Gender Imbalance, Marriage Stability, and Divorce Rate: Evidence from China*

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Abstract

The deficit of eligible men or women in a regional marriage market is a commonly observed phenomenon stemming from factors such as "Missing Girls" at birth, immigration, and higher mortality rates among men due to war. However, the impact of this deficit on marriage stability remains not well understood. In this paper, using provincial, census, and household survey data in China, we find that a higher male-to-female ratio increases divorce rates. Further analyses support the hypothesis that this impact is primarily driven by married women having more options outside their marriage. The effect is more pronounced in economies with greater income inequality, where there are more wealthy prospective partners. These findings highlight the significance of gender balance in sustaining stable marriages and uncover a new contributing factor to the escalating divorce rates in China.

Keywords: Divorce Rate, Gender Imbalance, Outside Option, Inequality
JEL Codes: D10, J12, J16, N35

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1 Introduction

The phenomenon of "Missing Women" caused by son preference is a stark issue in many Asian countries (Sen, 1990, 1992).[1] The global count of "Missing Women" is expected to peak at 150 million in 2035 (Bongaarts and Guilmoto, 2015). The deficit of women has been documented to profoundly affect various aspects of social development. However, its impact on marriage stability has been largely ignored in the literature. Addressing this aspect could provide a deeper understanding of the broader societal impacts of gender imbalance.

The importance of a stable marriage to the welfare of household members and the overall societal development cannot be overstated. Regrettably, many developing economies witnessed a notable increase in divorce rates over the past decades.[2] In particular, the crude divorce rates[3] in China rose from 0.96 in 2000 to 3.36 in 2019, representing a nearly 3.5-fold surge.[4] In fact, the crude divorce rate in China has surpassed that of the United States since 2016, prompting significant government attention and the implementation of various policies. It is noteworthy that the surge in divorce rates has coincided with the marriage and divorce of the birth-control generation, which has faced a highly imbalanced sex ratio. This paper investigates whether the sex imbalance has contributed to the escalating divorce rate in China.

The impact of sex ratio on divorce is ex-ante ambiguous. Previous literature has provided evidence that women can benefit in a marriage market characterized by a relative shortage of females. For example, a higher male-to-female ratio can boost women's chances of marrying up, raise bride prices, and increase women's within-household bargaining power. Theoretically, this would enhance their satisfaction in marriage and increase marital stability. On the other hand, gender imbalance in the marriage market can create more "outside options" for married women. In other words, there are more available men in the marriage market, which may prompt married women to consider leaving their current marriages.

There are multiple reasons why more available men could potentially increase the likelihood of married women seeking a divorce. In the perfect information setting, there would be no divorce, as people who want a marriage would always marry their best

[1] The "missing women" phenomenon refers to the lower number of women in the population than expected if both genders were subject to similar birth and mortality rates.

[2] For example, according to the OECD Family Database, the crude divorce rates rose from 0.66 to 1.8 in Vietnam and from 1.1 to 1.9 in Thailand from 2000 to 2019 (OECD and OECD Korea Policy Centre, 2021).

[3] The crude divorce rate is the number of divorce cases during a given year per 1000 people.

[4] Before 2001, divorce was very rare in China as women's property rights were not well-protected after divorce. In 2001, the government launched a pro-women divorce reform, which liberalized divorce in favor of women and secured women's property rights after separation (Sun and Zhao, 2016).

option and stay in the marriage forever. However, at least two sources of imperfect information contribute to the possibility of divorce. Firstly, the information on which couples relied before entering into marriage is incomplete (Becker et al., 1977). Once married, if the wife finds the realized utility low, such as in cases of an abusive husband, she may feel inclined to explore alternative prospects outside the current marriage. Secondly, changes in the choice set, such as the rise of new contacts in the workplace, can lead to divorce (McKinnish, 2004). If a married woman meets a man she believes can provide a better marriage than her current husband, she may divorce and remarry the new prospect. In both scenarios, more available men in the marriage market expand the options for married women seeking to improve their marital situation. Additionally, the increase in women's bargaining power within marriage, due to the shortage of women in the marriage market, may provide her with a higher capacity to protect her interests should she undergo a divorce. For example, she can control more household wealth or disposable assets during and after divorce. With enhanced financial independence and resources, women may feel more empowered to pursue a divorce and confidently navigate their lives outside the marriage, leading to a rise in divorce rates.

The outside option channel is particularly relevant when there is sex imbalance in regional marriage markets—a phenomenon frequently observed. Aside from "missing women," various factors can lead to sex imbalance. For example, the regional industrial structure can shape the gender composition of laborers, which subsequently affects the gender structure in the marriage market (Kearney and Wilson, 2018). Additionally, immigration (Angrist, 2002; Lafortune, 2013) and war (Abramitzky et al., 2011; Brainerd, 2017; Ogasawara and Igarashi, 2021) have been documented in previous literature as factors that impact sex imbalance. Moreover, as more women migrate to urban areas in search of high-income husbands, simultaneous imbalances can arise, with a deficit of men in the urban marriage market and a deficit of women in the rural marriage market (Edlund, 2005; Ong et al., 2020). By documenting the outside option channel, our framework offers a valuable perspective for understanding the impact of sex imbalance on marriage stability.

Despite its perceived importance, the outside option channel has received very little empirical attention, possibly due to data limitations. Our data uniquely provides information on remarriage and the quality of the subsequent husbands, offering an opportunity to fill this gap in the literature by investigating its implications.

We examine the hypotheses in the Chinese context. China suffers a bigger challenge than other countries from sex imbalance because it faces a severe "Missing Women" problem and because of its huge population size.[5] China has one of the highest sex ratios at birth in the world, with 121.7 boys born for every 100 girls in rural areas in 2000 (Li, 2007). The nationwide sex imbalance is believed to be predominantly driven by the combination of son preference and birth control policies. The deeply rooted preference for sons stems from their expected role in caring for parents in old age and continuing the family lineage. Consequently, when China implemented the One-Child Policy (OCP) in the late 1970s, there was a significant surge in parents' tendency to practice sex selection.[6] The widespread utilization of B-ultrasound devices greatly facilitated the sex selection for many households.[7] OCP remained in effect until a relaxation in 2011 and was formally abandoned in 2016.[8] The policy has had a lasting impact on cohorts spanning over 30 years and is expected to continue influencing the marriage market for decades.

While commonly referred to as the "one-child policy," it's important to note that additional births were not always prohibited, and the stringency of enforcement varied substantially across regions and over time. As a prominent fertility policy, the fine rates for above-quota births, set by provincial governments based on their local conditions and changed over time, ranged from 10 to 50 percent wage deductions spanning 5 to 14 years (Ebenstein, 2010). Furthermore, Qian (2009) and Liu (2014) both point out that within the same province, there were substantial variations in local fertility policies. Even with the same policy, local implementation exhibited differences due to factors such as varying administrative capacities and implementation approaches (Li and Zhang, 2017). In this paper, we leverage the extensive geographical and temporal variation for identification. Specifically, for the main analyses using individual-level data, we construct the sex ratio at the prefecture times birth year level and examine its impact on divorce, controlling for various individual-level characteristics, birth year fixed effects,

[5]See Das Gupta et al. (2010) for a discussion of the challenges confronted by China because of the gender imbalance.

[6]Studies based on Chinese census data suggest that the "missing girl" phenomenon is closely linked to the enforcement of the OCP. For example, Ebenstein (2010) presents evidence from Chinese census data that the "missing girl" is caused by the enforcement of the One-Child Policy (OCP). Li et al. (2011) find that the OCP could explain 94%, 57%, and 54% of total increases in sex ratios for the 1980s, the 1990s, and the 2001-2005 birth cohorts, respectively. More detailed discussions about the OCP in China can be found in Bongaarts and Greenhalgh (1985) and Greenhalgh (2005), among others.

[7]Chen et al. (2013) estimate that roughly 40% to 50% of the increase in the sex imbalance at birth can be explained by local access to B-ultrasound examination. Similarly, according to Hesketh and Xing (2006)'s estimation, the number of missing women attributable to gender selection using B-ultrasound devices was up to 80 million in China and India.

[8]The first relaxation of the policy occurred in 2011 when it became permissible for couples who were both only children to have two children. On January 1, 2016, the revised Article 18, Clause 1 of the "People's Republic of China Population and Family Planning Law" stated that the state encourages couples to have two children, effectively ending the one-child policy that had been in place for more than three decades.

and prefecture fixed effects.

