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Reproductive Attitudes, Norms and Constraints: Comparative Evolutionary Approaches to Second-Birth Intentions and Behaviour in Chinese Mothers

Jianghua Liu

The Institute for Population & Development Studies, School of Public Policy and Administration, Xi'an Jiaotong University, No.28, West Xianning Road, Xi'an 710049, P. R. China; liujianghua@tsinghua.org.cn

Abstract

This study takes comparative evolutionary approaches to relative contribution of various factors to women's reproductive behaviour in low-fertility societies like China. A series of theoretical hypotheses about second-birth intentions and behaviour—a key to understanding low-fertility behaviour—are raised and then tested by dominance analysis of longitudinal data from a sample of one-child mothers in China. It is found that behavioural ecology approach has the largest explanatory power. All members within nuclear family were complete stakeholders of reproduction: Husband's fertility attitude, i.e., injunctive norms of him as perceived by wife, made the largest contribution to fertility intentions, followed by wife's own attitudes, which were further followed by firstborn's. Among incomplete stakeholders, injunctive norms of peer relatives and friends contributed less to fertility intentions than parents', but the opposite held for descriptive norms, i.e., actual number of children. Regarding the actual behaviour followed over 2.5 years, fertility intentions were the dominating predictor of it; husband's, firstborn's and wife's fertility attitudes were equally important predictors; neither injunctive nor descriptive norms of other social-network members were significant contributing factors. Perceived challenge in investing in children was an important factor for both fertility intentions and behaviour and other constraints only became important at the latter stage. The study consolidates the theoretical foundation of collective decision-making in family reproduction, helps to clarify kin influence on women's fertility, suggests cultural evolution of fertility by horizontal transmission of new pronatalist norms in current China, and further supports comparative evolutionary approaches to reproductive behaviour and fertility policies in modern low-fertility societies.

Keywords: collective fertility decision-making; kin influence; injunctive norms; descriptive norms; quality-quantity trade-off

Introduction

The low-fertility challenge is confronted by many countries now and is related to a major theoretical question arising in both demography and human evolutionary biology in the past decades: What are the relatively important factors underlying women's low-fertility behaviour in modern societies, when there are increased resources available for reproduction (Borgerhoff Mulder 1998)? Taking China as an example, the country is now facing the challenge of the lowest-low fertility rate, fast declining births, rapid population aging, and consequent shortage of labour force and pension deficit (Qiao 2021). According to the latest release, China's total fertility rate was around 1.05 in 2023, i.e., just half of the replacement level (National Bureau of Statistics, Department of Population and Employment Statistics 2023). Thus, it is not strange that China relaxed its birth control policies again and again in the past 10 years to cope with the urgent challenge and since 2021, married couples

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have been universally allowed to have three children in their lifetime (Xinhua News Agency 2021; Liu and Zhang 2022). At the same time, there has been some debate in China: What are really important factors that have caused fertility limitation and thus, should be taken into account in designing counteracting measures? Some studies argued that endogenous factors, i.e., spontaneous and voluntary preferences for small family size in reproductively-aged couples, could explain low fertility better than other factors and thus, the focus should be put on promoting high-fertility ideology (Mu and Lin 2021; Yang and Wu 2021; Feng 2022); by contrast, others emphasized the importance of provision of convenient childcare services and parenting stipends (Song et al. 2021). As to be shown, an evolutionary approach to the debate helps to provide theoretical insights—not so evident from a demographic perspective—into it, which will naturally promote the solution of it.

In ranking fertility predictors, demographers and evolutionary anthropologists have different focuses. The former tend to focus on fertility intentions, rather than fertility behaviour *per se*, whereas the opposite is true for the latter. One reason for demographers' choice might be that fertility intention is proximate to actual childbearing behaviour, easy to measure in a cross-sectional study and convenient to analyse with the theory of planned behaviour or TPB in social psychology (Ajzen 1991; Miller 2011; Ajzen and Klobas 2013). According to TPB, fertility intention is determined by fertility attitudes (personal favourable or unfavourable evaluation of fertility behaviour), subjective norms (perceived social pressures on performing or not performing fertility behaviour) and perceived behavioural controls (the ease or difficulty of performing fertility behaviour). Influences of such factors on fertility intentions vary with parity (Klobas 2010; Ajzen and Klobas 2013; Erfani 2017). Subjective norms tend to be the most important predictor of an intention to have the first child: Childless couples have no experience of child-bearing and -rearing and thus, they will rely heavily on social custom of transition to parenthood regardless of perceived or practical constraints on reproduction (Billari et al. 2009; Ciritel et al. 2019). By contrast, attitudes may have a larger effect on fertility intentions in cases of second- or higher-order births: Parents have reproductive experience now and thus, there will be more own evaluation of costs and benefits of having another child (Dommermuth et al. 2011). For instances, reproductive attitudes were the leading predictor of mothers' fertility intentions in the nine European countries analysed by Billari et al. (2009) and Klobas (2010). Generally, perceived economic constraints (i.e., economic control factors) are not the leading predictors of fertility intentions in low-fertility societies (Klobas 2010). Besides TPB predictors, previous studies have also shown significant effects of some background factors on fertility intentions; in particular, age is a major or even the most important predictor (Ajzen and Klobas 2013; Liu and Lummaa 2019; Llorente-Marrón et al. 2022).

