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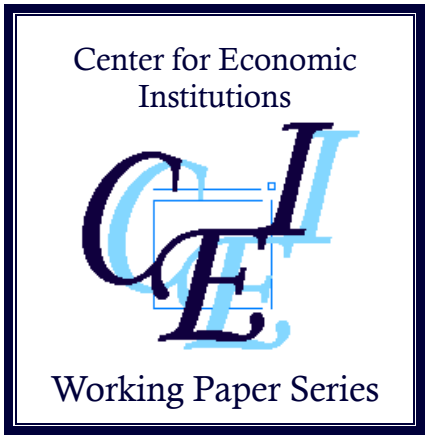

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The Timing of Childbearing and Female Labor Supply in China

Xinxin Ma and Jingwen Zhang

Abstract

For decades Chinese married women have delayed conceiving their first child influenced by government birth limitation policies, the improvement of women's educational attainment and the changes in childbearing preferences. Even though it can be thought that the delayed childbearing may affect female labor supply in China, there are few empirical studies on the issue. Long-term longitudinal survey data from the China Health and Nutrition Survey (CHNS) from 1989 to 2015 is used to conduct an empirical study to investigate the impact of the timing of childbearing on the labor supply (labor participation and irregular work) of Chinese married women. This study employs the random-effects model and the instrumental variables (IV) method to address the heterogeneity and endogeneity problems. The results indicate that the decision to delay childbearing may increase the female labor supply and decrease the probability of women becoming irregular workers. Robustness checks confirm these results.

Keywords: Timing of childbearing, female labor supply, irregular work, work-family conflict, China

JEL codes: J13, J16, J22

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1. Introduction

In 2010 the proportion of population aged 65 years and older in China reached 7.1%: this indicates that China is an ageing society. From 1979 the total fertility rate (TFR) decreased with the implementation of the one-child policy [1] that accelerated the proportion of elders in the population. To address the imbalance of demographic structure the Chinese government abolished the one-child policy, and enforced a set of population policies such as the selective two-child policies in the 2000s, and from 2016 the universal two-child policy [2].

The incidence of infertility, post-natal depression, miscarriages and birth defects may increase as the mother ages: hidden medical costs and loss of work days may be associated with delayed pregnancies. Family planning policy may also affect the childbearing decisions of women or households and affect the parity (viable pregnancies with healthy infant born) of births. For example, based on the annual report of the National Bureau of Statistics (NBS), although the fertility rate in 2017 was lower than in 2016, there occurred a significant change of the newborn parity and the proportion of second births has recently been greater than first births (Geng, 2018). It may be that the changes of newborn parity composition relate to decisions about the best time to have the first and second child.

The biological limitations of childbearing age and considerations about career development mean women have to plan for their pregnancies and assess the fertility intervals between the birth of the first child and the birth of the second child. Thus decisions about the timing of pregnancies may significantly influence the course of women's lives and the family. Particularly, the time of childbearing is closely associated with the accumulation of human capital and is an opportunity cost of work career development. Career interruption due to childbearing may lead to a reduction in human capital and to firms completing less vocational training and this may negatively affect women's promotion and career development. These disadvantages can be regarded as the motherhood penalty.

Does the timing of childbearing influence the female labor supply? There are empirical

studies of populations of women in developed countries (Hofferth, 1984; Waite et al. 1985; O'Connell and Bloom's, 1987; Wenk and Garrett, 1992; Del Boca et al. 2004; Buckles, 2008; Miller, 2011), but there are few empirical studies focusing on China[3]. This study mitigates this neglect.

This study is one of the few studies among the empirical studies of the motherhood penalty in China, that employs a detailed analysis of irregular work. Compared with other countries, the female labor force participation rate (FLFPR) in China has been high, which may be because the government enforced a set of policies to promote female labor participation in the public sector (e.g. government organization, state-owned enterprises) during the planned economy period (Pan, 2002, Ma, 2011).

However, since market-oriented reform was implemented, the FLFPR has been decreasing. It should be noted that these changes vary for the regular worker and irregular worker groups[4]. The number of regular workers has decreased but the number of irregular workers has recently increased. For example, the proportion of female irregular workers increased from 33.9% in 1996 to 68.6% in 2010 (Zhang and Hu, 2017). Compared with the regular worker group, the irregular workers usually obtain a lower wage and fewer fringe benefits. Their social security entitlement is poorer and the risk of unemployment is higher (Ma, 2008, 2009, 2011; Wu, 2009).

For the female labor supply side, working hours are more easily adjusted for irregular workers enabling a woman to raise children while working. Therefore, irregular work may reduce work-family conflict (Zhang and Li, 2017). It is thought that with the introduction of the universal two-child policy, the problem of work-family balance may become more severe. A woman with two or more children has more family duties and the risk of career interruption may be higher than for a woman with one child. From the perspective of labor demand, in order to reduce the labor turnover cost, firms may reduce the recruitment of married women who may bear (or have borne) two or more children, which may increase discrimination against women in the labor market. Considering the factors from both the supply and demand sides, with the implementation of the universal two-child policy, the proportion of female regular workers may further decrease, while more women may

choose “family-friendly” irregular work.

How do decisions about the best time to have children affect the female labor supply? Using the long-term longitudinal survey data (CHNS from 1989 to 2015), this paper conducts an empirical study of its impact on labor participation, the decision to work or not to work, and the probability of becoming an irregular worker. The random-effects model and instrument variable (IV) method are used to address the heterogeneity and endogeneity problems

The remainder of the paper is structured as follows: the second section reviews the related theories and the results of previous empirical studies on the impacts of timing of childbearing on the female labor supply. Section 3 presents the empirical method, including the models, data and variable setting. Section 4 reports the estimation results. The final section summarizes the conclusions and policy implications.