Our study constitutes three sets of analyses. Firstly, using province-level panel data, three waves of individual-level census data, and individual-level survey data, we demonstrate that a surplus of males in the marriage market leads to an increase in the divorce rate. Specifically, at the province level, an increase in the sex ratio (male-to-female ratio) among populations aged 20-40 significantly raises the annual divorce rate. For individual-level analyses, we examine the census sample data in 2005, 2010, and 2015. We document that the sex ratio faced by young women at the prefecture times birth year level significantly increases their probability of being currently divorced. To complement the census data, we utilize marriage history information from the 2010 wave of the China Family Panel Studies (CFPS) data and construct the "ever divorced" indicator as the outcome variable. We find that a higher sex ratio increases the likelihood of women experiencing a divorce at some point in their lives. Moreover, we rule out several other potential explanations, such as changes in the age of marriage, increased cohabitation with the husband's parents, and shifts in the gender education gap. There were no significant changes in divorce laws that could potentially introduce confounding factors to our results during our sample period.[9]

The second set of analyses focuses on examining the underlying channel. We first show that, as documented in the existing literature, a higher sex ratio increases the quality of marriage for women. These results suggest that the impact of sex ratio on divorce is not due to the marriage market being too frictional for women to find suitable partners in their first marriage. Specifically, we find that women faced with a higher sex ratio are married to men with better education and higher income, and women with rural *Hukou* are more likely to have a husband with urban *Hukou*. Furthermore, these women live in higher-quality houses characterized by larger areas, more rooms, and higher house prices. The results on housing quality are consistent with findings in existing studies (Wei and Zhang, 2011; Wei et al., 2017; Nie, 2020; Tan et al., 2021; Bhaskar et al., 2023). Furthermore, regarding mental well-being, women facing a higher sex ratio reported lower levels of depression.

Additional evidence supports the importance of the outside option channel. We document that divorced or widowed women confronted with a higher sex ratio in the local marriage market have a higher probability of remarriage. Furthermore, women

[9]The pro-women divorce reform in 2001 was the major relevant change in the marriage law in recent decades. Notably, between 2005 and 2015, there were no considerable alterations in divorce laws, except for the introduction of the "Judicial Interpretation III of the Marriage Law" in 2011, which undermines the protection of women's property rights post-divorce. As our regressions control for calendar year fixed effects and birth year fixed effects, Interpretation III's simultaneous nationwide application should not affect our results.

who remarry in male-skewed marriage markets tend to have remarriage partners of higher quality. A higher likelihood of remarriage and the anticipation of a high-quality subsequent husband can diminish the reluctance to divorce, explaining the higher divorce rates observed in marriage markets with an excess of men.

Moreover, China's current economic situation features notable income inequality, which has drawn considerable attention from the government and researchers.[10] Given the outside option channel, we argue that income inequality can amplify the impacts of sex ratio on divorce as married women have more wealthier outside options.[11] Assuming that wealth is essential when women choose a marriage partner, a married woman who encounters a wealthier man than her current husband may divorce and remarry that wealthier man. Holding constant the number of potential mates, a higher inequality indicates the presence of a larger fraction of men with high incomes or wealth, thereby providing more options for married women. We provide supportive evidence that the impacts of sex ratio on divorce are intensified in a more unequal economy. Following Gould and Paserman (2003), we explore different inequality measures, and the results remain robust.

This paper contributes to several strands of literature. First, this paper mainly contributes to the large strand of literature that examines the impacts of gender imbalance since Becker's seminal work (Becker, 1973, 1981), especially the consequence of "Missing Girls" (Sen, 1990, 1992). This literature has overlooked the potential destabilizing effects of a deficit of marriageable women on marriages, and this paper aims to fill this gap. Existing studies have focused on the impacts of sex imbalance on marriage decisions, within-household resource allocation, labor market outcomes, and social stability.[12] Specifically, it has been documented that the relative shortage of marriageable women increases their probability of marrying up (Das Gupta et al., 2010; Abramitzky et al., 2011; Du et al., 2015), boosts the bride price (Francis, 2011; Tertilt, 2005; Nick and Walsh, 2007; Grossbard, 2015), and pushes grooms or grooms' parents to save more and purchase high-value houses/apartments for their marriage (Wei and Zhang, 2011; Wei et al., 2017; Nie, 2020; Tan et al., 2021; Bhaskar et al., 2023). As a natural

[10] See, for example, the studies by Piketty et al. (2019), Meng (2004), Sicular et al. (2007) and literature review in Gustafsson et al. (2008), Wang et al. (2014), Li and Sicular (2014).

[11] Sociologists have provided evidence suggesting that not only the quantity but also the quality of mate availability in the marriage market is correlated with divorce rates.

[12] For papers on the impacts of sex imbalance on marriage and labor market outcomes, see, for example, Grossbard-Shechtman (1984), Samuelson (1985), Angrist (2002), Chiappori et al. (2002), Lafortune (2013), Negrusa and Negrusa (2014), Ong et al. (2020). For impacts on crimes such as sexual assault, violent crimes, and trafficking in females, see, for example, Hudson and Den Boer (2002, 2004), Hesketh and Xing (2006), Edlund et al. (2013), Cameron et al. (2019). Gender imbalance also changes parents' investment in children's education, but the results are mixed in the literature (Bhaskar and Hopkins, 2016; Lafortune, 2013; Bhaskar et al., 2023).

extension, sex imbalance could significantly influence marriage stability. This paper examines the impact and investigates the underlying channel.

Few studies have explored the relationship between the deficit of women and divorce rates. Most of the related papers examine the symmetric case where there are "missing men" in the marriage market due to high male mortality rates during wars. Existing papers present mixed findings and primarily concentrate on developed countries. For example, Abramitzky et al. (2011) document that the relative shortage of men after WWI in France reduced their divorce rates. Brainerd (2017) and Ogasawara and Igarashi (2021) provide evidence from Russia and Japan, respectively, that male scarcity due to WWII increased divorce rates. Using war to identify the causal effect of gender imbalance on divorce rates faces potential challenges. War may cause mental health problems, which could influence the divorce decisions of veterans.[13] War can also alter labor market conditions for both men and women, which can influence marriage outcomes. Our paper examines a different setting with the opposite scenario where there are more men than women. Given the differences in what men and women seek from marriage and the varying contexts between developed and developing countries, this paper contributes to a deeper understanding of the relationship between gender imbalance and marriage outcomes. The context of China, known for a stark increase in divorce rate in recent years and a strong son preference, makes it a useful step towards explaining the complex interplay between gender norms and marriage market outcomes.

Additionally, several early sociology studies document the correlation between the sex ratio in the marriage market and divorce rate (Trent and South, 1989; South and Lloyd, 1992, 1995).[14] We complement by exploiting more comprehensive data with larger sample sizes, which enable us to examine causality and explore the underlying mechanisms.

Second, this paper contributes to the literature investigating determinants of divorce. A rich literature from demographers, sociologists and economists documents the effects of various factors such as education (e.g., Bruze et al., 2015), age of marriage (Teachman, 2002; Rotz, 2016), employment, income (see, for example, Bertrand et al., 2015),

[13] Particularly, Negrusa et al. (2014) find that deployment in the Iraq and Afghanistan wars significantly increases American soldiers' divorce rate. For more papers on the impacts of war on mental health, see, e.g., Angrist and Johnson IV (2000); Negrusa and Negrusa (2014).

[14] Additionally, two papers address the impacts of oversupply on divorce on one side of the marriage market, although their focus differs from ours. Lafortune (2013) shows that an exogenous rising supply of males relative to females due to immigration destabilizes males' marriages. Their research centers on the impacts of sex imbalance on pre-marriage investment changes. Weiss et al. (2013) investigate the handover of Hong Kong to the People's Republic of China in 1997, which they take as a supply shock of low-education mainland women. They find that more Hong Kong men have turned to marrying mainland women, while Hong Kong women have lower marriage rates, higher divorce rates, and increased emigration. Their focus is not the sex imbalance but the change in the composition of marriageable women.

presence of a child and the gender of the child (e.g., Dahl and Moretti, 2008; Mammen, 2008), culture (Hirschman and Teerawichitchainan, 2003; Furtado et al., 2013), etc.[15] However, the impact of gender imbalance in the marriage market on divorce rates or marriage stability is ignored to a large extent by economic literature.[16] This paper highlights that the increasing divorce rates in China can be partially attributed to the deficit of marriageable women in the marriage market. Empirical evidence is consistent with the notion that the main driving force is the increased outside options available to married women, which may also be relevant in other economies. This paper calls for further investigation into the potential impacts of gender imbalance in regional marriage markets shaped by factors such as industrial structure, labor migration, or urbanization observed in other settings.