Regarding actual fertility behaviour, previous studies have also drawn some important conclusions. First, in demography, fertility intentions have been consistently found to be the most important predictor of actual fertility outcomes and they mediates substantially the effects of TPB factors as well as background factors on fertility behaviour. In their analysis of Italian population based on data from Generations and Gender Survey, Letizia et al. (2015) found that once fertility intentions were controlled for, fertility attitudes, subjective norms and perceived behavioural controls showed no significant effects on fertility outcomes. Similarly, Kuhnt & Trappe (2016) found that the effects of social pressures on fertility outcomes were mainly via their effects on fertility intentions. Second, tending to focus directly on fertility behaviour rather than fertility intentions (McAllister et al. 2016; Međedović 2023), evolutionary anthropologists found that the factors studied by the typical evolutionary models about the causes of the demographic transition—i.e., child mortality, biased cultural transmission, and parental investment—all contributed to fertility choices (Borgerhoff Mulder 2009; Shenk 2009); further analyses indicated that investment factors seemed to explain them best (Shenk et al. 2013; Snopkowski and Kaplan 2014).

Currently, there are still some gaps in previous comparative analyses. First, few of them have conducted an integrative analysis of fertility-related factors' relative influences on both fertility intentions and fertility behaviour, which can have dramatically different sensitivity to such factors. This raises a question: Will focusing just on one of them (intention vs. behaviour) lead to misleading

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results of ranking relative importance? Although somewhat time-consuming in collection, longitudinal data on fertility intentions and their time-lagged realization are suitable for such an integrated analysis (Rutigliano and Lozano 2022; Wang et al. 2022; Zhang et al. 2022). Second, previous studies have generally viewed subjective norms or social influences as an undifferentiated whole, i.e., few have differentiated influences from different social-network members. Liu and Lummaa (2019) found that in China, husband's and firstborn's reproductive attitudes in terms of their emotional support for further reproduction played a major role in one-child mother's fertility desire, the main predictor of fertility intention; by contrast, other social-network members like community neighbours almost did not have a significant influence.

By integrating different evolutionary approaches, the current study aims to answer both theoretically and empirically the question mentioned at the beginning: What are the relatively important factors influencing women's reproductive behaviour in modern societies? The focus will be on one-child mothers' intentions to have a second child and actual second-birth behaviour, the key to understanding low-fertility pattern and its dynamics in China—even under the three-child policy (Feng 2022)—and other low-fertility societies (Harknett et al. 2014). The predictors considered include TPB ones—mothers' reproductive attitudes, subjective norms of family members and non-family social-network members, perceived constraints on having a second child—as well as background factors like age. The dominance analysis is used to assess the relative importance of predictors.

The Theoretical Predictions

Two evolutionary perspectives—a benefit one and a cost one—are used to predict relative importance of nuclear-family members in fertility intentions and they will give the same predictions. As one of pillars of an evolutionary approach to animal behaviour, the kinship theory posits that for a given gene in the ego, there is a copy of it identical by descent in a relative at the probability of the degree of relatedness between them (Hamilton 1964; Trivers 1985); thus, the birth of a relative brings some genetic benefit. Another pillar theory, i.e., parental investment theory, posits that investment in an offspring is "at the cost of parent's ability to invest in other offspring" (Trivers 1972); thus, the birth of an offspring brings some cost in terms of taking up investment resources such as food, time and protection (Sear 2011). The theory also posits that parental investment is one key factor limiting reproduction; thus, it is reasonable to argue that larger investment means larger bargaining power in reproductive decision-making. In the light of genetic benefit, all members in nuclear family would play more or less the same important role in fertility decision-making, as they have an equal incentive for further reproduction: Mother herself, husband, and the firstborn child all have a coefficient of genetic relatedness with the potential second child at 0.5 (Hamilton 1964; Trivers 1985) (Figure 1). In the light of investment cost, members in the nuclear family will also play more or less an equal role in second-birth decision-making, as the required investment in the second child is likely the same for each of them (Table 1). In a word, **husband and the firstborn child would likely pay the same quantity of cost and gain the same quantity of benefit as mother herself; thus, they are the complete stakeholders of a potential second child, just as mother herself**. Given the above consideration (note: other factors like information asymmetry, when the firstborn child does not know parents' fertility plan timely or is not informed sufficiently, will be informally considered later), we have the following group of hypotheses about relative importance of nuclear-family members in fertility intentions:

Hypothesis H1a: *Injunctive norms of husband and the firstborn child significantly influence mother's fertility intention.*

Hypothesis H1b: *Both the effect of husband's injunctive norms on mother's fertility intention and that of the firstborn child's injunctive norms are at a size comparable to that of mother's own reproductive attitude.*

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Regarding the relative importance of nuclear-family members in actual fertility behaviour, there seems a difference between their attitudes. According to TPB, mother's own fertility attitudes tend not to affect fertility behaviour directly (Ajzen 1991). However, it has been indicated that husband's and the firstborn's attitudes towards second childbirth, i.e., their injunctive norms (Ajzen 2002), play a dual role (Liu and Lummaa 2019). On the one hand, such attitudes work as norms as those of non-family members and affect fertility behaviour indirectly via fertility intentions; on the other hand, they work as constraints or behavioural control factors that facilitate or inhibit performance of one's intention and thus, affect actual fertility behaviour directly (Ajzen and Klobas 2013; Liu and Lummaa 2019; Zhang et al. 2022). We now have a group of hypotheses about relative importance of nuclear-family members at the stage of actual fertility behaviour:

Hypothesis H2a: *After fertility intention is set up, injunctive norms of husband and the firstborn child significantly influence actual fertility behaviour.*

Hypothesis H2b: *After fertility intention is set up, injunctive norms of husband and the firstborn child are more important than mother's fertility attitudes in influencing actual fertility behaviour.*