2. Literature Review

2.1 The influence of the timing of childbearing on the female labor supply

Most published studies on the relationship between the timing of childbearing and the female labor supply in China focus on the change of labor supply or wage before and after childbearing (Jia et al., 2013; Yu and Xie, 2014). Research on the impact of the timing of childbearing on the female labor supply is scarce. There is one paper (Yang and Bai, 2017) that indicates that 23% of women delayed having a second child for work-related reasons. Most studies on this subject focus on delayed marriage and postponed childbearing and its impact on the low birth rate (Zhao, 2016; Guo and Tian, 2017). Some studies investigate the influence of education, occupation and wage on childbearing postponement (Wang and Wu, 2013; Guo 1994).

In contrast, there are many empirical studies on the impact of the timing of childbearing on the female labor supply for the USA and European countries. Three hypotheses are proposed to explain the mechanism of the impact of timing of childbearing on the female labor supply: firstly, human capital theory; secondly the career development threshold

hypothesis, and thirdly the life cycle hypothesis.

Firstly, human capital theory emphasizes the influence of education, training and work experience on the female labor supply and wage (Becker, 1964; Mincer, 1974). Erosa, Fuster and Restuccia (2002) analyze the influence of the age at which the mother has a child on tenure years, and indicate that early childbearing is costly because it increases the probability of unemployment in the future. Wenk and Garrett (1992) indicate that women who delay childbearing have more years of work experience, which may positively affect women's career development in the future. Taniguchi (1999) finds that women who become mothers at an early age are more likely to suffer a wage penalty because their career is interrupted during the important period of development. Gustafsson (2001) indicates that firms would like to provide training to young workers because longer periods of work are left for young workers and the human capital investment returns will be higher. Therefore, leaving the labor market during the childbearing period may greatly reduce the human capital accumulation in the individual's life course. Happel et al. (1984) found that highly educated women usually delay having their first child to avoid limitation of their work-related skill level.

Secondly, the career development threshold hypothesis indicates that workers with uninterrupted careers that extend past some important time points, such as becoming a tenured professor, may gain a higher salary and more fringe benefits, obtain a stabler job and be promoted to a higher rank. Thus, delaying childbearing, especially after threshold points, may positively affect women's career development. Rosenfeld (1978) indicates that early career development significantly affects the probability of promotion to a higher occupational position.

Thirdly, the life-cycle hypothesis is based on the assumption of an imperfect capital market. Generally, the individual worker in regular work or a full-time job cannot adjust her working hours to accommodate family or parental duties. The income effect for a woman whose work experience years are longer may mean a higher income enables her to have more children. However, for a woman whose work experience years are shorter (e.g. a new worker), the greater substitution effect means she experiences a large change from

the non-work to work therefore the new-worker may choose to delay childbearing (Ahn and Mira, 2002). Mincer (1974) finds that the age-wage curve has a quadratic shape, which indicates that the opportunity cost may be different for each childbirth age group.

Most published empirical studies indicate that the delay of childbearing leads to better career development. For example, Wenk and Garrett (1992) use logistic regression and survival analysis methods and use longitudinal survey data. They find that a woman who delayed childbearing is more likely to be employed during the childbearing period and the probability of return to the labor market is higher. Waite et al. (1985) use the fixed-effects model that gives results that indicate that postponement of childbirth positively affects the female labor supply. Buckles (2008) finds the raw return of delayed childbearing to hourly wages is approximately 3 percent per year in 2003 and the childbearing wage penalty for highly skilled women becomes less when they delay childbearing. Hofferth (1984) uses the data for retired women with children, and found that in comparison with the group of women younger than 30 years old, income is higher for the women who bore their first child at 30 or older. There is a long-term influence from delayed childbearing on women's labor market outcomes. Most published studies indicate that delayed childbearing may positively affect the female labor supply, Joshi (1990) finds the relation between age at first birth and employment is not linear, for example, the motherhood penalty is greatest for the women aged from 25 to 30 years old. In addition, O'Connell and Bloom (1987) find the probability of becoming a regular worker is greater for a woman who delayed childbearing. Miller (2011) indicates that weekly working hours may be longer and the probability of becoming a regular worker may be greater for a woman who delayed childbearing.

2.2 Childbearing and irregular work

The labor supply comprises the labor participation (decision on work or not work) and the choice of employment status (to become a regular worker or an irregular worker). Most irregular workers may work part-time or with a flexible working schedule that accommodates the demands of pregnancy and childcare. Studies of developed countries,

for example, Bardasi and Gornick (2000) use international data from five developed countries (Canada, Germany, Italy, the UK, and the US), and find that the probability of entering part-time work is greater for mothers than for childless women. Drobnic et al. (1996) find that in Germany, women of childbearing years return to part-time work more easily than to full-time work. Zhang and Wang (2017), Shikata and Ma (2006), and Ma (2008, 2009) find in Japan the probability of entering irregular work is greater for women with younger children and for women with more children.

Some published studies about China explore the influence of irregular work on childbearing by analyzing descriptive statistical results and description studies. For example, Zhang and Hu (2017) argue that irregular work can be expected to reduce work-family conflict, therefore a woman who plans to be pregnant or have younger children is more likely to work as an irregular worker. The number of female irregular workers has increased in recent years along with the progress of market-oriented reform, access to information, and the development of the internet industry. Ding and Shi (2016) argue that during the childbearing period women take on more family responsibility resulting in greater work-family conflict thus leading more women to leave the labor market.