Third, this paper contributes to the literature investigating the impacts of inequality on social stability. For example, previous literature shows that inequality affects crimes (e.g., Kang, 2016) and sociopolitical unrest (Venieris and Gupta, 1986; Alesina and Perotti, 1996; Perotti, 1996). Following the study by Gould and Paserman (2003), existing papers also document the effects of inequality on the marriage market. However, the specific impacts of inequality on divorce have yet to be explored. In this paper, we empirically show that the interplay of inequality and gender imbalance could increase divorce rates, which can be considered a form of socioeconomic instability.[17] We argue that inequality breeds more available men with higher income or more wealth, which serves as outside options for married women in a male-skewed marriage market. Consequently, inequality can intensify the impact of sex imbalance on marriage stability. Understanding how greater inequality in male quality affects marriage stability can offer valuable insights into the relevance of the outside option explanation and how income inequality influences the marriage market.

[15]Other factors include duration of the marriage (Gottman and Levenson, 2000), communication difficulties between wife and husband (Thompson, 2008), marriage and divorce law (Kneip et al., 2014; Brassiolo, 2016; MacDonald and Dildar, 2018), race (Teachman, 2002; Zhang and Van Hook, 2009), religion (Teachman, 2002; Vaaler et al., 2009; Glass and Levchak, 2014), public policy (Barham et al., 2006; Tjøtta and Vaage, 2008), discrimination in the labor market (Teachman and Tedrow, 2008), experience of parent's divorce/intergeneration transmission of divorce (Teachman, 2002; Lyngstad and Engelhardt, 2009; Fu and Wolfinger, 2011; Wolfinger, 2011; Sieben and Verbakel, 2013), and risk preference (Light and Ahn, 2010). The literature review on the linkage between social, demographic, and economic variables and divorce can be found in Faust and McKibben (1999), White (1990), and Amato (2010).

[16]Zhang (2017) is pertinent to our study as we both investigate the effects of the One Child Policy on divorce rates in China. However, our focus diverges as we examine different affected populations and propose distinct mechanisms. Zhang (2017) explores the impact of reduced fertility on mothers' divorce decisions, while our research examines how the biased gender ratio experienced by the birth control generation affects their own divorce behaviors.

[17]Edlund and Pande (2002) document that the divorce rate even shapes the political gender gap in the United States, and they provide evidence from longitudinal data indicating that following divorce, women are more likely to support the Democratic Party.

2 Data and Descriptive Patterns

The main analyses involve regressing divorce on sex ratio, controlling for various control variables and fixed effects. Below, we describe the datasets and how we construct the main variables. Our empirical analyses draw on several datasets. Provincial aggregate results are derived from provincial panel data, while individual-level analyses combine census and survey data. The different datasets provide different measures of divorce, enabling us to get a comprehensive understanding of how sex imbalance affects marriage stability.

2.1 Provincial Panel Data

We begin with province-level analyses using data from the China Statistical Yearbook between 1997 and 2020. The National Bureau of Statistics (NBS) compiles these yearbooks, which provide comprehensive annual data for each province. The data includes the number of divorce cases, demographic composition, and social economics characteristics such as GDP per capita. In addition, we use 2000 census sample data to infer the sex ratio in the marriage market for each province each year. For example, we use the sex ratio of those aged 15-35 in the 2000 Census sample as a proxy for the sex ratio of the population aged 20-40 in 2005.

For the provincial analyses, the main outcome variable is the number of divorce cases during a given year per 1000 people aged 15-64. For robustness, we employ alternative measures of provincial divorce rates, such as the divorce-to-marriage ratio. We measure the sex ratio in the marriage market by the male-to-female ratio of the population aged 20-40. More than 90% of women who divorced got divorces when they were of this age range.[18] The descriptive statistics of the key variables are shown in Table A.1 Panel A.

2.2 Census Data

The second data source is the individual-level census sample data for 2000, 2005, 2010, and 2015. The census sample data provides information on each woman's current marital status, prefecture of residence, and other demographic and socioeconomic characteristics such as fertility, education attainment, and employment.

We focus our analyses on the currently married or divorced women aged 20-40. We measure the sex ratio following the previous literature (Brainerd, 2017; Ogasawara and Igarashi, 2021). For women living in prefecture c born in year y, the sex ratio is

[18] The age of divorce data are from the 2010 wave of the China Family Panel Studies (CFPS), where the marriage history information is available. A detailed description of the CFPS data is in Section 2.3.

constructed in the following way:

$$Sex\_ratio_{cy} = \frac{\sum_{t=y-8}^{y+2} \#\ of\ men\ born\ in\ year\ t\ in\ prefecture\ c}{\sum_{t=y-8}^{y+2} \#\ of\ women\ born\ in\ year\ t\ in\ prefecture\ c} \tag{1}$$

To avoid the endogeneity issue caused by gender-biased local labor market shocks, which can affect both the gender composition of the labor force and people's marriage behavior, we use the 2000 census data to construct this measure.[19] We restrict the birth year gap to [-8,+2] as women tend to marry men who are older than themselves.[20] The sex ratio is then merged with 2005, 2010, and 2015 census data based on each woman's prefecture of residence and birth year.

Our analyses use census data in 2005, 2010, and 2015. The divorce rates were very low before 2005. A comprehensive revision of the marriage law took effect in 2001, aiming to enhance women's rights after divorce. It was after the revision that the divorce rate began to rise. Hence, data on census years after 2001 are more relevant for our study, which focuses on the increasing divorce rates since the early 2000s.

The key variables are summarized in Table A.1 Panel B. The natural sex ratio at birth is typically around 1.05 or 1.06 (Sen, 1992). However, the sex ratio of the marriage-age population tends to be lower due to various factors, including natural factors,[21] war casualties, aging, etc. The average male-to-female ratio for the population aged 20-40 in the United States was approximately 1.01 in 2010.[22] In our census sample data, which covers 2005, 2010, and 2015, the sex ratio is around 1.03. However, it's important to note that this figure includes individuals born before and after the birth control policy. When we consider only those born before the one-child policy, the average sex ratio is 1.01, while for those born after, it rises to 1.08. The disparity highlights the impact of the birth control policy on the sex ratio.

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[19] The 2000 census sample used in this paper also has the largest sample size compared to 2005, 2010, and 2015 census waves, which makes the calculation of sex ratio for each $prefecture \times birth\ year$ cell more precise. We have tried measuring the sex ratio using all the census waves, and the results remained similar. The estimation results are reported in Table A.2.

[20] As some prefecture-year cells have few observations, to avoid the impacts of outliers, we Winsorize sex ratios at the 1st and 99th percentiles. The results obtained without Winsorizing are quantitatively similar. We have also tried sex ratios constructed using other age gap ranges; the results are similar. The corresponding estimation results are reported in Table A.2.

[21] Men often exhibit higher susceptibility to different health conditions compared to women, referred to as "male disadvantage". The disadvantage can be attributed to biological differences, such as variations in maturity, sex chromosomes, and hormones (Ritchie and Roser, 2019).

[22] The number is derived from the authors' calculation using data from United Nations, Department of Economic and Social Affairs, Population Division (2022).

2.3 CFPS 2010

The third dataset is the 2010 wave of the China Family Panel Studies (CFPS). This longitudinal survey is conducted by the Institute of Social Science Survey at Peking University and provides comprehensive information on households and individuals. The CFPS sample encompasses 25 provinces in China, which covers approximately 94.5% of the total Chinese population.[23]

The survey data possesses two key strengths, making it a valuable complement to the main analyses using the census data. Firstly, it provides rich information on the complete marriage history of women, enabling the construction of an indicator for "ever divorced" instead of relying solely on the current marital status. Specifically, the marriage history includes details such as the year of each marriage, the year of each divorce, and the total number of marriages and divorces. Leveraging this data, we generate an indicator that identifies individuals who have ever experienced divorce, serving as an additional proxy for divorce behaviors. Secondly, the survey data collects rich information on household and individual characteristics such as the number of siblings, income, psychological well-being, etc. The rich information allows us to account for additional individual characteristics, further addressing potential biases related to omitted variables.

For the sex ratio, we use the same data as in the main analyses of the census data. The sex ratio is merged with the survey data based on each woman's prefecture of residence and birth year. The key variables are summarized in Table A.1 Panel C.

3 Main results

3.1 Gender Imbalance and Divorce Rate: Provincial Panel Data

We first report the regression results at the province level. Specifically, for each province p in year t, we estimate the following equation:

$$Divorce\_rate_{pt} = \beta_0 + \beta_1 Sexratio20\_40_{pt} + X_{pt}\eta + \gamma_p + \mu_t + \epsilon_{pt} \tag{2}$$

where $Sexratio20\_40_{pt}$ is the male-to-female ratio of population aged 20-40 in year t in province p. X_{pt} is a vector of control variables, including GDP per capita, average household size, and average years of education. γ_p and μ_t are province fixed effects and year fixed effects. With only 31 provinces in mainland China, there is a potential concern that there may not be enough clusters for the asymptotics (Donald and Lang,

[23] The excluded provinces/cities/autonomous regions in mainland China are Xinjiang, Tibet, Qinghai, Inner Mongolia, Ningxia, and Hainan.