The above theoretical argument—focused on members within nuclear family—for fertility intentions can be generalized to members in wider social network: the kin other than nuclear-family members and non-kin members (Figure 1; Table 1). Firstly, from a benefit perspective, the higher an ego's genetic relatedness with a given alter (e.g., a child), the stronger the ego will react to favourable or unfavourable things happening to it (e.g., birth or death); in other words, greater genetic relatedness or differential in it when considering an alternative outcome means greater selection pressure for the reaction (Cant and Johnstone 2008; Lahdenperä et al. 2012). Consequently, injunctive norms of kin of a potential child, i.e., their attitudes about whether the mother should have the child or not, tend to influence mother's fertility decision-making: If the mother neglect completely such norms, conflicts will arise, just as the case when a stakeholder's interest in an enterprise has not been considered sufficiently. In other words, balancing opinions from different stakeholders or kin weighted by their genetic relatedness to the potential child seems to be an optimal strategy in family reproductive decision-making, which is somewhat parallel to Pareto efficiency in collective decision-making in economy (Browning and Chiappori 1998). By contrast, injunctive norms of non-kin of the potential child such as mother's colleagues, friends or community neighbours will not influence the mother's fertility decision-making much: They hold no a stake in the reproduction and thus, neglecting their attitudes will not cause much conflict. The above theoretical argument explains some interesting findings in previous studies: e.g., receiving emotional support from partners or parents meant higher likelihood of a second birth in modern UK (Schaffnit and Sear 2017; Sear 2018); social pressure on reproduction mainly came from family members rather than non-family members (Samandari et al. 2010; Kavas and de Jong 2020); injunctive norms played a more important role in family planning in rural Highland Madagascar with a higher kin density than in urban area (Smith 2001); in a sample of Dutch women, slightly more pressure to have children was perceived from parents than from friends (Stulp and Barrett 2021). Given the above argument, we have a group of hypotheses about kin influence versus non-kin influence from the benefit perspective:

Hypothesis H3a: *Similarly as the case of husband and the firstborn child, injunctive norms of other kin of the potential second child significantly influence mother's second-birth intention, but those of non-kin do not.*

Hypothesis H3b: *Injunctive norms of husband and the firstborn child are more important than those of mother's parents/parents-in-law', which are more or less equally important as those of mother's other peer kin, which are further more important than those of non-kin, in influencing mother's second-birth intention.*

However, the cost perspective will lead to predictions somewhat different from the above ones. Although grandparental parental investment in the potential child is smaller than that of nuclear-

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family members, their investment will generally be larger than that of other kin, which is almost negligible in the context of nuclear family, e.g., in current China (Table 1). Evidently, although some kin—e.g., siblings or uncles—are stakeholders of second childbirth from the benefit perspective, they are not so from the cost perspective; in other words, only nuclear-family members (husband & the firstborn) and those kin especially grandparents who will invest substantially in the second child can be seen as substantial stakeholders of second childbirth. Given the above argument, we have a group of hypotheses about kin influence versus non-kin influence from the cost perspective:

Hypothesis H4a: *Similarly as the case of husband & the firstborn, injunctive norms of mother's parents/parents-in-law significantly influence mother's intention to have a second child, but those of other kin and non-kin do not.*

Hypothesis H4b: *Injunctive norms of nuclear-family members (husband & the firstborn child) are more important than those of mother's parents/parents-in-law, which are more important than those of other kin and non-kin, in influencing mother's intention to have a second child.*

In the above discussion, we note that non-kin alters will not influence the ego's fertility decision-making through their injunctive norms, but they can have an influence as a result of their descriptive norms, i.e., their own reproduction choices. Actually, according to the theory of cultural evolution, horizontal transmission of new cultural norms (e.g., peers' fertility choices) might be more efficient than vertical transmission (e.g., parents' fertility choices), owing to its timely response to ecological changes—thus shorter generation length—as well as one-to-many efficiency (Cavalli-Sforza and Feldman 1981; Boyd and Richerson 1985; Colleran 2016). Given the above argument, we have a group of hypotheses about horizontally versus vertically transmitted descriptive fertility norms:

Hypothesis H5a: *Both numbers of children of mother's parents/parents-in-law and those of peers' (kin or non-kin peers) significantly influence mother's second-birth intention.*

Hypothesis H5b: *Numbers of children of mother's parents/parents-in-law are less important than those of peers (kin or non-kin peers) in influencing mother's second-birth intention.*

Lastly, some predictions can be set up with respect to the influences of various socio-economic constraints. As mentioned above, such constraints tend to have no major influence on fertility intentions in low-fertility countries (e.g., Billari et al. 2009; Klobas 2010; Liu and Lummaa 2019). However, their influences may become larger from fertility decision-making to actual fertility behaviour, as decision-makers become more practical in the interim. Especially, evolutionary anthropologists argue that some evolutionary psychological mechanisms regulating parental investment in offspring quality will promote greater investment in own and offspring in modern competitive societies, which will then be associated with smaller desired and actual family size (Kaplan 1996; Kaplan et al. 2002). The argument has received empirical support in anthropological and demographic studies: Socio-economic resources available for parenting and investment in own and offspring education can be major factors limiting actual choice of family size (Mace 1996; Borgerhoff Mulder 2000; Huber et al. 2010; Lawson and Mace 2010; Wheeler 2011; Berrington and Pattaro 2014; Hašková and Pospíšilová 2019). Given the above argument, we have the following hypothesis about the influence of constraints:

Hypothesis H6: *After fertility intention is set up, constraints become more important in influencing actual fertility behaviour.*

