the largest effect on the divorce rate in central China, followed by eastern China, but it was not obvious in western China during this period.

Moreover, considering our sample contains provinces with different levels of divorce rate, mobile phone penetration, urbanization, education, and economic development, this paper uses quantile regression to further test the reliability of benchmark model at the national level. Compared with the traditional method, which just examines the effect of the independent variable on the conditional expectation of the dependent variable, the advantage of quantile regression is that it can provide comprehensive information about the conditional distribution of the dependent variable [99]. In this paper, quantile regression was mainly used to investigate the effect of mobile phone penetration on divorce rate at five points including: 0.1, 0.25, 0.5, 0.75, and 0.9. The estimation results are shown in Table 5, and Figure 4 shows the variation in the mobile phone penetration coefficient over the conditional quantiles.

Table 4. Robust analysis using Divorce1 as the dependent variable.

Variables	Dependent Variable: Divorce1							
	Whole Nation		Eastern China		Central China		Western China	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mobile	0.026 ***	0.013 ***	0.021 ***	0.008 *	0.038 ***	0.037 ***	0.026 ***	0.0004
	(0.002)	(0.005)	(0.002)	(0.004)	(0.004)	(0.006)	(0.004)	(0.005)
Constant	1.161 ***	−7.861 ***	0.989 ***	−9.297 ***	0.971 ***	−6.134 *	1.427 ***	−5.222 **
	(0.138)	(1.189)	(0.172)	(2.124)	(0.162)	(2.776)	(0.295)	(2.211)
F	80.490	123.530	40.190	78.740	86.450	78.60	117.960	148.750
Hausman	3.350	26.650	1.240	67.390	0.650	41.130	0.540	2.430
	(0.187)	(0.000)	(0.539)	(0.000)	(0.721)	(0.000)	(0.765)	(0.787)
Control variables	NO	YES	NO	YES	NO	YES	NO	YES
Observations	496	496	176	176	128	128	192	192
Provinces	31	31	11	11	8	8	12	12
R^2	0.747	0.846	0.741	0.878	0.881	0.919	0.745	0.880
Model	RE	FE	RE	FE	RE	FE	RE	RE

Note: *, **, and *** represent 10%, 5%, and 1% levels of statistical significance, respectively. Robust standard errors are reported in parentheses. The *p* values shown are according to the Hausman test. FE stands for fixed effects model, RE stands for random effects model.

Table 5. Robust analysis: quantile regression.

Variables	Dependent Variable: Divorce				
	0.1	**0.25**	**0.5**	**0.75**	**0.9**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Mobile	0.004 ***	0.009 ***	0.012 ***	0.011 ***	0.017 ***
	(0.001)	(0.002)	(0.002)	(0.003)	(0.006)
Control variables	YES	YES	YES	YES	YES
Observations	496	496	496	496	496
Provinces	31	31	31	31	31

Note: *** represents 1% levels of statistical significance. Standard errors are reported in parentheses. The bootstrap value was set to 300.

According to the results in Table 5 and Figure 4, the mobile phone penetration has a significantly positive effect on divorce rate for all quantiles, which is consistent with the benchmark model estimation results in Table 2. In summary, the above analysis shows that the estimation results are robust and reliable in this paper.
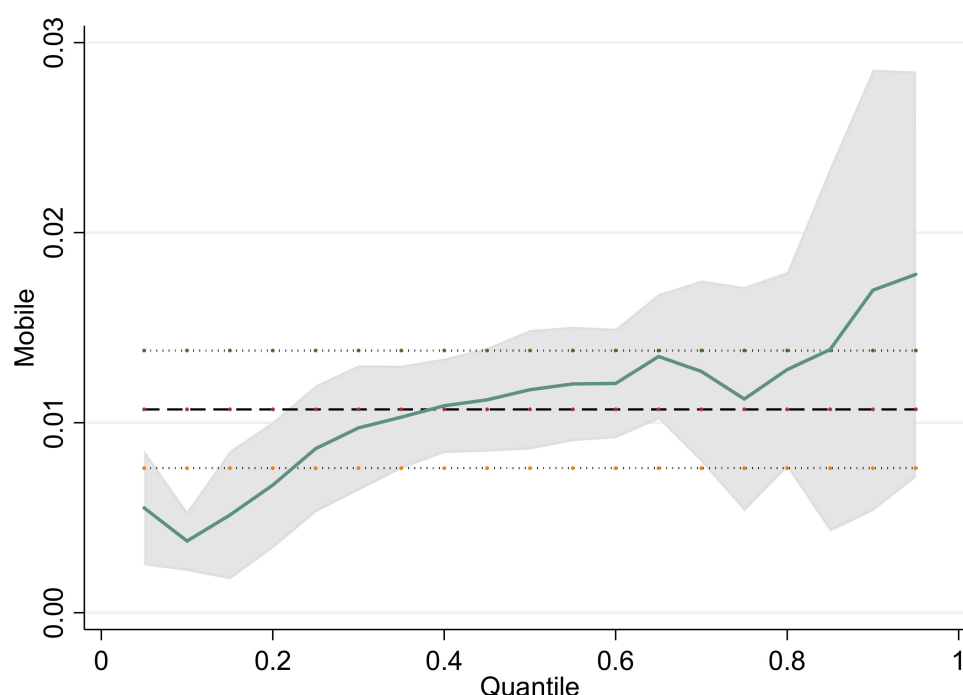