2007). To address this issue, we conduct the wild cluster bootstrap test, as suggested by Cameron et al. (2008), and report the p-values in square brackets.

The results are shown in Table 1. In all regressions, the coefficients of the sex ratio variable are positive and significant, which suggests a positive relationship between the sex ratio and divorce rate. The magnitudes of the coefficient are non-negligible. Taking the coefficient of Column (4) as an example, the coefficient indicates that a one-standard-deviation increase in the sex ratio can increase the divorce rate by 11.3%.[24] The results remain robust if the outcome variable is the number of divorces divided by the number of marriages in the province for a given year. This measure addresses the concern that there are more divorces because more people are married.

Table 1: Gender Imbalance and Divorce Rate at Provincial Level

	Divorce Cases Divided by Population Aged 15-64				Divorce Cases Divided by Marriage Cases
	(1)	(2)	(3)	(4)	(5)
Sexratio20_40	8.114**	6.212**	5.504*	5.516*	57.099*
	(2.953)	(3.013)	(2.906)	(3.018)	(28.999)
	[0.012]	[0.060]	[0.088]	[0.097]	[0.065]
ln(GDP per capita)		0.838	0.891	0.885	-11.906**
		(0.556)	(0.553)	(0.563)	(5.164)
Household size			0.340*	0.342*	9.582***
			(0.172)	(0.194)	(1.945)
Years of education				0.015	-0.986
				(0.288)	(1.642)
Obs.	744	744	744	744	651
Adj. R-sq	0.878	0.880	0.880	0.880	0.869
Mean of Dep. Var.	2.503	2.503	2.503	2.503	28.449

NOTE: Standard errors clustered at province level are reported in parentheses. The entries in square brackets are $p - values$ from the wild cluster bootstrap test with the null of the coefficient equal to zero. ***p<0.01, **p<0.05, *p<0.1

[24] In the dataset, the standard deviation of sex ratio is .051, and the mean divorce rate is 2.503. Therefore, with a coefficient of 5.516, a one-standard-deviation increase in the sex ratio can increase the divorce rate by $5.516 \times .051/2.503 \times 100\% \approx 11.3\%$

3.2 Gender Imbalance and Women's Probability of Divorce: Census Data

The province-level analyses are not merely aggregates of the individual-level analyses. The provincial data is annual and thus more frequent, and the measurement of divorce is different. On the other hand, provincial analyses can be susceptible to omitted variable bias, and provinces can be too large when it comes to marriage markets. Therefore, we turn to individual-level analyses, where more factors can be controlled for, and the marriage market can be analyzed at the prefecture level. Specifically, for each woman i living in prefecture c born in year y and surveyed in census wave w, we estimate the following equation:

$$Divorce_{icyw} = \alpha_0 + \alpha_1 Sex\_ratio_{cy} + Z_{icyw}\eta + \delta_{cw} + \kappa_{yw} + \epsilon_{icyw} \tag{3}$$

where Z_{icyw} is a vector of controls including whether the woman has any son, her ethnicity (whether she identifies as Han), her employment status, whether she is a migrant, whether she lives in an urban area, as well as fixed effects for education level and number of children. δ_{cw} are the prefecture times census wave fixed effects and κ_{yw} are the birth year times census wave fixed effects. Standard errors are clustered at the prefecture level.

Before diving into the analyses, we first show that there are significant variations in sex ratios across prefectures and birth cohorts, given the variation in policy enforcement stringency. Figure 1 shows the residualized sex ratios obtained by regressing sex ratios on prefecture fixed effects and birth year fixed effects. The six prefectures are picked randomly from the sample. Two key observations emerge. First, there is no consistent pattern across prefectures. The sex ratio increased and decreased at different times in different prefectures, and there is no persistent trend in most prefectures. Secondly, there is substantial variation across time in most prefectures. In terms of magnitude, a change of .05 means there are five more men per 100 women.

The main results are reported in Table 2. The coefficient of the sex ratio variable is positive and significant when pooling all the censuses. Specifically, a coefficient of 0.020 indicates that a one-standard-deviation increase in the sex ratio corresponds to a 9.6 percent increase in the probability of being currently divorced.[25] Alternatively, this implies that the changes in the sex ratio from 2005 to 2015 can account for approximately

[25] In our dataset, the standard deviation of the sex ratio is 0.077, and on average, 16 out of 1000 women are currently divorced. Therefore, a one-standard-deviation increase in the sex ratio is associated with a $0.077 \times 0.020/0.016 \times 100\% = 9.6\%$ increase in the likelihood of being currently divorced.

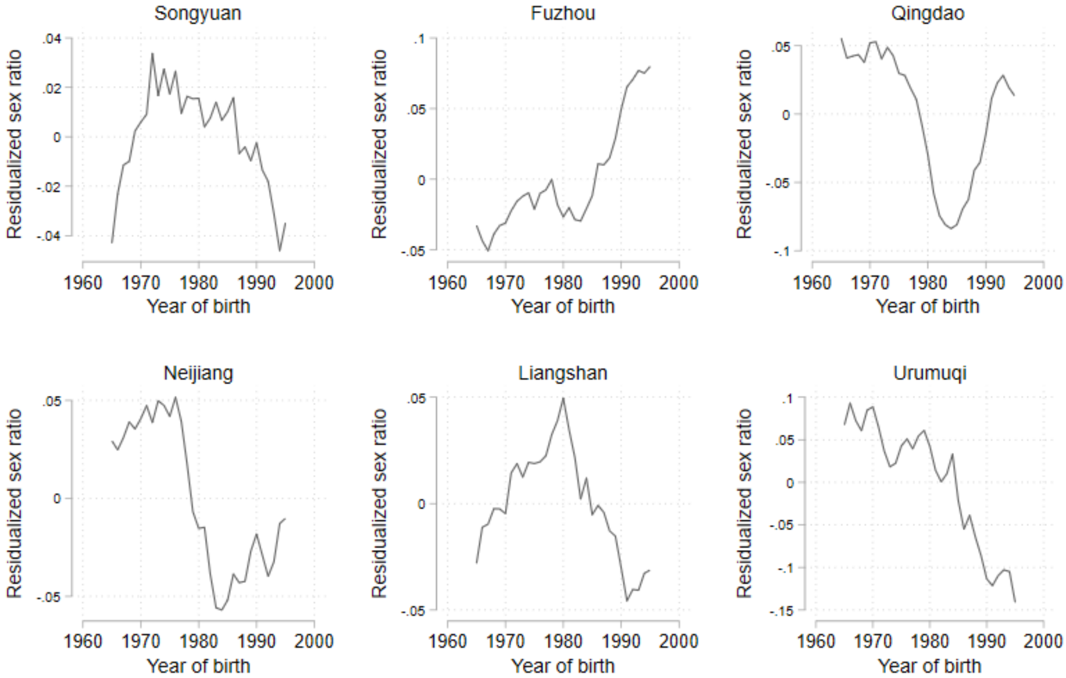

Figure 1: Residualized Sex Ratios

NOTE: The figure shows the residualized sex ratios obtained from regressing sex ratio on prefecture fixed effects and birth year fixed effects.

5% of the change in the divorce rate during that period.[26] When analyzing different census waves separately, we find that the coefficient of sex ratio is positive and marginally significant for the 2005 census, while it becomes larger and more significant for the two subsequent waves. This disparity is likely due to the rarity of divorce in the early 2000s. The increase in divorce rates over time enlarges the variation in divorce rates across prefectures and cohorts, making the impact of the sex ratio on divorce more apparent and significant in subsequent censuses.

We conduct a series of robustness tests. All the results are reported in Appendix Table A.2. First, we altered the age range to 20-45, the 1st and 99th percentiles of women's age at the time of divorce in CFPS 2010. Secondly, we changed the age cohort for sex ratio calculation to [-6,+1] or [-8,+2]/[-7,+3].[27] Thirdly, we used the census

[26]In 2005 and 2015, the mean sex ratio is 1.026 and 1.047, and the share of currently divorced women is 0.011 and 0.020, respectively, so the sex ratio can explain (1.047-1.026)×0.020/(0.020-0.011)=5% of the change in the divorce rate during that period.

[27][-6,+1] refers to $sexratio_{cy} = \frac{\sum_{t=y-6}^{y+1} \# \ of \ men \ born \ in \ year \ t \ in \ prefecture \ c}{\sum_{t=y-6}^{y+1} \# \ of \ women \ born \ in \ year \ t \ in \ prefecture \ c}$, and [-8,+2]/[-7,+3] refers to $sexratio_{cy} = \frac{\sum_{t=y-8}^{y+2} \# \ of \ men \ born \ in \ year \ t \ in \ prefecture \ c}{\sum_{t=y-7}^{y+3} \# \ of \ women \ born \ in \ year \ t \ in \ prefecture \ c}$

wave-specific sex ratio instead of the sex ratio in the base year 2000. These robustness tests provide additional support to the positive relationship between the sex ratio and the probability of being currently divorced.