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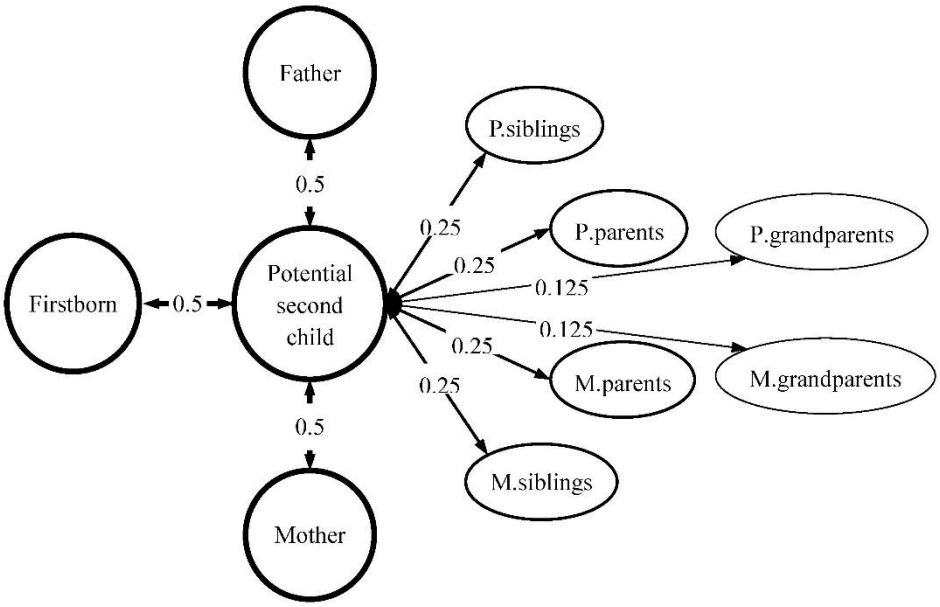

Figure 1. The illustration of some kin of a potential second child. For each line, the number on it refers to the coefficient of genetic relatedness between two persons at the ends of it (half-sibling and false paternity are not considered); width and length of it are proportional and inversely proportional to the coefficient, respectively. P.—paternal. M.—Maternal.

Table 1. The parental investment in a second-born child by an ego (e.g., a mother) and members of its social network.

The relationship with the ego	Investment
The ego itself	≈C/2[a]
The ego's partner	≈C/2
The ego's firstborn child	≈C/2[b]
The ego's parents/parents-in-law	< C/2[c]
The ego's siblings	<< C/2[d]
The ego's partner's siblings	<< C/2
The ego's colleagues	0[e]
The ego's friends	0

[a]The needed total investment in a second child is denoted as C. It is assumed that two partners invest more or less the same in the coming second child, an assumption reasonable for highly competitive societies, where both paternal and maternal parental investment is indispensable for reproduction and survival of the child (Trivers 1985; Kaplan et al. 2000). [b]Theoretically, the part of C, which will be taken out of what is otherwise invested in the first child if a second birth is not planned, varies from 0 to C; in other words, although the firstborn child does not invest in the second one directly, the possible cost incurred for it can be seen as *de facto* investment. When the family is in good socio-economic condition, it might not be necessary to divert any investment from the firstborn child to the second one; thus, the amount diverted could be 0. By contrast, when the family is in bad socio-economic condition, it might be necessary to divert limited time, food and other resources from the firstborn child to the second one; in extreme cases, all the investment in the second child will be necessarily diverted from that in the firstborn child and thus, the amount diverted could be as high as C. Then, (C+0)/2=C/2 could be a reasonable estimate for population mean of the amount diverted, when the distribution of the amount is symmetric. The argument can be naturally extended into families with more than one child: e.g., with two children already born, the total investment diverted from all two already-born children owing to the third childbirth is still estimated at C/2; however, the cost incurred for the firstborn child would be just C/4 now. [c]In societies with grandparental care for grandchildren (e.g., in current China; see Zhao and Zhang 2019), grandparental investment can be substantial, but it is reasonable to assume such an investment is less than that

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of parents (for a comparison between maternal and grandparental effects on child survival in basically natural fertility populations, see Sear and Mace 2008). [d]In a society with nuclear family as its main family structure, e.g., China (Wang 2024), it is assumed that help or investment from siblings is far less than parents' investment (see also Trivers 1985). [e]It is assumed that non-genetic social-network members do not invest in the ego's children.

Materials & Methods

The Baseline and Follow-Up Surveys

Our study was based on the longitudinal data from two waves of a fertility survey. The baseline survey was conducted in the Xi'an metropolitan area, Shaanxi Province, from December, 2017 to February, 2018, when the so-called universal two-child policy—i.e., almost all married couples were allowed to have two children (Xinhua News Agency 2015)—had been implemented for about two years. According to the 7th National Population Census, total fertility rate in the province was about 1.16 and that in the city was just 1.03 in 2020, reflecting the lowest-low fertility pattern in China (Office of the Leading Group of the State Council for the Seventh National Population Census 2022). The respondents in the baseline survey were mothers of one child, not pregnant with the second child yet, and 20–44 years old. Before questionnaire survey, a judgmental sampling was implemented so that the final sample can roughly represent the Xi'an population at that time. All qualified mothers from 17 communities/villages in 9 streets/towns belonging to 4 districts (two in main city, one in inner suburb and the last one in outer suburb) were sampled. Then, the selected mothers were interviewed through telephone and 541 effective questionnaires were collected in total. The follow-up survey was conducted from January to August, 2020 (this survey lasted for a relatively long time, owing to the COVID-19 pandemic); in other words, it was about two and a half years after the baseline survey. All 541 mothers interviewed in the baseline survey were re-contacted through telephone, and 262 effective questionnaires were collected (i.e., effective follow-up rate ≈ 48%). There was no sign that follow-up attrition changed substantially characteristics of mothers; e.g., mean values of age and fertility intention in the full baseline sample were specifically 33.53 years and 3.57, close to those values in the final follow-up sample (Table 2).