Figure 4. Variation in the mobile phone penetration coefficient over the conditional quantiles. Confidence intervals extend to 95% confidence intervals in both directions. Horizontal bold dotted lines represent ordinary least squares (OLS) estimates with 95% confidence intervals.

4.5. The Lagged Effect of Mobile Phone Penetration on Divorce Rate

Measurement errors, omitted variables, and mutual causal relationships among the independent variable with the dependent variables may all lead to endogenous problems. In this paper, a mutual relationship between the mobile phone penetration rate and the divorce rate may exist. With the increase in divorce rates, the dating behaviour of people (e.g., using mobile phones to meet people) and the holding rate of mobile phones may possibly change. Generally, two approaches are used to solve endogenous problems. One way is to use instrumental variables that are highly relevant to mobile phone penetration rate but do not have direct relationships with divorce rate. Another method is to add the lag term of endogenous variables. However, it is difficult to find an appropriate instrumental

variable for mobile phone penetration. As such, this paper adopts the latter method of applying the lag term of mobile phone penetration. The main logic is that the divorce rate in the current period has no effect on the lag of the mobile phone penetration rate. In addition, theoretically, there is a time lag between residents' use of mobile phones and the possible impact on divorce rates. This paper successively added the one-year to five-year lag times of the mobile phone penetration; the estimation results are shown in Table 6. Furthermore, adding different lag terms of mobile phone penetrations is valuable in order to observe the dynamic impact of mobile phone penetration on divorce rate. Since the adoption of the lag term of mobile phone penetration would reduce the sample size, this paper conducts the analysis only at the national level.

Models (1)–(5) are the estimation results with the crude divorce rate as the dependent variable, and Models (6)–(10) are the estimation results with divorce rate for the marriage-age population as the dependent variable. As shown in Table 6, there was still significant positive relationships between the lag term of mobile phone penetration and divorce rate, which is consistent with the process of "Mobile phone use → Making friends → Having an affair → Having family conflict → Divorce" [100]. It was shown that the mobile phone penetration had a dynamic impact process on the divorce rate. In addition, according to the R^2 value and the mobile phone penetration coefficient of each model, the mobile phone penetration rate with one lag period has the greatest impact and predictive ability on the divorce rate.

Table 6. The lagged effect of mobile phone penetration on divorce rate.

Variables	Dependent Variable: Divorce					Dependent Variable: Divorce1				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
L1.Mobile	0.010 *** (0.001)					0.012 *** (0.002)				
L2.Mobile		0.009 *** (0.001)					0.011 *** (0.002)			
L3.Mobile			0.007 *** (0.001)					0.009 *** (0.002)		
L4.Mobile				0.008 *** (0.001)					0.009 *** (0.002)	
L5.Mobile					0.009 *** (0.002)					0.010 *** (0.002)
Constant	−4.923 ***[*] (0.563)	−4.660 *** (0.584)	−5.275 *** (0.600)	−5.216 *** (0.652)	−5.269 *** (0.661)	−7.411 *** (0.742)	−7.069 *** (0.772)	−7.920 *** (0.794)	−7.939 *** (0.862)	−8.046 *** (0.874)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	465	434	403	372	341	465	434	403	372	341
R^2	0.839	0.835	0.833	0.825	0.811	0.843	0.839	0.838	0.830	0.820
Model	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE

Note: *** represents 1% levels of statistical significance. Robust standard errors are reported in parentheses. FE stands for fixed effects model, RE stands for random effects model. L represents the lag term. Because of multicollinearity, policy variable is removed in Models (2)–(5) and Models (7)–(10).