Table 2: Gender Imbalance and Women's Probability of Divorce: Censuses

	Pooled (1)	Census 2005 (2)	Census 2010 (3)	Census 2015 (4)	IV (5)
Sex ratio	0.020***	0.010*	0.023***	0.020***	0.099**
	(0.004)	(0.006)	(0.005)	(0.007)	(0.041)
Han ethnicity	-0.003***	-0.005***	-0.003**	-0.001	-0.002
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Having a son	-0.005***	-0.004***	-0.006***	-0.006***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Employed	0.001**	-0.002**	0.001**	0.003***	-0.000
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Migrant	-0.003***	-0.005***	-0.002***	-0.003***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Urban	0.008***	0.009***	0.009***	0.005***	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
1st-Stage F-stat					6.393
Observation	1,150,344	339,405	593,688	217,250	461,665
Adj. R-sq	0.018	0.017	0.018	0.016	0.000
Mean of Dep. Var.	0.016	0.011	0.018	0.020	0.018

NOTE: Prefecture × wave fixed effects and birth year × wave fixed effects, education, and number of children fixed effects are controlled for all columns. For Column (5), the instrumental variable is the interaction of a measure of prefecture-level gender norms and the indicator for being born in and after 1979, the starting year of the One-Child Policy. Standard errors clustered at the prefecture level are reported in parentheses. ***p<0.01, **p<0.05, *p<0.1.

We take various measures to address potential threats to the identification. Firstly, the impact of the sex ratio on women's education attainment and labor market outcomes could affect women's independence and subsequently influence the probability of divorce. In the main analyses, we have controlled for the education and employment status of the women. The results remain robust when we further include industry and occupation fixed effects, which suggests that the potential impact of the increased independence is not a main concern for our findings. Secondly, the changes in social attitudes towards divorce should not account for our findings as the results remain robust when we control for province times birth year fixed effects. Thirdly, as documented by Chen et al. (2021) and Alm et al. (2022), people in some regions resort to "fake divorces" to get additional quotas for house purchasing. As the previous literature has established that a biased sex ratio can increase demand for houses, the observed positive impact of sex ratio on divorce can be caused by this impact of sex ratio on house demand, with the increased divorce rate serving as a method to secure quotas for purchasing houses. To address the potential effects of fake divorces, we control for the house purchasing quota policy, and the results remain robust. Finally, as we can only observe the sex ratio of the prefecture of residence but not the sex ratio the women were exposed to when they divorced, it is possible that migrants were exposed to a different sex ratio when making divorce decisions. To address this concern, we drop the migrants, and the results remain. All the results are reported in Appendix Table A.3.

Given the extensive time span of over twenty years, it is unlikely that parents engaged in sex selection practices with the anticipation of future conditions in the marriage market. Therefore, we consider the potential omitted variable problem the largest threat to our results. In Section 3.4, we explore and rule out the major potential confounding factors. It is important to note that our sex ratio measure is highly granular, and we have controlled for prefecture fixed effects and birth year fixed effects. By doing so, any remaining threats to identification should vary at the prefecture times birth year level.

Finally, we experiment with multiple instruments to address concerns about potential omitted unobservables. However, the high granularity of the sex ratio measure results in weak first stages, causing the second-stage estimations to be 1-5 times the size of the OLS estimations and less precisely estimated. To mitigate potential issues related to the instruments, our primary analyses focus on Ordinary Least Squares (OLS) estimates. The preferred instrumental variable result is included in Table 2, Column (5). Specifically, the instrumental variable is the interaction of a measure of prefecture-level gender norms and the indicator for being born in and after 1979, the starting year of the One-Child Policy.[28] The coefficient on sex ratio remains positive and significant in our 2SLS estimation. See Appendix Section A.3 for results of other instrumental variables and detailed discussions.[29]

[28]The gender norm variable is constructed using the 2010 wave of the Chinese General Social Survey (CGSS) dataset. Specifically, each interviewee responded to 5 statements related to gender norms, providing a score ranging from 1 to 5 to indicate their levels of agreement. A higher score reflects a greater level of agreement. The five statements are: "Women prioritize their families, while men prioritize their careers," "Men are inherently stronger than women in terms of abilities," "A successful marriage is preferable to a successful career," "When the economy is struggling, female employees should be laid off first," "Household chores should be divided equally between spouses." We recode the score of the last question so that a higher average score of the five questions reflects a higher degree of gender discrimination. We expect a positive sign in the first stage, given that sex selection, following the launch of the One-Child Policy, is likely to be more prominent in regions characterized by stronger gender discrimination.

[29]We only show results that have a significant first-stage coefficient. We have experimented with multiple instruments, incorporating insights from Zhang (2017), such as minority fractions across cohorts, excess fertility residuals, and fine rates. All of them result in weak first stages.

3.3 Gender Imbalance and Women's Probability of Divorce: Individual Survey Data

The census data only has information on the current marital status of women. If a woman divorced and remarried, they will be coded as "married" rather than "divorced." This will lead to an underestimation of the impact of sex ratio on divorce. To address this issue, we exploit the CFPS data where the whole marriage history is observed. Specifically, we estimate the following equation:

$$Ever\_divorced_{icy} = \alpha_0 + \alpha_1 Sex\_ratio_{cy} + Z_{icy}\eta + \delta_c + \kappa_y + \epsilon_{icy} \tag{4}$$

where Z_{icy} is a vector of individual characteristics. In addition to the control variables in the regressions using census data, we control for the indicator for co-habitation before marriage and fixed effects for the number of male and female siblings. The standard errors are clustered at the prefecture level.

The regression results are reported in Table 3. Even after controlling for a rich set of control variables and fixed effects, the coefficients of sex ratio remain positive and significant, implying that an increase in sex ratio will increase the probability of a woman experiencing divorce. Specifically, a coefficient of 0.098 indicates that a one-standard-deviation increase in the sex ratio corresponds to a 23 percent increase in the probability of ever getting a divorce.[30] Compared to the estimation using the census data, the larger magnitude of this effect aligns with the recognition that the census data tends to underestimate, as about half of the divorced women remarry.[31] The results remain robust when we control for the women's income.

We address one potential omitted variable bias by controlling for sibling fixed effects. Specifically, the birth control policy can simultaneously influence the sex ratio, the sex composition of siblings, and the number of siblings. There has been literature on the "little prince/princess" phenomenon, which suggests that the children of the birth control generation can be spoiled as they gain seemingly excessive amounts of attention from their parents and grandparents (Cameron et al., 2013). If the spoiling changes the children's expectations of marriage, their divorce decisions can also be affected. However, as shown in Column (3), the positive impact of sex ratio on divorce remains robust when the sibling fixed effects are controlled for. Additionally, the magnitude of the coefficient changes little, indicating that the impact of the lack of siblings is not a

[30]One standard deviation in sex ratio is 0.065, and the mean divorce rate is 0.028. Therefore, a one-standard-deviation increase in the sex ratio corresponds to 0.065×0.098/0.028*100%≈23%

[31]The fraction of remarried women among those who have ever divorced is calculated using the 2005 census and CFPS 2010 data, where the relevant information is available.

Table 3: Gender Imbalance and Women's Probability of Divorce: CFPS 2010

1{Ever divorced}	(1)	(2)	(3)	(4)
Sex Ratio	0.085*	0.098**	0.098**	0.098**
	(0.047)	(0.046)	(0.047)	(0.046)
Controls	-	Y	Y	Y
Male siblings FE & Female siblings FE	-	-	Y	Y
Income	-	-	-	Y
Obs.	8,799	8,798	8,717	8,715
Adj. R-sq	0.019	0.073	0.074	0.075
Mean of Dep. Var.	0.028	0.028	0.028	0.028

NOTE: Fixed effects for prefecture, birth year, education, and the number of children are controlled for all columns. All the control variables for the census regressions are controlled for in Columns (2)-(4). Additionally, the indicator for cohabitation before marriage is controlled. Column (4) controls for the inverse hyperbolic sine of income. If controlling for log income instead, the coefficient increases slightly with no change in statistical significance, and the sample size shrinks to three quarters. Standard errors clustered at the prefecture level are reported in parentheses. ***p<0.01, **p<0.05, *p<0.1.

significant contributing factor to the observed relationship between gender imbalance and divorce rates.

3.4 Rule Out Other Potential Explanations

Previous literature and anecdotal evidence suggest three potential channels that may play a role in the observed impacts of sex ratio on divorce. In this section, we examine these alternative explanations.