Table 2. The descriptive statistics of variables used in modelling[a].

Groups of variables	Variables	Statistics
Fertility behaviour	Whether a mother had a second child between two surveys	
	had a second child	13.74%[b]
	did not have a second child	86.26%
Fertility intention	Intending to have a second child at the time of the baseline survey	3.58(1.44)[c]
Background factors	Settlement	
	urban community	59.54%
	rural village	40.46%
	Age	33.18(5.72)
	Education	
	pre-college level	46.95%
	college education or above	53.05%
	Household annual disposable income in the last year[d]	3.48(1.69)
	The sex of the firstborn child	
	boy	56.11%
	girl	43.89%
Fertility attitudes	Benefit of having a second child to lineage endurance[e]	2.18(1.09)
	Benefit of having another kid to the firstborn child's companionship	1.71(0.99)
	Benefits of having a second child to personal well-being	2.45(0.98)

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	Costs of having a second child to offspring quality	3.65(0.92)
	Costs of having a second child to personal well-being	2.53(0.87)
Injunctive norms: nuclear-family members	Husband's attitude to second childbirth	2.92(1.41)
	The firstborn child's attitude to second childbirth	
	supportive	33.21%
	no explicit support	46.56%
	not asked	20.23%
Injunctive norms: other kin	Attitude of parents or parents-in-law to second childbirth	2.38(1.24)
	Attitude of peer relatives to second childbirth	2.54(1.22)
Injunctive norms: non-kin	Attitude of friends/colleagues to second childbirth	2.60(1.21)
Descriptive norms: parents/parents-in-law	Number of children of parents	
	two or more	89.69%
	only one	10.31%
	Number of children of parents-in-law	
	two or more	83.21%
	only one	16.79%
Descriptive norms: peer kin	Number of children in peer relatives	
	most of them had two or more children	17.18%
	others	82.82%
Descriptive norms: peer non-kin	Number of children in friends/colleagues	
	most of them had two or more children	10.31%
	others	89.69%
Constraints	Difficulty in financial and housing condition	
	feeling clear difficulty	29.01%
	feeling no clear difficulty	70.99%
	Difficulty in caring and educating offspring	
	feeling clear difficulty	49.24%
	feeling no clear difficulty	50.76%
	Difficulty in balancing childbirth and work	
	feeling clear difficulty	31.30%
	feeling no clear difficulty	68.70%

[a]Fertility behaviour was measured in the follow-up survey and all other variables were measured in the baseline survey. [b]For each categorical variable, statistics refer to proportions of categories of the variable. [c]For each continuous variable, statistics refer to mean and standard deviation in bracket. [d]The measure of annual disposable income was a 6-point Likert scale: 1-'less than 20,000 yuan;' 2-'20,000~40,000 yuan;' 3-'40,000~60,000 yuan;' 4-'60,000~80,000 yuan;' 5-'80,000~100,000 yuan;' 6-'more than 100,000 yuan.' [e]The answers to the questions of intention and attitudes were all a 5-point Likert scale: 1('completely agree') → 5('completely disagree').

Fertility behaviour, i.e., whether a one-child mother had a second child between the baseline and follow-up surveys, was measured with a question in the follow-up survey, 'how many children do you have now?' Mother's fertility intention at the time of baseline survey was measured with a Likert scale, 'do you agree with the following statement: you have a plan to have a second child in the next two years? (Options: 1–completely agree; 2–rather agree; 3–neither agree nor disagree; 4–rather disagree; 5–completely disagree)' The measurement of predictors in the baseline survey can be found in Table 2, *SI* Appendix A (Supplementary Text) and *SI* Appendix B (Table A.1); they were classified into five groups: background factors; mother's fertility attitudes; injunctive norms of nuclear-family

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members, other kin and non-kin; descriptive norms of parents, parents-in-law, peer relatives and peer non-kin; constraints (Table 2; Figure 2).

The two waves of the survey were approved by the Biomedical Ethics Committee of Xi'an Jiaotong University (Approval Nos. NO2017100 and NO2020002). Their conduction was in line with the Declaration of Helsinki and before a questionnaire survey, each interviewee was informed of the research purpose and expressed her consent to take part in it.