Chinese women who are not willing to exit from the labor market for reasons like low-household income, or to avoid the interruption of career progression, may choose to work as irregular workers (Rosenfeld and Birkelund 1995). Xu (2018) finds descriptive statistical results show that because irregular work times are more flexible female irregular workers are less likely to give up work than female regular workers. Zhang and Wang (2017) employ correlation analyses using CGSS (Chinese General Social Survey) data and indicate that the possibility of becoming an irregular worker is greater for women who have more children.

Some published studies argue that mothers taking irregular work is a forced choice. The wage level is lower, the fringe benefits are less, the social security is poorer and the chance of promotion is less for the irregular worker group than for the regular worker group. Ma (2008, 2009), Huang et al. (2017) and Chen (2018) point out that discrimination against women of childbearing age segments the Chinese labor market into regular and irregular

worker groups. However, empirical study of the impact of childbearing on women's irregular work is minimal: this paper makes a contribution to remedy this neglect.

3. Data and Models

3.1 Data

Data from the China Health and Nutrition Survey (CHNS) from 1989 to 2015 is used in this study. CHNS is a nationwide longitudinal survey conducted by the Carolina Population Center at the University of North Carolina and the National Institute for Nutrition and Health (NINH, former National Institute of Nutrition and Food Safety) at the Chinese Center for Disease Control and Prevention (CCDC). The survey was conducted by an international team of researchers whose backgrounds include Nutrition, Public Health, Economics, Sociology, Chinese Studies, and Demography. The survey took place over a 7-day period using a multistage, random cluster process to draw samples from 15 provinces and municipal cities (Beijing, Liaoning, Heilongjiang, Shanghai, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou, and Chongqing) that vary substantially in geography, economic development and government resources. Three provinces were added in CHNS 2011 and another three provinces joined in 2015. In 1989, the CHNS surveyed 3,795 households and 15,907 individuals. For 2015, there are 11,130 communities and 42,829 individuals in the survey. This study uses data from 10 waves, including the most recently updated data from 2015. CHNS provides extensive information about fertility and pregnancy history as well as basic social demographic and employment information that facilitate the empirical analysis in this study.

This study investigates the impact of the timing of childbearing on the female labor supply. The marriage of very young females is regulated by law, traditional culture around early pregnancy, and the employment situation in different sectors. Therefore this study is limited to samples of married women aged from 20 to 52 years old. Table 1 presents the descriptive statistics of variables.

Table 1 Descriptive statistics

Variable	All sample		One child		two child and more		p-value
	Mean /Proportion (standard deviation)		Mean /Proportion (standard deviation)		Mean /Proportion (standard deviation)		
Labor participation	0.78	(0.41)	0.78	(0.42)	0.79	(0.41)	0.10
Irregular worker	0.64	(0.48)	0.41	(0.49)	0.83	(0.37)	<0.01
Age	39.71	(7.76)	37.63	(7.84)	41.96	(6.82)	<0.01
Age at first birth	24.08	(3.15)	24.86	(3.23)	23.26	(2.76)	<0.01
Age at second birth	27.07	(4.08)	31.95	(4.62)	26.78	(3.87)	<0.01
Han ethnicity	0.88	(0.32)	0.91	(0.29)	0.86	(0.35)	<0.01
Rural *Hukou*	0.63	(0.48)	0.44	(0.50)	0.80	(0.40)	<0.01
Schooling years	7.72	(4.02)	9.53	(3.46)	6.02	(3.79)	<0.01
Region category							
Eastern Region	0.26	(0.44)	0.35	(0.48)	0.18	(0.39)	<0.01
Central Region	0.31	(0.46)	0.23	(0.42)	0.39	(0.49)	
Western Region	0.23	(0.42)	0.17	(0.38)	0.29	(0.45)	
Northeast Region	0.18	(0.39)	0.24	(0.43)	0.14	(0.35)	
Youngest child age category							
0-3 years old	0.12	(0.32)	0.14	(0.35)	0.10	(0.30)	<0.01
4-6 years old	0.11	(0.31)	0.12	(0.33)	0.10	(0.30)	
7-14 years old	0.32	(0.47)	0.31	(0.46)	0.33	(0.47)	
Non-child or child aged over 14 years old	0.45	(0.50)	0.42	(0.49)	0.47	(0.50)	
have at least a boy	0.73	(0.44)	0.60	(0.49)	0.87	(0.33)	<0.01

First child is boy	0.47	(0.50)	0.40	(0.49)	0.54	(0.50)	<0.01
Husband income (per thousand RMB)	19.84	(51.19)	25.66	(42.78)	14.59	(57.86)	<0.01
Living with mother	0.02	(0.15)	0.03	(0.18)	0.02	(0.13)	<0.01
Living with father	0.02	(0.13)	0.02	(0.16)	0.01	(0.10)	<0.01
Number of observations	16,190		7,709		8,298		

Source: CHNS data from 1989 to2015.

Two sorts of dependent variables are constructed as follows: firstly, a binary probability variable equal to 1 when a woman is working, and equal to 0 when she is not working. Secondly, a binary probability variable equal to 1 when a woman is an irregular worker, and equal to 0 when she is a regular worker. There is no common definition of irregular work in previous studies, and classification of regular work or irregular work is usually based on the working hours, labor contract or occupation types (Yan et al. 2013; Yang,2015; Zhang and Qin 2015; Wang, 2016; Zhang et al. 2018). In this study irregular work is defined by the type of occupation as in the CHNS questionnaire. Irregular workers comprise self-employed workers with no employees (including small farmers), temporary workers, paid family workers or unpaid family workers. Regular workers comprise self-employed workers who employ others, workers who work for others or work in units (enterprises or organizations) as a permanent employee or workers with a long-term labor contract.