First, a higher sex ratio may lead women to marry earlier as they may encounter more men when they are young. Marrying younger may result in a higher probability of divorce as younger people's ability to deal with challenges in marriage can be low (Rotz, 2016). To check if this is a relevant story, we control for the fixed effects of age at first marriage in addition to the baseline specification. The result is shown in Table 4 Column (2). Column (1) shows the baseline results copied from Table 2. The coefficient of sex ratio in Column (2) remains positive and significant, and the magnitude is very close to the baseline result. The result suggests that changes in the ages at the first marriage do not explain the impact of sex ratio on divorce. Further analyses indicate that an increase in the sex ratio results in a very slight increase in the marriage age, rather than a decrease.

Secondly, besides affecting sex ratios, birth control policies also contribute to the

Table 4: Rule Out Other Explanations: Censuses

	Baseline	Marriage age	Fraction of wives co-living with husband's parent	Gender Edu Gap	Add all controls
	(1)	(2)	(3)	(4)	(5)
Sex ratio	0.020***	0.021***	0.021***	0.020***	0.022***
	(0.004)	(0.005)	(0.008)	(0.004)	(0.008)
Co-live			0.022***		0.025***
			(0.003)		(0.003)
Education gap				-0.004***	-0.004**
				(0.001)	(0.002)
Marriage age FE	-	Y	-	-	Y
Obs.	1,150,344	933,093	795,372	1,150,344	695,204
Adj. R-sq	0.018	0.019	0.019	0.018	0.020
Mean of Dep. Var.	0.016	0.016	0.017	0.016	0.016

NOTE: Fraction of wives co-living with husband's parent is at the prefecture times birth year level for each census wave, distinguishing between urban and rural areas. The gender education gap is calculated in the following way. For a woman observed in census wave w living in prefecture c born in year y, we first calculate the average education gap between men and women for each census wave × prefecture × birth year cell. Then, we take the average of the gaps for birth years in the range $[y - 8, y + 2]$. This gap is taken as a proxy for the education gap the woman faced in her marriage. Prefecture times wave, birth year times wave, education, and number of children fixed effects are controlled for all columns. Column (1) shows the baseline results copied from Table 2. All the control variables for the census regressions are controlled for all columns. Standard errors clustered at the prefecture level are reported in parentheses. ***p<0.01, **p<0.05, *p<0.1.

prevalence of many one-child households. In the Chinese context, especially in rural areas, it is common for married couples to live with the husband's parents. A higher likelihood of the husband being the only child results in a higher probability of women co-living with their parents-in-law, which may be associated with an increased divorce rate. Therefore, co-living can lead to omitted variable bias in our setting. To address this concern, we calculate the co-residence fraction at the prefecture times birth year level for each census wave, distinguishing between urban and rural areas. We then control for the co-living fraction in the regression. The result is shown in Table 4, Column (3).[32] The coefficient of sex ratio remains positive and significant. This indicates that the omitted variable bias caused by co-living is not a primary concern in our context. The coefficient of the co-living fraction is positive and significant, suggesting that co-living

[32]The observations decrease because we exclude the prefecture × birth year × urban cells with too few observations in order to improve the precision of the co-living fraction.

with parents-in-law increases the probability of divorce for women.

Thirdly, birth control policies can increase the education attainment of both men and women, with a potentially larger impact on women's education, leading to a reduction in the gender education gap (Chae et al., 2023). This reduced gap may also influence the probability of divorce, introducing an omitted variable bias. To address this concern, we control for the education gap. Specifically, for a woman observed in census wave w living in prefecture c born in year y, we first calculate the average education gap between men and women for each census wave times prefecture times birth year cell. Then, we take the average of the gaps for birth years in the range $[y-8, y+2]$ and use it as a proxy for the education gap the women faced in her marriage. The result is shown in Table 4, Column (4). In the existing literature, whether a narrowed gender education gap destabilizes marriages remains controversial (see Bertrand et al. (2015) and Binder and Lam (2022)). In any case, it does not affect the main results.

Finally, when we include all controls in the same regression, the coefficient for the sex ratio is positive and significant and has a similar magnitude as the main results.

4 Mechanism

Overall, we observe a robust pattern that facing a higher sex ratio will increase women's probability of divorce. We investigate potential channels that may contribute to this pattern to understand this relationship further.

As mentioned before, the impact of sex ratio on divorce is ex-ante ambiguous. On the one hand, a higher sex ratio gives women higher bargaining power in the marriage market. As a result, they can marry a better husband, which should decrease the probability of divorce. On the other hand, a higher sex ratio also leads to more outside options, which can make marriages less stable. In our subsequent analyses, we thoroughly examine both of these directions.

4.1 Do Women Marry Up When the Sex Ratio is Higher?

We first examine whether women experience marriages of higher quality in the presence of a higher sex ratio. The implications of the main results are different if there is excessive friction in the marriage market that prevents women from finding a preferred husband.[33] To examine whether women marry up when faced with a higher sex ratio,

[33]It is also theoretically possible that, knowing there is a high likelihood of a second chance, women may be less stringent about their first marriage. Therefore, a higher sex ratio does not necessarily lead to higher marriage quality.

we regress various husband quality measures on sex ratio. The results are reported in Table 5 Column (1)-(3). Only couples married within three years are included in the sample to limit survivorship bias. The results indicate that women faced with a higher sex ratio tend to marry men with more years of education and higher monthly income. Women with rural *Hukou* are more likely to marry husbands with urban *Hukou*.

Moreover, given the important role of houses in marriage, we examine the impacts of sex ratio on housing quality. Specifically, in the Chinese context, where parents-in-law often make substantial contributions to marriage-related house purchases, these measures can serve as proxies of parental affluence. Column (4)-(6) of Table 5 show the regression results. As expected, a higher sex ratio is associated with an increase in housing quality measured by house area, number of rooms, and house price.

Other than social and economic characteristics, we recognize that unobserved features, such as personality, also play a role in determining the quality of marriage. While lacking information on the unobserved features, we can examine the quality of marriage directly by examining women's happiness in their marital relationships. Specifically, we examine whether women are less likely to experience mental health issues in marriage when faced with a higher sex ratio. To do this, we utilize the CFPS data, which has information on nonspecific psychological distress collected using the Kessler 6 Scale (K6) instrument (Kessler et al., 2002). During the survey, the interviewees were asked about the frequency of feeling "upset", "stressed", "cannot calm down", "hopeless", "everything is difficult" and "life is meaningless". The responses were coded into indexes ranging from 0 to 4: 0 for "none of the time," 1 for "a little of the time," 2 for "some of the time," 3 for "most of the time," and 4 for "all of the time."

We regress these indexes on the sex ratio for currently married women, and the results are shown in Table 6. All the coefficients of sex ratio are negative, which indicates that a higher sex ratio decreases the probability of the wife feeling depressed in various ways. The results remain robust when we control for the income of the women.[34]

In conclusion, we observe that women marry better when exposed to a higher sex ratio, which could potentially decrease the probability of divorce. The results suggest that the higher divorce rate cannot be solely attributed to the frictional nature of the marriage market, where women struggle to find suitable partners in their first marriage. Instead, the results suggest that another force, which we identify as the outside option channel, plays a dominant role in increasing divorce rates.

[34] Additionally, it has been documented in the previous literature that women's labor supply can decrease when they have higher within-household bargaining power. We verify this result using our data and find that when faced with a higher sex ratio, women decrease labor supply both at the intensive and extensive margins. These results suggest that women have higher bargaining power within household when sex ratio increases.

Table 5: Gender Imbalance and Husband Quality

	Husband Characteristics			Housing Quality		
	Education	Monthly Income	Has Urban Hukou	lnArea	# of Rooms	lnHouseprice
	(1)	(2)	(3)	(4)	(5)	(6)
Sex ratio	0.585**	1014.971***	0.105***	0.779***	1.175***	0.298*
	(0.236)	(373.288)	(0.039)	(0.174)	(0.275)	(0.156)
Obs.	103,260	30,198	72,229	103,169	103,169	24,202
Adj. R-sq	0.627	0.263	0.152	0.312	0.256	0.575
Mean of Dep. Var.	10.684	910.448	0.083	4.376	3.200	10.227

NOTE: Only couples married within three years are included in the sample to limit survivorship bias. As Census 2015 does not have information on marriage year, only Census 2005 and 2010 are used. Columns (2) and (6) use Census 2005 only due to data availability. Column (3) only includes women who have rural *Hukou*. Prefecture × wave fixed effects, birth year × wave fixed effects, and wife's education fixed effects are controlled for all columns. Fixed effects for the year of construction of the house are controlled for Columns (4)-(6). All the control variables for the census regressions are controlled for all columns except for the number of children or the indicator for having a male child. These two variables are omitted as fertility occurs after marriage and is not expected to impact husband and housing characteristics directly. Results are similar if they are included in the regressions. Standard errors clustered at the prefecture level are reported in parentheses. ***p<0.01, **p<0.05, *p<0.1.