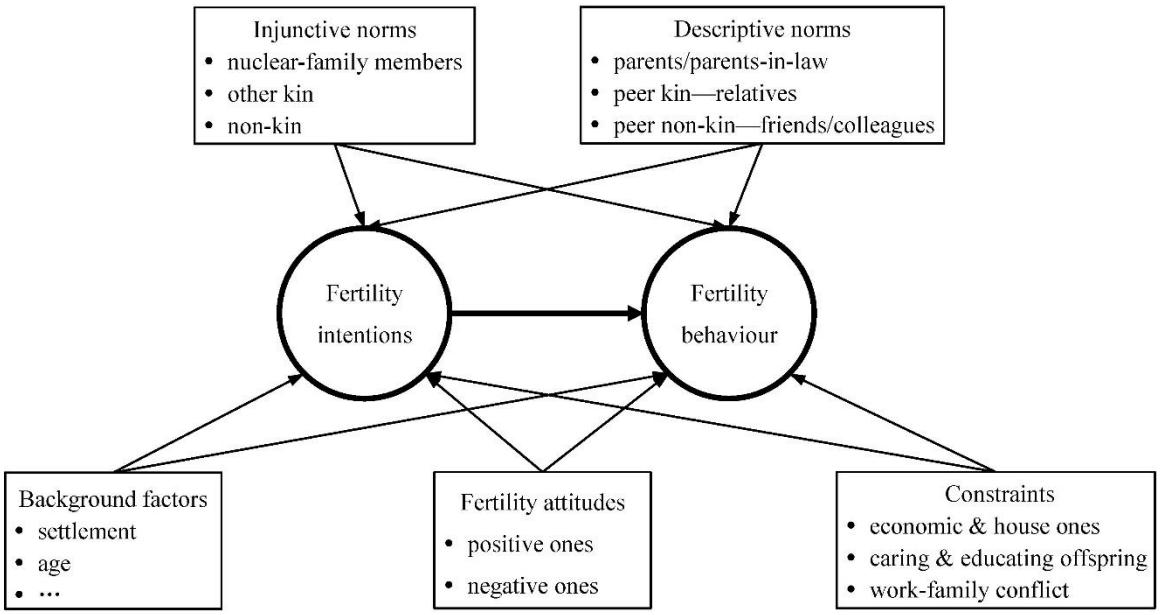

Figure 2. The predictors of fertility intention and behaviour.

Statistical Modelling

Fertility intention was modelled as a continuous response variable in regression analysis and we used OLS (ordinary least square) method to estimate effects of predictors. It was predicted by five groups of predictors as mentioned above and together with such predictors, it predicted actual second-birth behaviour during the interval between two surveys (Figure 2). Table 2 shows the coding of predictors in modelling (see also *SI* Appendix A: Supplementary Text). Before modelling, six missing values in constraint variables were imputed by *mice* package in *R* (van Buuren and Groothuis-Oudshoorn 2011; R Core Team 2024).

We did not collapse the Likert scale of fertility intention into a binary variable as by some researchers, for the following three reasons. First, it has been suggested that such a scale meets the assumption of interval measurement, i.e., equal distance between points (Thomson and Brandreth 1995; Kan 2023). Second, modelling fertility intention as a continuous variable can take advantage of full information on the fine changes between categories that would otherwise be lost in collapsing (Atalay et al. 2017; Mayer et al. 2023). Thirdly, modelling fertility intention as a continuous variable has a higher statistical power for detecting the effect of a given predictor (Fedorov et al. 2009; Shentu and Xie 2010).

Given that most of mothers did not produce a second child, a small proportion did, and only one mother produced more than one child (twins) during the between-survey interval, we modelled fertility behaviour as a binary response variable: '0—still having only one child now' vs. '1—having two or three children now.' We used GLM (generalized linear model) based on probit transformation rather than logit transformation to analyse predictors' effects on actual fertility behaviour, as the former led to a lower AIC value.

We used dominance analysis to evaluate the relative importance of predictors of fertility intention and actual fertility behaviour. The platform was *R* 4.4.1 (R Core Team 2024) and the package

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used was *dominanceanalysis* (Bustos Navarrete and Coutinho Soares 2024). It is known that a given predictor's contribution to explaining response variable, e.g., R^2 in an OLS regression model, depends on the predictor's sequence in entering the model and its association with other predictors (Zhu and Gu 2023). Dominance analysis calculate its contributions in all possible subset models, e.g., model including just the predictor, model including another predictor and then the predictor under question, etc. (Azen and Budescu 2003; Azen and Traxel 2009; Coutinho Soares 2024). By averaging these contribution values, dominance analysis gives an assessment of a predictor's general contribution or general dominance. Through this way, dominance analysis gives a reasonable and intuitive estimation of predictors' contribution, in the sense of being positive, robust to correlation between predictors, a decomposition of model's goodness-of-fit index like R^2, and able to evaluate relative importance of groups of predictors; thus, it is a recommended statistical tool for analysing relative importance of predictors (Azen and Budescu 2003; Zhu and Gu 2023). For OLS regression models, dominance analysis uses explained R^2 to represent a predictor's relative importance. For GLM models, it uses a series of pseudo-R^2; Azen & Traxel (2009) especially recommended McFadden's index. The robustness of general dominance was evaluated using bootstrap re-sampling for 1,000 times, to see if the ranking of predictors' relative importance could be reproducible reasonably well in bootstrap samples (i.e., reproducibility ≥ 70%; see Azen and Traxel 2009).

Results

Descriptive Statistics

First, we have descriptive statistics of two response variables (Table 2). Among the 262 mothers who had one child at the time of baseline survey, 36 of them had a second child; in other words, during the 2.5 years of follow-up interval, the vast majority of mothers did not reproduce again. In baseline survey, 57.25% of reproductive-aged mothers did not plan to have a second child ('rather disagree' or 'completely disagree'). Although 70 mothers initially planned to have a second birth, only 24 of them really did so; among 42 mothers who had no clear fertility intention initially, seven of them reproduced again; finally, among 150 mothers who initially did not plan to give another birth, five of them actually did so.

Second, we have descriptive statistics of five groups of predictors. (1) Background factors. At the time of baseline survey, close to 60% of mothers lived in urban areas. On average, they aged at 33.18 years. Slightly more than half of mothers had received a college/university-level education. As residents in a city located in West China, they had on average an annual family disposable income about 60,000 yuan or 9,000 dollars at that time. Although sex ratio in firstborns seemed to be son-biased, the ratio was actually not significantly different from the theoretically normal value around 106:100 (test of goodness of fit: $\chi_1^2 = 2.27$, $P = 0.13$). (2) Fertility attitudes. Mothers' attitudes towards the benefits of having a second child to lineage endurance and child companionship were basically positive, but that towards the benefits to personal well-being was less so. The attitude towards the costs to personal well-being was more or less neutral, but that towards the costs to offspring quality was more negative. (3) Injunctive norms. Although husbands' attitude towards having a second child was not positive on average, it was more "positive" than mother's fertility intention ($t_{521.79} = -5.23$, $P < 0.001$). About 20% of the firstborn children were not inquired about their attitude towards having a second child; among those inquired, about two in five explicitly thought their mothers should reproduce again and others did not express such a (positive) attitude. Most of parents or parents-in-law, peer relatives, and friends/colleagues thought that one-child mothers should have a second child; further analysis indicates that although parental opinion seemed to be slightly more positive, their norms did not differ significantly ($F_{2, 783} = 2.23$, $P = 0.11$). (4) Descriptive norms. Close to 90% of mothers had at least one sibling (i.e., number of children of their parents was at least two) and the relevant proportion in their husbands was slightly lower. By contrast, only one in six mothers reported that most of their peer relatives had two or more children and only one in ten mothers reflected such a result in their friends/colleagues. (5) Constraint factors. Mothers felt more or less each