The main independent variable is the timing of childbearing, which is defined as the age at which the woman gives birth. In order to investigate the impact of the timing of childbearing by different parities, two kinds of variables are constructed: the age of the mother when she gave birth to her first child (the first child birth age), and the age of the mother when she gave birth to her second child (the second child birth age).

Different covariates are used to control other influences on the female labor supply. First, for the individual characteristics factors, (1) it is thought the market wage affects the labor

supply. According to human capital theory (Becker, 1964; Mincer, 1974), an individual's wage level is determined by human capital such as education and years of experience. The years of schooling, age and age-squared are used as the human capital index. (2) The culture and willingness to work may differ for the various ethnicity groups, and the rural and urban registration groups, therefore the ethnicity dummy (Han=0; other ethnicity=1), and registration system (urban=0; rural=1) variables are constructed.

Second, for family factors, (1) the Douglas (1934) and Arisawa (1956) indicate the husband's income negatively affects the wife's labor participation. The annual income of the women's husband is used to control the effect. (2) Living with parents may influence the female labor supply. For example, when a woman is living with her parents, she may obtain childcare support from the parents, which may increase the female labor supply. However, she may live with infirm parents who need to be cared for by the woman, and this may decrease the female labor supply. Living with parents may affect the female labor supply but its influence is not clear and it needs to be investigated further using empirical study results. Two kinds of dummy variables are constructed in this study: the living with mother dummy and the living with father dummy. (3) The nature and duration of childcare may differ with the age of the child. For example, the younger child needs more intensive and constant childcare than the older child: it is thought the influence of childcare on the female labor supply may differ according to the age of the child. The youngest child age dummy variables (child aged 14 and older/no-child, child aged 0-3 years old, child aged 4-6 years old, child aged 6-14 years old) are used.

Third, based on the internal labor market hypothesis and labor market segmentation hypothesis (Piore, 1970), the labor market may be segmented into various sectors, in which wage level, training, promotion opportunity and social security may differ. The Chinese government promoted a gradualist market-oriented reform that caused labor market segmentation into the public sector and private sector (Ma, 2018). It is thought that the proportion of irregular workers is larger in the private sector than in the public sector. Thus, a variety of work unit dummy variables are used to control the influence of labor market segmentation on labor supply.

Fourth, the Two-child Policy was implemented in some regions from 2013 and in order to control the effect of population policy, the policy implementation dummy variable (after 2014=1; before 2014=0) is used.

Finally, the culture and the economic development level may differ in each region and four region dummy variables (Eastern Region; Central Region; Western Region, and Northeast Regions) are used.

3.2 Models

Due to the feature of the longitudinal survey data, a fixed-effects model is usually used to address the unobserved heterogeneity problem. However, in this study, the independent variable is the age of the mother when she gives birth, the childbirth age, which is a time-invariant, therefore the random-effects model is used. It is expressed by Eq. (1).

$$\ln\left(\frac{p_{it}}{1-p_{it}}\right) = \beta_0 + b_1 X_{1it} + \sum b_k C_{kit} + a_i + u_{it} \qquad (1)$$

In Eq. (1), *i* indicates the individual, *t* represents the year, β_0 is constant, C_k is the timing of childbearing variable, X_1 is other variables, b_1 *and* b_k is the coefficient of each variable, a_i is the unobserved time-invariant individual error and u_{it} is the real error term.

Although the random-effects model can address the unobserved heterogeneity problem, because the labor supply may also affect the timing of childbearing decision, the endogeneity problem may remain in the results. For example, if a woman expects she will not obtain more income from the labor market or she expects that the probability of becoming a regular worker or to be promoted to higher position (e.g. to become a manager) is lower in the future, she may invest more time in her family by becoming a mother earlier, or bearing more children. To address the endogeneity problem the instrumental variable (IV) method is used. Chinese astrology predicts a person's character and destiny according to the year they were born. Most parents do not want to give birth to a baby in the Year of the Sheep (*Yangnian*) because it is untoward and the infant mortality rate is higher (Guo et al., 2017). Parents may avoid childbearing in the Year of the Sheep: it can be utilized as an

instrumental variable for the timing of childbearing. According to the annual report of National Bureau of Statistics, the birth rate increases markedly in the year after the Year of the Sheep (the Year of the Monkey, *Hounian*), which indicates that the parents avoided the Year of the Sheep. The Year of the Sheep may affect decisions about the timing of childbearing, whereas it does not influence the labor supply. Thus, based on Chinese traditional culture, the Year of the Monkey dummy variable is constructed as an instrumental variable (childbirth in the Year of the Monkey=1, other year=0), the IV method is shown by Eq. (2.1) and Eq. (2.2):

$$x_i = \pi_0 + \pi_1 Z_i + \sum \rho_{ik} C_{kit} + u_i \tag{2.1}$$

$$y(\ln\left(\frac{p_{it}}{1-p_{it}}\right) = \beta_0 + \beta_1 x_i + \sum \lambda_{ik} C_{kit} + \varepsilon_i \tag{2.2}$$

Corr (ε, Z) =0

Corr (u, Z) ≠0

Eq. (2.1) is the first stage of IV method. Z is the instrumental variable, which is whether or not birth occurred in the Year of the Monkey. Eq. (2.2) expresses the second stage regression. y_i is the dependent variable of labor supply, C_{ki} is the timing of childbearing for the woman i. X is the control variable. μ_I and ε_i are error terms.