Table 6: Gender Imbalance and Wife's Mental Health

The frequency of feeling	Upset	Stressed	Cannot calm down	Hopeless	Everything is difficult	Life is meaningless	Overall depression
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sex ratio	-0.624***	-0.117	-0.425**	-0.256*	-0.448**	-0.207	-0.957**
	(0.236)	(0.197)	(0.186)	(0.152)	(0.203)	(0.173)	(0.449)
Obs.	8,558	8,565	8,564	8,545	8,565	8,558	8,530
Adj. R-sq	0.056	0.046	0.056	0.051	0.082	0.060	0.088
Mean of Dep. Var.	0.763	0.569	0.493	0.325	0.562	0.333	-0.014

NOTE: This table shows estimations using the CFPS data. Only women who are currently married are included in the sample. Outcomes of Columns (1)-(6) are indexes that reflect the frequency of feeling depressed in various ways. These indexes range from 0 to 4: 0 for "none of the time", 1 for "a little of the time", 2 for "some of the time", 3 for "most of the time", and 4 for "all of the time." The outcome of Column (7) is the Principal Component Analysis (PCA) scores of the first principal component. Prefecture, birth year, education, and number of children fixed effects are controlled for all columns. All the control variables for the census regressions and the indicator for cohabitation before marriage are controlled for all columns. Standard errors clustered at the prefecture level are reported in parentheses. ***p<0.01, **p<0.05, *p<0.1.

4.2 Outside Option

In this section, we provide evidence for the outside option channel. This channel suggests that when faced with gender imbalances, individuals can have more alternative options, making marriages less stable and leading to a higher likelihood of divorce.

4.2.1 Do Women Remarry More Easily after Divorce?

We first check if divorced women are more likely to remarry if faced with a higher sex ratio in the local marriage market. If women are getting divorced because they no longer have the demand for marriage, we would not observe the impact of the sex ratio on remarriage. In other words, if we do find an effect, it suggests that the availability of alternative options may play a role in women's decision to divorce. The anticipation of easy remarriage could reduce women's reluctance to divorce, thereby contributing to the higher divorce rates of women faced with higher gender imbalances.

Table 7 reports our estimation results on the impacts of sex ratio on remarriage using CFPS data. We examine both ever-divorced and ever-widowed women samples, as women can remarry after divorce or during widowhood. For both samples, we find that women who have experienced the loss of a partner are more likely to get remarried when confronted with higher sex ratios. Overall, the results suggest that women can find a new partner relatively more easily when faced with higher sex ratios, which may increase the likelihood of divorce.

Table 7: Gender Imbalance and Remarriage

1{Ever-remarry}	Divorced	Divorced & Widowed
	(1)	(2)
Sex ratio	3.267**	2.550***
	(1.393)	(0.933)
Obs.	201	400
Adj. R-sq	0.258	0.139
Mean of Dep. Var.	0.507	0.450

NOTE: Prefecture, birth year, education, number of children, male and female siblings fixed effects are controlled for all columns. All the control variables for the census regressions and the indicator for cohabitation before marriage are controlled for all columns. Standard errors clustered at the prefecture level are reported in parentheses. ***p<0.01, **p<0.05, *p<0.1.

4.2.2 Is the Quality of the Subsequent Husband Better for Remarried Women?

We then investigate whether a higher sex ratio increases the quality of the subsequent partner for remarried women. If this impact is observed, it suggests that the availability of alternative options may play a role in women's decision to divorce. If women expect that potential new partners have relatively high quality and can lead to a more satisfying and stable future relationship, they are more likely to seek divorce.

Table 8 shows the results. The sample includes all currently married or remarried women. The coefficient for the remarriage indicator implies that the new partners of remarried women have fewer years of education and lower monthly income. On the other hand, for women with rural *Hukou*, the subsequent partners are more likely to have urban *Hukou*. The results suggest that in most aspects, the husbands of remarried women are of lower quality than those of women who remain in their first marriage. There are at least two potential reasons. Firstly, women who once divorced are less preferred for men, so only men with lower quality marry divorced women. Secondly, men of high quality were kept in the first marriage. Therefore, the husbands' quality of divorced women can change from very bad to not so good but cannot be better than those who remain in their first marriage. Our results suggest that a higher sex ratio can mitigate the reduction in husband's quality. Specifically, women who face a higher sex ratio are more likely to remarry a husband with higher education than women who face a lower sex ratio. For women with rural *Hukou*, a higher sex ratio further increases the likelihood of remarrying a husband with urban *Hukou*.

4.3 Heterogeneity: Inequality

Finally, we ask if women are more likely to divorce when there are more better alternative options. Specifically, we investigate if the sex ratio increases divorce more in regions with higher inequality. The intuition is that a higher sex ratio increases the number of outside options, and higher inequality increases the fraction of these outside options of higher quality than the current husband plus a divorce cost. If it is easier for women to find new partners that are better than their current husbands, the likelihood of divorce will increase. Notice that inequality may also improve the husband's quality in the first marriage, which should amplify the positive impact of sex ratio on first marriage quality and decrease the divorce rate. Therefore, the sign of the coefficient for the interaction of sex ratio and inequality is ex-ante ambiguous. A positive sign will suggest that the outside option channel dominates.

Table 9 shows the results. Specifically, we use five different measures of inequality. Our approach begins by computing the household's aggregate income divided by the

Table 8: Gender Imbalance and Quality of the Subsequent Husband

Husband's	Year of Education (1)	Monthly income (2)	Has Urban Hukou (3)
Sex ratio_demeaned	-0.120	445.943	0.026
	(0.147)	(316.331)	(0.020)
1{remarry}	-0.337***	-41.208**	0.042***
	(0.034)	(16.489)	(0.009)
Sex ratio_demeaned	1.057**	-378.955	0.305**
×1{remarry}	(0.531)	(293.300)	(0.146)
Obs.	207,826	207,826	149,283
Adj. R-sq	0.534	0.211	0.081
Mean of Dep. Var.	9.452	807.371	0.053

NOTE: Use census 2005 data. Column (3) uses the subsample of women with rural *Hukou*. Prefecture, birth year, and education fixed effects are controlled for all columns. All the control variables for the census regressions are controlled for all columns except for the number of children or the indicator for having a male child. Standard errors clustered at the prefecture level are reported in parentheses. ***p<0.01, **p<0.05, *p<0.1.

count of males aged 20-45 residing within the household. This construction takes into account that the entire household's income better captures the significance of parental earnings in the context of marriages in China. We take the log of this income measure and calculate its standard deviation and the Gini index for each prefecture. Additionally, we calculate the ratios between the 90th percentile and the 50th percentile of the log income measure (P90/50) as well as the ratios between the 90th percentile and the 10th percentile of the log income measure (P90/10). Moreover, inequality and social attitudes towards divorce may change simultaneously as the economy develops. To address this issue, we calculate the urban rate at census wave times province level and control for the interaction of sex ratio and the urban rate in all the regressions.

For all the inequality measures, the coefficients for the interaction of sex ratio and inequality are positive and significant, indicating that the effect of sex ratio on divorce is more pronounced in prefectures with higher levels of inequality. The results suggest that the influence of the outside option channel outweighs the impact of the matching quality channel when considering how inequality matters for the effects of sex imbalance on divorce. Moreover, the results indicate that societies undergoing both salient inequality and substantial sex imbalance, as observed in numerous developing countries today, may face heightened concerns regarding social instability stemming from the dissolution of marriages.

Table 9: Heterogeneous Effect of Gender Imbalance: Inequality

	(1)	(2)	(3)	(4)	(5)
Sex ratio * P90/50	0.128**				
	(0.064)				
Sex ratio * P90/10		0.062*			
		(0.032)			
Sex ratio * sd(ln(income))			0.222*		
			(0.123)		
Sex ratio * sd(residual ln(income))				0.264*	
				(0.138)	
Sex ratio * Gini					0.483**
					(0.219)
Obs.	378,794	378,794	378,794	378,794	378,794
Adj. R-sq	0.017	0.017	0.017	0.017	0.017
Mean of Dep. Var.	0.017	0.017	0.017	0.017	0.017

NOTE: Inequality is calculated using household total income divided by the number of males of age 20-45 within the household (89% households have one and 8% have two such males). Inequality is calculated using the CGSS data due to data availability. Prefecture, birth year, education, and number of children fixed effects are controlled for all columns. All the control variables for the baseline census regressions are controlled for. Standard errors clustered at the prefecture level are reported in parentheses. ***p<0.01, **p<0.05, *p<0.1.