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of three constraints on having a second child, but the perception differed between constraints: There was a significantly higher proportion—close to 50%—of perceiving difficulties in caring and educating offspring than that in other constraints ($\chi_2^2 = 27.74$, $P < 0.001$).

Predictors' Effects on Fertility Intentions and Their Relative Importance

Among the five groups of predictors, the following ones were found to be significantly associated with an intention to have a second child at the time of baseline survey (Table 3). (1) Among the background factors, only age had a significant (negative) effect: Mother's intention not to have a second child increased by 0.053 for every one-year increase in age ($P < 0.001$; Table 3). (2) Among the fertility attitudes, the attitude towards second childbirth's benefits to personal/family well-being was a highly significant predictor: The more positive the attitude, the stronger would be the mother's fertility intention (estimate $\beta = 0.295$, $P < 0.001$). Additionally, mother's recognition of a risk of lineage extinction, i.e., losing the only child, marginally significantly promoted a higher intention to have a second child ($\beta = 0.134$, $P < 0.10$). (3) Among the injunctive norms, both husband's and firstborn's fertility attitudes had a highly significant effect on mother's fertility intention. For every unit increase in husband's disagreement with second childbirth, mother's intention not to have a second child increased by 0.275 unit ($P < 0.001$). Compared to the case that a firstborn child was not inquired about his/her attitude towards second childbirth, mother's intention to have a second child would increase by 0.629 when her firstborn thought she should reproduce again ($P < 0.01$). None of injunctive norms of parents/parents-in-law, peer relatives and friends/colleagues were significant. (4) Among the descriptive norms, family sizes in peer relatives and friends/colleagues were significant predictors. Compared to the case where most of peer relatives had two or more children, a mother in other cases (e.g., few peer relatives had two or more children) had a higher intention not to have a second child ($\beta = 0.514$, $P < 0.05$). Similarly, the case when most of friends/colleagues had two or more children was associated positively with an intention to have a second child in a mother ($\beta = 0.619$, $P < 0.05$). Either mother's or husband's number of siblings did not have a significant effect on fertility intention. (5) Among the economic constraints, only perceived difficulty in caring and educating children had a significant effect on mother's fertility intention, such that 'feeling no clear difficulty' meant a more positive intention ($\beta = -0.442$, $P < 0.05$). None of any other constraints significantly predicted fertility intentions. The above estimates and their significance levels preliminarily suggest that significant predictors were important, but those non-significant ones were not so.

Table 3. Estimation of effects on mother's fertility intentions and behaviour[a].

Predictor	Fertility intention			Fertility behaviour		
	β [b]	CI.L[c]	CI.U	β	CI.L	CI.U
Intention to have a second child in baseline survey[d]	—	—	—	-0.546***	-0.818	-0.304
Settlement (ref. = urban community[e])						
rural village	0.192	-0.167	0.551	0.345	-0.312	1.016
Age	0.053***	0.023	0.082	-0.052	-0.120	0.011
Education (ref. = pre-college level)						
College level or above	-0.117	-0.483	0.248	0.586†	-0.033	1.234
Household disposable income in the last year	-0.020	-0.121	0.082	0.074	-0.108	0.261
Firstborn's sex (ref. = male)						
female	-0.194	-0.490	0.102	-0.090	-0.656	0.462
Attitude towards the benefit to lineage endurance	0.134†	-0.016	0.284	-0.069	-0.376	0.218
Attitude towards the benefit to firstborn's companionship	-0.077	-0.249	0.095	0.244	-0.093	0.594
Attitude towards the benefits to personal/family well-being	0.295***	0.125	0.464	-0.063	-0.366	0.231
Attitude towards the costs to offspring quality	-0.114	-0.313	0.086	0.028	-0.331	0.390

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Attitude towards the costs to personal well-being	-0.039	-0.244	0.167	-0.016	-0.365	0.334
Husband's attitude towards second childbirth	0.275***	0.157	0.394	-0.025	-0.263	0.210
Firstborn's attitude towards second childbirth (ref. = unasked)						
supportive	-0.629**	-1.070	-0.188	0.957*	0.152	1.843
no explicit support	-0.112	-0.519	0.294	0.682†	-0.086	1.539
Attitude of parents/parents-in-law to second childbirth	0.108	-0.037	0.254	0.036	-0.268	0.344
Attitude of peer relatives to second childbirth	0.037	-0.135	0.209	0.243	-0.094	0.586
Attitude of friends/colleagues to second childbirth	0.021	-0.139	0.182	-0.181	-0.503	0.142
Number of kids of parents (ref. = one)						
two or more	-0.400	-0.897	0.097	-0.848*	-1.675	-0.022
Number of kids of parents-in-law (ref. = one)						
two or more	0.116	-0.301	0.533	0.663†	-0.037	1.423
Number of kids in peer relatives (ref. = '≥2 kids'[f])						
other values	0.514*	0.092	0.937	0.084	-0.691	0.933
Number of kids in friends/colleagues (ref. = '≥2 kids')						
other values	0.619*	0.095	1.143	0.034	-0.769	0.884
Difficulty in financial and housing conditions (ref. = feeling clear difficulty)						
feeling no clear difficulty	0.136	-0.226	0.498	-0.631†	-1.386	0.094
Difficulty in caring and educating offspring (ref. = feeling clear difficulty)						
feeling no clear difficulty	-0.442*	-0.798	-0.086	0.717*	0.057	1.428
Difficulty in balancing family and work (ref. = feeling clear difficulty)						
feeling no clear difficulty	-0.093	-0.436	0.251	0.712†	-0.047	1.550