4. Results

4.1 The results of the random-effects model

Table 2 presents the estimation results of the logistic regression using the random-effects model. The odds ratios are summarized in Table 2. The dependent variables are the probability of labor participation for model 1 and for model 3, and the probability of becoming an irregular worker for model 2 and model 4. In order to investigate the different impacts of the age of the mother when she gave birth to her first child (first child birth age)

and the age of the mother when she gave birth to her second child (second child birth age) model 1 and model 2 analyze the impacts of the first child birth age on the female labor supply, and model 3 and model 4 analyze the impacts of the second child birth age on the female labor supply.

First, for the impact of the first birth age on female labor supply, (1) the results based on model 1 and model 2 indicate that when the first child birth age is delayed one year the probability of entry into the labor market as a regular or irregular worker may increase by 4 percentage points, and it is statistically significant at the 1% level. It is shown that delayed childbearing may increase female labor participation. (2) When the first child birth age is delayed by one year, the probability of becoming an irregular worker may decrease by 2.9 percentage points (which means the probability of becoming a regular worker may increase by 2.9 percentage points), and it is statistically significant at the 1% level. It is shown that delayed childbearing may decrease the probability of a woman becoming an irregular worker. The results indicate that when a woman delays her childbearing she may obtain more outcomes in the labor market and a more successful career path. These results may be because human capital accumulation is important at the early period of career development according to the career development threshold hypothesis and human capital theory.

Second, with the deregulation of the one-child policy in 2013, the ratio of second birth children to the total newborns greatly increased. How does the second child birth age affect the female labor supply? According to the results of model 3 and model 4, the coefficients of the second child birth age are not statistically significant. It is shown the second child birth age does not significantly affect the female labor supply. The reason may be as follows. The second child birth period is usually parallel with the period when career development is in a stable situation, and when the intensive human capital investment (e.g. education, training from the firm) has been completed. Therefore, the influence of the second childbirth age on the female labor supply is not significant. In other words, the influence of the timing of the birth of the first child on female labor supply is greater than influence of the timing of the birth of the second child. However, because the universal

two-child policy was recently implemented few women in the sample have borne their second child: this may influence the estimation results. Longer-term survey data should be used in future research to confirm the findings in this paper.

Table 2 Impacts of childbirth age on female labor supply (Random-effects model)

	Random effects model			
	(1) Labor participation (Odds Ratio)	(2) Irregular worker (Odds Ratio)	(3) Labor participation (Odds Ratio)	(4) Irregular worker (Odds Ratio)
Age at the 1st birth	1.040***	0.971*		
	(0.0114)	(0.0156)		
Age at the 2nd birth			0.992	0.969
			(0.0113)	(0.0187)
Current age	1.310***	0.972	1.160***	0.912
	(0.0471)	(0.0553)	(0.0595)	(0.0805)
Current age squared	0.996***	1.001	0.997***	1.002
	(0.000450)	(0.000736)	(0.000630)	(0.00112)
Ethnicity (0= han)	0.777**	0.560***	0.820	0.555***
	(0.0858)	(0.0901)	(0.112)	(0.127)
Hukou(0=urban)	1.601***	12.41***	2.625***	13.02***
	(0.111)	(1.298)	(0.241)	(2.110)
Schooling years	1.016*	0.763***	0.962***	0.806***
	(0.00928)	(0.0119)	(0.0111)	(0.0176)
Region (1=Eastern Region)				
Central Region	0.668***	3.865***	0.983	2.985***

	(0.0558)	(0.477)	(0.111)	(0.589)
Western Region	1.377***	2.623***	2.505***	1.458*
	(0.136)	(0.349)	(0.339)	(0.301)
Northeast region	0.807**	4.573***	0.967	2.698***
	(0.0792)	(0.675)	(0.139)	(0.706)
Age of the youngest child (0= over 14 years old of non-child)				
0-3	0.461***	1.414*	0.647**	1.544
	(0.0618)	(0.271)	(0.124)	(0.481)
4-6	1.174	1.333*	1.452**	1.765**
	(0.145)	(0.224)	(0.255)	(0.490)
6-14	1.092	1.256*	1.219*	1.633**
	(0.0868)	(0.148)	(0.134)	(0.315)
Have at least one boy	1.280***	1.239**	1.382***	1.034
	(0.0938)	(0.130)	(0.155)	(0.196)
Work unit type (1=government organization and SOEs				
COEs		43.99***		131.4***
		(6.767)		(34.84)
FOEs		4.010***		1.568
		(1.714)		(1.543)
		58.93***		148.5***
		(9.305)		(41.03)

Husband income	1.000***	1.000***	1.000***	1.000***
	(6.66e-07)	(1.30e-06)	(1.02e-06)	(2.20e-06)
Living with father	0.697	1.596	0.530	1.488
	(0.203)	(0.643)	(0.220)	(1.105)
Living with mother	1.656*	0.863	1.821	0.942
	(0.439)	(0.289)	(0.670)	(0.521)
Two child policy	0.460***	0.290***	0.209***	0.200***
	(0.0355)	(0.0378)	(0.0256)	(0.0447)
Constant	0.0548***	0.186	0.629	0.374
	(0.0399)	(0.209)	(0.658)	(0.651)
Observations	16,190	12,610	8,804	6,993

Source: CHNS from 1989 to 2015
Notes: Robust standard errors are in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

4.2 The results from the instrumental variables (IV) method

Table 3 summarizes the results based on the IV method, which uses the Year of the Monkey (the year after the Year of the Sheep) as the instrumental variable. The findings are as follows:

First, the coefficient of the IV is significant in the first stage for both model 1 and model 2, which indicates that delayed childbearing in the Year of the Sheep contributes to the increased births in the following year. The results of the Hausman Test suggest the endogeneity problem remains in the results of the random-effects model, thus the IV method should be employed.