5. Discussion

Marital happiness is of great practical significance to China's social stability and economic sustainable development in the future. In traditional Chinese society, interpersonal communication is often based on blood ties, and men and women are limited in their choice of partners. Furthermore, traditional Chinese societal values typically look unfavourably upon, which still has a profound impact on the marriage concepts of modern Chinese residents. However, since the beginning of the 21st century, the divorce rate in China has risen rapidly compared with that before the 21st century, which has attracted wide attention from various social institutions. Previous literature has explained the rising divorce rate in China from various aspects, such as economic development and social reform, but few studies have paid attention to the possible significant impact of the popularization of mobile phones on China's divorce rate. Moreover, this is of great value in explaining why the divorce rate in China has changed so much since the beginning of the 21st century.

Therefore, this paper attempts to study the relationship between the mobile phone penetration and the divorce rate in China based on province-level data during the period 2001–2016. The most

striking conclusion of this study is that there was a significant positive correlation between the mobile phone penetration and the divorce rate in China during the period 2001–2016. Furthermore, mobile phone penetration had the largest effect on the divorce rate in central China, followed by eastern China, but it was not obvious in western China during this period.

In order to get a more robust conclusion, this paper further conducts the robustness test through two steps. Firstly, two indexes of divorce rate are adopted as the dependent variables. Secondly, this paper uses quantile regression to further test the reliability of the benchmark model at the national level. Although no suitable instrumental variables were found to deal with the possible endogenous problem caused by mobile phone penetration, the one-year to five-year lag times of mobile phone penetrations are used as the core explanatory variable to deal with endogeneity problem and to analyse the possible delayed impact of mobile phone penetration on divorce rate. Through the above tests, the main conclusions of this paper are still reliable and robust.

China is vigorously promoting the construction of a digital economy and trying to promote the sustainable development of the Chinese economy through information technology. Information technology has had a profound impact on Chinese society. Although for a long time, the relationship between social media tools, such as the Internet and mobile phones, and the divorce rate was recognized by scholars, little research has been done to explain the rising divorce rate in China in recent years from the perspective of the spread of mobile phones.

In the theoretical analysis part of this paper, three reasons are provided for the mobile phone penetration contributing to the rising divorce rate in China. First, the spread of mobile phones has affected people's social networks and greatly reduced the cost of searching for partners for both men and women. Secondly, the use of mobile phones can affect people's interpersonal communication, thus affecting the relationships between couples. Finally, the popularization of mobile phones promotes the spread of modern marriage concepts, democracy concepts, and equality concepts.

Why does mobile phone penetration have the largest effect on the divorce rate in central China, followed by eastern China, but not have an obvious effect in western China during this period? This paper argues that, compared with central and western of China, the eastern part of China has experienced a relatively fast economic development, a high degree of marketability, and a higher average human capital. Therefore, the modern marriage concept is more popular and deeply ingrained in society. As a result, despite the high prevalence of mobile phones, the modern concept of marriage has not been impacted much. In the central regions, the economic development has been relatively slow, the industrialization degree is low, and the traditional culture and religious culture have a higher influence on marriage. Therefore, with the popularization of new media tools such as mobile phones, greater effects on traditional concepts of marriage may be experienced in the central regions. For western China, there is no direct link between mobile phone penetration and divorce rates. That may be because, on the one hand, mobile penetration in western China is still low. On the other hand, especially for the vast rural areas in western China, the traditional marriage concept still has a deep impact on the values and beliefs of residents.

The results are consistent with Valenzuela et al. [64] in that the use of social media tools (mobile phones in this study) is positively correlated with experiencing a troubled relationship and thinking about divorce. These findings shall inspire China and other countries in the future. The quality of marriage is an important guarantee for a happy life and harmonious society. With the development of the economy in developing countries, ICT will be further popularized and applied. Thus, public policy formulation should consider the potential impact of ICT on marriage stability in the future. Deciding how to guide and standardize the behaviour of citizens using mobile phones is an important issue to be considered in public policy. This paper also further enriches relevant studies on the impact of ICT on social development.

There are still many aspects that can be further explored in the future. Firstly, future research may use smaller geographical units (such as cities) and family or individual data, which will be better able to investigate the relationship between mobile phone use and the risk of divorce for particular

couples. Secondly, a common issue involving endogenous problems was encountered in this study due to the lack of suitable tool variables for mobile phone penetration. As such, endogenous problems are not solved perfectly in this paper. However, future research can address this problem by other means, such as through approaches using Generalized Method of Moments (GMM) and propensity score matching (PSM). Finally, future studies can also empirically examine the mechanisms by which mobile phone penetration affects divorce rate.

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