5 Conclusion

While the birth control policy has been officially terminated, its profound impacts will persist in the Chinese economy for a considerable period. One of its side effects, sex imbalance, has dramatically transformed society. In addition to the impact of sex imbalance on various outcomes in marriage and labor markets documented in the previous literature, this paper sheds light on the overlooked robust relationship between sex imbalance and divorce. Further investigation reveals that the outside option channel plays a dominant role. We show that women facing a higher sex ratio are more likely to remarry after divorce, and the new partners are of higher quality compared to remarried women facing a lower sex ratio. With the expectation of easy remarriage and the prospect of better subsequent husbands, women are more inclined to divorce.

As the main mechanism we reveal is the outside option channel, regions with an imbalanced sex ratio may experience similar marriage instability. Our framework, therefore, provides a valuable perspective in other sex-imbalance settings, such as those affected by gender-biased industry structures.

We acknowledge that there could be other factors shaping the influence of sex ratio on divorce rates. Specifically, sex ratio can affect both the quality of marriages and the availability of alternative options. Factors such as social norms (for instance, whether there is bias against divorced women), legal institutions (including the extent of legal protection for women should they go through a divorce), and social support (such as the capacity of divorced women to lead independent lives and raise children on their own) can affect which force dominates, the increase in marriage quality or the increase in outside options, thereby influencing the overall impact. This variability may explain the conflicting findings in prior literature regarding the effects of male scarcity on divorce rates across different contexts. The purpose of this paper is not to establish a universally applicable rule of when the outside option channel dominates. Our study aims to offer complementary insights into a distinct scenario of female scarcity, and we hope our study can help open up new directions for future research on gender-based variations in marriage-related preferences and behaviors.

Last but not least, our findings have important implications on how policies can be designed to either slow down the trend of increasing divorce rates or address the consequences in regions with high gender imbalance and divorce rates. First, social protection programs covering the divorced population, their children, and those who cannot find mates because of gender imbalance are needed. Second, local governments may want to pay more attention to the marriage market if the regional industrial structure, immigration, or internal migration can lead to sex imbalance. Third, reducing the degree of information asymmetry in the marriage market can improve marriage-matching efficiency. For example, local governments can release more information about the relative shortage of men or women in the marriage market to guide those single adults to find the "right" destination where opportunities exist for finding both marital partners and jobs.

A Appendix

A.1 Descriptive Statistics

Table A.1: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
	Panel A: Province-level Data			
(# of divorce cases / population aged 15-64)×1000‰	2.503	2.118	.001	9.479
(# of divorce cases / # of marriage cases)×100	28.449	14.96	6.872	80.812
Sex ratio	1.056	.051	.946	1.224
ln(GDP per capita)	9.947	.937	7.719	12.009
Average household size	3.258	.485	2.222	6.79
Average year of education	8.309	1.375	2.948	12.782
	Panel B: Census Data			
Divorce	.016	.127	0	1
Sex ratio	1.031	.077	.826	1.259
Birth year	1977.454	6.482	1965	1995
Han Ethnicity	.913	.282	0	1
Employed	.775	.417	0	1
Migrant	.269	.444	0	1
Urban	.353	.478	0	1
Having a son	.651	.477	0	1
Number of children	1.297	.762	0	9
	Panel C: Individual Survey Data			
Divorce	.028	.166	0	1
Sex ratio	1.039	.065	.842	1.325
Birth year	1971.262	8.599	1956	1992
Han Ethnicity	.912	.283	0	1
Employed	.753	.431	0	1
Migrant	.093	.291	0	1
Urban	.472	.499	0	1
Cohabit	.122	.327	0	1
Having a son	.692	.462	0	1
Number of children	1.581	.851	0.000	7
Number of male sibling(s)	1.485	1.181	0.000	7
Number of female sibling(s)	1.364	1.302	0.000	8
Income	8348.388	17044.929	0.000	800000

NOTE: The province-level data has 744 observations except for the divorce-marriage ratio, which has 651 observations. The census data has 1,150,344 observations; the CFPS survey data has 8,717 observations.

A.2 Robustness Tests

Table A.2: Robustness Tests

	Age 25-45	[-6,+1]	[-8,+2]/[-7,+3]	Wave-specific sex ratio
	(1)	(2)	(3)	(4)
Sex Ratio	0.022***	0.016***	0.020***	0.021***
	(0.006)	(0.004)	(0.004)	(0.005)
Obs.	1,387,342	1,150,344	1,150,344	1,231,916
Adj. R-sq	0.020	0.018	0.018	0.018
Mean of Dep. Var.	0.019	0.016	0.016	0.016

NOTE: This table shows the results of the first set of robustness tests. Column (1) reports the estimations using the sample of women aged 20-45. Columns (2) and (3) report results using [-6, +1] and [-8,+2]/[-7,+3] age gaps for the calculation of the sex ratio. Column (4) shows the results using census wave-specific sex ratio. Specifically, we construct the sex ratio by aggregating data from both the present and preceding waves of censuses. For example, to construct the sex ratio for observations in the 2010 census, we calculate the sex ratio pooling 2000, 2005, and 2010 waves. Standard errors clustered at the prefecture level are reported in parentheses. ***p<0.01, **p<0.05, *p<0.1.

Table A.3: Robustness Tests (Cont.)

	Industry & occupation	Province $\times$ year FE	Fake divorce	Exclude migrants
	(1)	(2)	(3)	(4)
Sex Ratio	0.018***	0.016***	0.019***	0.017***
	(0.005)	(0.004)	(0.004)	(0.005)
Obs.	891,713	1,150,344	1,150,344	840,430
Adj. R-sq	0.021	0.018	0.018	0.020
Mean of Dep. Var.	0.016	0.016	0.016	0.017

NOTE: This table shows the results of the second set of robustness tests. Column (1) reports the estimations controlling for census wave-specific occupation and industry fixed effects. Column (2) reports the results controlling for province × year fixed effects. Column (3) reports results controlling for the implementation of fake divorce. Column (4) shows the results excluding migrants. Standard errors clustered at the prefecture level are reported in parentheses. ***p<0.01, **p<0.05, *p<0.1.

A.3 Results using Instrumental Variables

We have experimented with three types of instruments. First, previous literature has documented that the land reform in China in the 1980s has increased the male-to-female ratio (Almond et al., 2019). We use the indicator for whether the land reform has begun in the women's living prefecture five years before her birth year as the instrument for the sex ratio in her birth cohort.[35]

Secondly, the spread of ultrasound machines facilitated sex selection (see, e.g. Hesketh and Xing, 2006). We use the indicator for the presence of ultrasound machines in the capital of each woman's province of residence in her birth year as an instrument for the sex ratio.[36]

Finally, as migrants remain primarily men in our sample period, increases in migration can decrease the origin's sex ratio. Correspondingly, we use the FDI in the main flow-in prefectures in China: Beijing, Shanghai, and Shenzhen weighted by the inverse distance to the women's prefecture of residence as an instrument for sex ratio. Specifically, for women living in prefecture p born in year y, we construct the following instrument:

$$IV_{py} = \sum_{c} \frac{lnFDI_{c,y+20}}{distance_{pc}}$$

where c can be Beijing, Shanghai, or Shenzhen, $lnFDI_{c,y+20}$ is the log of FDI in prefecture c in year $y+20$, $distance_{pc}$ is the distance in miles between prefecture p and c. The sample excludes women living in Beijing, Shanghai, and Shenzhen. The first stage is expected to be negative as migration decreases the origin's sex ratio.

Table A.4 presents the results using all three instruments. The IVs have relatively weak first stages. Only lnFDI/distance has an F-stat larger than 10, the rule of thumb. While the second-stage estimations are noisy, all the confidence intervals cover the OLS estimation. We have experimented with various variations for all these instruments, including age thresholds, distance measures, etc. The results remain quantitatively similar.

[35] The authors thank Shuo Chen for kindly providing data on county-level land reform starting years.

[36] The data on the presence of ultrasound machines comes from Almond et al. (2019).

Table A.4: IV Results

	Sex ratio (1)	Divorce (2)	Sex ratio (3)	Divorce (4)	Sex ratio (5)	Divorce (6)
Sex ratio_w		0.119**		0.012		0.044**
		(0.055)		(0.046)		(0.020)
Land Reform	0.027***					
	(0.008)					
Ultrasound			0.014**			
			(0.006)			
lnFDI/distance					-5.499***	
					(1.339)	
F-stat	11.04		5.467		16.865	
Obs.	1,071,983	1,150,344	1,048,586	1,048,586	892,060	892,060

NOTE: Odd columns are the first stages, and even columns are the second stages for IV estimations. Standard errors clustered at the prefecture level are reported in parentheses. ***p<0.01, **p<0.05, *p<0.1.

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