Second, the coefficient of first child birth age is not statistically significant in model 1, whereas it is statistically significant at 1% level in model 2, and it is indicated that when the first child birth age is delayed one year, the probability of becoming an irregular worker may decrease by 19.3 percentage points. These results show that even though postponement of childbirth may not increase the probability of female labor participation

statistically, it may increase the probability of becoming a regular worker, which means a woman who delayed childbearing may obtain a better job (here, regular work).

Table 3 Impact of childbirth age on female labor supply (IV method)

	(1)		(2)	
	Age at first birth (Odds Ratio)	Labor participation (Odds Ratio)	Age at first birth (Odds Ratio)	Irregular worker (Odds Ratio)
	First stage	Second stage	First stage	Second stage
The Monkey Year （IV）	1.685***		1.764***	
	(0.174)		(0.204)	
Age at the first birth		0.938		0.818**
		(0.0922)		(0.0677)
Current age	1.729***	1.177***	1.643***	1.109**
	(0.0536)	(0.0570)	(0.0587)	(0.0503)
Current age squared	0.996***	0.998***	0.996***	0.999
	(0.000395)	(0.000357)	(0.000457)	(0.000415)
Ethnicity (0= han)	0.812***	0.890***	0.790***	0.781***
	(0.0586)	(0.0370)	(0.0621)	(0.0400)
Hukou(0=urban)	0.501***	1.189**	0.530***	2.294***
	(0.0262)	(0.102)	(0.0351)	(0.477)
Schooling years	1.175***	1.016	1.165***	0.934**
	(0.00754)	(0.0163)	(0.00865)	(0.0269)
Region (1=Eastern Region)				
Central Region	0.518***	0.803***	0.551***	1.433***

	(0.0298)	(0.0490)	(0.0359)	(0.188)
Western Region	0.994	1.154***	1.000	1.349***
	(0.0659)	(0.0422)	(0.0732)	(0.0851)
Northeast Region	0.460***	0.852**	0.522***	1.513***
	(0.0307)	(0.0652)	(0.0395)	(0.222)
Age of the youngest child (0= over 14 years old of childlessness)				
0-3	97.74***	0.980	73.91***	2.538***
	(10.17)	(0.466)	(8.569)	(0.898)
4-6	37.04***	1.371	28.48***	2.008**
	(3.443)	(0.486)	(2.898)	(0.566)
6-14	8.744***	1.234	7.320***	1.559***
	(0.554)	(0.262)	(0.515)	(0.257)
Have at least one boy	0.350***	1.022	0.344***	0.887
	(0.0180)	(0.115)	(0.0200)	(0.0966)
Work unit type (1=government organization and SOEs				
COEs			0.738***	3.813***
			(0.0580)	(0.961)
FOEs			1.089	1.438**
			(0.259)	(0.234)
POEs			0.713***	4.007***
			(0.0555)	(1.049)

Husband income	1.000*	1.000***	1.000	1.000***
	(4.29e-07)	(3.49e-07)	(7.63e-07)	(7.99e-07)
Living with father	0.658*	0.762**	0.510***	1.051
	(0.150)	(0.0936)	(0.127)	(0.172)
Living with mother	1.010	1.367***	1.254	0.961
	(0.194)	(0.147)	(0.258)	(0.114)
Constant	3,514***	0.533	16,319***	2.444
	(2,142)	(0.495)	(11,407)	(2.577)
Observations	16,190	16,190	12,610	12,610
Hausman Test		118.77		321.13
		(<0.01)		(<0.01)

Source: CHNS data from 1989 to 2015.
Notes: Robust standard errors are in parentheses. ***, **, * denote statistical significances at the 1%, 5%, and 10% levels, respectively.

4.3 The results by various subgroups

The individual characteristics, work or leisure preference and the labor supply and demand situation in the labor market which the individual faces may differ for various groups, for example, the influence of the timing of childbearing on the female labor supply may differ for the rural and the urban registration groups, and the living with parents or the not living with parents groups. To examine the heterogeneity problem between various groups, a set of subsamples is used. The main findings are as follows.

(1) Results for the rural group and the urban group

In China there is considerable disparity between rural and urban groups of preference for family size, the gender of the child, the timing of marriage and childbearing as well as the informal childcare support and public childcare provision (Zhang, 2011). During the economic system transition period the household registration status (*Hukou*) system caused labor market segmentation, which led to the difference of employment situation and work

opportunity between the rural and the urban groups. The rural-urban gap may partly arise from the differentials of human capital but it is mainly caused by discrimination against migrants (Meng and Zhang, 2001; Messinis 2013; Ma 2018). Thus, analysis of these two groups is used[5]. The results are reported in Table 4.

The coefficients of childbirth age are not statistically significant for the urban and rural groups in model 1. It is shown that in general the first child birth age does not have a statistically significant effect on female labor participation for the urban or the rural groups. In addition, according to the results in model 2, although the first child birth age does not affect female labor participation for the urban women's group, it may affect the employment status for the rural women's group. When a rural woman delays childbearing by one year, the probability of becoming an irregular worker may decrease by 18.1 percentage points.

The results can be explained as follows. The rural women group suffers the double discrimination of *Hukou* and gender discrimination and they have to make a greater effort to improve their employment status by investing more time to develop their human capital. Therefore, rural women are more likely to postpone having children so they can obtain regular work. Compared with rural women, urban women can obtain more advantages in the workplace, and more formal or informal childcare support. For example, urban women can more easily find employment in state-owned enterprises, where they may obtain better employment rights and more social benefits, including maternity leave. Moreover, urban women may live with or near their parents who can provide childcare support, whereas most women migrants cannot live with their children, they have to leave their children in the rural regions which results in the "left-behind children" problem in China. Urban women may receive more public childcare support than rural women. These factors may reduce the motherhood penalty on urban women, and it is shown that the influence of the timing of childbearing on labor supply is not significant for the urban women group.

Table 4 Impact of childbirth age on female labor supply for the rural group and the urban group

	Labor participation				Irregular work			
	Urban		Rural		Urban		Rural	
	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage
The Year of the Monkey （IV）	1.576***		1.762***		1.441**		1.989***	
	(0.238)		(0.245)		(0.238)		(0.309)	
Age at first birth		0.890		0.948		1.240		0.819**
		(0.141)		(0.117)		(0.204)		(0.069)
observations	6,059	6,059	10,131	10,131	4,462	4,462	8,220	8,220
Hausman Test		85.89		84.00		57.93		118.20
p-value		(<0.01)		(<0.01)		(<0.01)		(<0.01)

Source: CHNS data from 1989 to 2015.
Notes: Robust standard errors are in parentheses. ***, **, * denote statistical significances at the 1%, 5%, and 10% levels, respectively. The covariates are the similar with those in Table 3.

(2) Results for different living arrangements

A factor that supports childcare may increase the female labor supply because childcare is one of the main opportunity costs of the female labor supply. Maurer-Fazio et al. (2017) found that the probability of entering work is greater for women living with their parents. In China the retirement age is usually from 45 to 55 years old for a female worker, and from 50 to 60 years old for a male worker, it is thought that the grandparents can provide childcare (positive effect). If a woman has to provide the care to her infirm parents the co-residence may become a barrier for her labor supply (negative effect). In addition, parents' high income and better housing conditions might be another reason for a woman to live

with her wealthier parents. In this case, the parents' assets are a kind of non-labor income and may reduce her willingness to work (negative effect). According to the theoretical analysis above, the effect of living with parents could positively or negatively influence the female labor supply, therefore the impact of first child birth age on the female labor supply might be different for various living arrangements with parents. Table 5 reports the results for two groups: living with parents and no-living with parents.

The influence of first child birth age on the female labor supply is not statistically significant for the non-co-residence group; even though the coefficient of first child birth age is statistically significant for the co-residence group, the coefficient of IV is not statistically significant in the first stage. Thus, the influence of the timing of childbearing on the female labor supply is smaller for both the co-residence group and the non-co-residence group. These results are similar to those shown in Table 3.

The influence of first child birth age is not statistically significant for the co-residence group, but for a woman who does not live with her parents, the probability of becoming an irregular worker may decrease 18.3 percentage points when she delays having children for one year. It is shown that the timing of childbearing may not influence the employment status for a woman living with parents. The reasons may be that she may receive more childcare support from her parents allowing more time for human capital investment, which may reduce the motherhood penalty. To consider the two effects of the influence of living arrangement on female labor supply described above, it is indicated that the influence of the positive effect is greater than the negative effect.

Table 5 Impact of childbirth age on female labor supply by living arrangement status

	Labor participation				Irregular worker			
	Co-residence		Non co-residence		Co-residence		Non co-residence	
	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage
Year of the	0.495		1.783***		0.303**		1.907***	

Monkey（IV）								
	(0.247)		(0.188)		(0.166)		(0.225)	
Age at the first birth		1.378***		0.971		0.846		0.817***
		(0.135)		(0.0917)		(0.196)		(0.0601)
observations	451	451	15,747	15,747	368	368	12,247	12,247
Hausman Test		25.61		3.64		8.04		417.31
p-value		(0.01)		(0.9891)		(0.922)		(<0.01)

Source: CHNS data from 1989 to 2015.
Notes: Robust standard errors are in parentheses. ***, **, * denote statistical significances at the 1%, 5%, and 10% levels, respectively. The covariates are the similar with those in Table 3.

4.4 Robustness checks

To consider how the dependent variable setting for irregular workers may influence the estimation results, a new definition is used to construct a new irregular worker variable. The irregular worker is defined as a self-employed worker with no employees, farmer, temporary worker, paid family worker, and unpaid family worker. The regular worker is defined as the worker for another person or for a unit (enterprise or organization) as a permanent employee, or a worker with a long-term labor contract. The results shown in Table 6 use the new dependent variable. These results are consistent with those in Table 2 and Table 3, the main findings are confirmed regardless of the various definitions of irregular work.

Table 6 Robustness check with a new definition of irregular work

	Random-effects model	IV estimation	
	Irregular work (Odds Ratio)	First stage	Second stage
Year of the Monkey （IV）		1.764***	
		(0.204)	
Age at the first birth	0.960**		0.759***
	(0.0172)		(0.0370)
observations	12,610	12,610	12,610
Hausman Test			99.06
p-value			(<0.01)

Source: CHNS data from 1989 to 2015.
Notes: Robust standard errors are in parentheses. ***, **, * denote statistical significances at the 1%, 5%, and 10% levels, respectively. The covariates are the similar with those in Table 3.

To consider how the use of various independent variables may affect the estimation results, some variables are changed for the robustness checks. These results are summarized in Table 7.

Firstly, the husband income is replaced by husband education, and the results are consistent with those shown in Table 2 and Table 3.

Second, the proportion of irregular workers may differ for each ownership sector. For example, the proportion of irregular workers may be larger for the privately owned sector and self-employed sector than for the public sector. Thus, the definition of workplace ownership type and irregular worker may overlap. The ownership type dummy variables are excluded and the analyses are employed using similar methods. It is shown that the results from the random-effects model are consistent with the results in Table 2 and it is

clear that the influence of timing of childbearing on the female labor supply became statistically insignificant based on the results from the IV method, which differs from the results in Table 3. These results indicate the influence of timing of childbearing may be different for each sector.

Based on these results by various subsamples and robustness checks, it is confirmed that the timing of childbearing may influence the female labor supply, particularly the influence on employment status as irregular or regular worker is greater.

Table 7 Results using different independent variables

	Husband's education			Exclude work unit type		
	Random - effects model	IV estimation		Random- effects model	IV estimation	
		1st stage	2nd stage		1st stage	2nd stage
Year of the Monkey （IV）		1.783***			1.746***	
		(0.195)			(0.200)	
Age at the first birth	0.965**		0.823**	0.947***		0.934
	(0.0146)		(0.0627)	(0.0157)		(0.108)
observations	12,610	12,610	12,610	12,682	12,682	12,682
Hausman Test			388.89			532.53
p-value			(<0.01)			(<0.01)

Source: CHNS data from 1989 to 2015.

Notes: Robust standard errors are in parentheses. ***, **, * denote statistical significances at the 1%, 5%, and 10% levels, respectively. The covariates are the similar with those in Table 3.

5. Conclusions

Using the longitudinal survey data of CHNS from 1989 to 2015, this paper analyzes the impact of the timing of childbearing on the female labor supply (labor participation and irregular work). The random-effects model and IV method are used to address the heterogeneity and endogeneity problems. The main findings and policy implications are as follows.

Firstly, the results indicate that early motherhood might negatively affect women's career development. Its negative influence is greater for employment status than labor participation. It is shown that early motherhood may cause a higher probability of becoming an irregular worker. These results can be explained by the human capital theory, life cycle hypothesis, and career development threshold hypothesis. From the labor demand perspective, the childbearing period usually overlaps with the period of intensive human capital investment. If women delay their childbearing, they can invest more time to develop their human capital, which leads them to be promoted more easily and to reduce the risk of replacement when pregnant. With economic growth and the increase in women's educational level the opportunities for women to work have increased but the work conditions for regular workers may be stricter and the discrimination against women more severe due to implicit rules in the workplace (Ding and Shi, 2016). Therefore women are more likely to be employed as irregular workers.

During the childbearing period women, strangely unlike men, need more time to run the home and provide childcare which may increase the probability of leaving the labor market. When conditions at work are strict (for example, the working hours will be longer for the regular worker than the irregular worker), women may have no choice but to become an irregular worker. Therefore, as in Japan, in China there may be many women forced unwillingly to become irregular workers (Ma, 2015). In this study no detailed analyses of the willingness to do irregular work could be made because there are no questionniare items about the willingness to do regular or irregular work. For subsequent studies the research instrument could usefully address willingness to work.

Second, with the implementation of the Universal Two-child Policy, 2016, more women may choose to bear more children, and the childbearing period will be longer. As a result more women may become irregular workers in order to address the work-family conflict problem. The new jobs related to Internet shopping and SOHO (small office and home office) jobs may provide more opportunities to become irregular workers in the future. However, as described above, in comparison with the regular workers group, the irregular workers' income is lower, the training and promotion opportunity is less, and social security (e.g. public pension, public health care insurance) is poor. These gaps between regular workers and irregular workers may enlarge income inequality in China. How can the reward gaps between the irregular worker and the regular worker groups be reduced? How can women be supported to continue to work as regular workers during the childbearing period? Policy makers might usefully address these questions.

The motherhood penalty may increase in the future. The growth in the number of children may increase the opportunity cost of the labor supply of women, and discrimination against women with more children may become severe. The provision of more public childcare is likely to improve the female labor supply. As stated by Connelly et al. (2018), the Chinese government should invest to further improve the public childcare services for children aged from 3 to 6 years old, and initiate day care services for infants aged from 0 to 3 years old. In addition, paternal or other family member's support for childcare and other homemaking duties may increase the female labor supply. As in Japan and Northern European countries, the father's right to paternity leave, better maternity leave and community childcare provision should be promoted to mitigate the motherhood penalty. In the long-term these policies can be expected to increase the fertility rate, slow down the speed of population ageing and remedy labor shortages.

Notes

1. The one-child policy was a family planning policy in China, which consists of a set of regulations, including the restrictions on number of children born for each household and the minimum marriage age. The one-child rule mostly applied to urban residents

and employees in the public sector. In rural regions when the first child was a girl a second child was allowed. If both the wife and husband were Chinese citizens returning from abroad, for ethnic minorities or if both the wife and husband are without siblings, a second child was allowed (Hesketh et al., 2005; Wang et al., 2013). This policy was abolished in October 2015.

2. In order to address the potential consequences of the one-child policy, such as the ageing population and labor shortages, the universal two-child policy was introduced in October 2015 to replace the one-child policy. Based on the new policy, a married woman can have two children. The new law came into force on January 1, 2016.
3. Empirical Studies for China only analyzed the impact of the number of children on female employment, including labor participation, working hours and wage (Zhang, 2011; Yang, 2017).
4. In previous studies employment status as a regular worker or an irregular worker is usually determined according to the hours worked, labor contract or occupation type. In this study, an irregular worker is defined according to the occupation type based on the survey questionnaire. For the detailed definitions, please see section3.
5. In this study, we distinguish the rural and urban groups based on the registration. For example, based on the CHNS questionnaire, when a woman answered that her registration is rural, she is assigned to the rural women's group.

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