[a]The fit indices of the regression models of fertility intention and fertility behaviour were R^2=0.422 and McFadden's R_M^2 =0.375, respectively. [b]Estimation of regression coefficients.[c]CI.L, CI.U—the lower and upper bounds of 95% confidence interval. The confidence intervals were calculated by *confint*() function in *R*, which is based on profile likelihood method and gives more reliable results than the default function *confint.default*() that is based on asymptotic normality. [d]The answers to the questions of fertility intention and attitudes were all a 5-point Likert scale: 1('completely agree') → 5('completely disagree'). [e]ref.—reference level. [f]'≥2 kids'—most of peer relatives had two or more children. †$P < 0.10$; *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

The formal dominance analysis indicates the ranking of relative importance of predictors of fertility intention in the current sample, which was basically robust as can be seen from bootstrap resampling (Figure 3). Injunctive fertility norms of husband were the most important predictor of mother's fertility intention, followed by mother's own fertility attitudes. These two factors made larger contribution to explaining variance of fertility intention than any other factors. Following these two factors, family sizes in peer relatives and friends/colleagues, injunctive norm of parents/parents-in-law, injunctive fertility norm of the firstborn child and age were of similar size in relative importance, as can be seen from the bootstrap resampling: The reproducibility of dominance comparison between any pair of them was lower than 60%. The difference in dominance of age and perceived difficulty in rearing and educating offspring was marginally significant. The dominance of the latter was of similar size as that of injunctive norms of peer relatives, which was further significantly larger than those of friends/colleagues and background factors. Family sizes of parents or parents-in-law and other perceived difficulties in rearing two children were least important in predicting mother's fertility intention.

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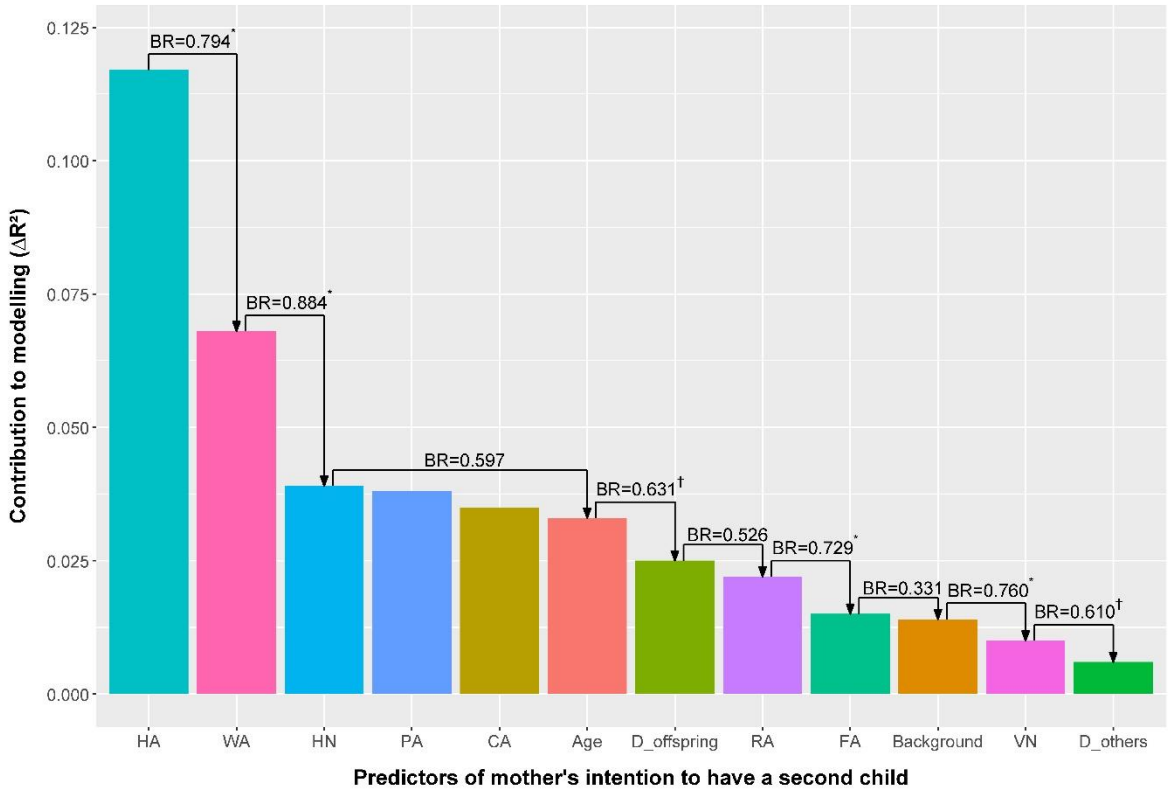

Figure 3. The relative importance or dominance of predictors of fertility intentions in terms of their contribution to the OLS regression model (the sum of each predictor's contribution $\sum(\Delta R^2)$ = model's $R^2 = 0.422$). BR—reproducibility of relative importance of given predictors in 1,000 bootstrap samples; the predictor on the left was dominant over the one on the right; when more than two predictors are included under a BR connection line, none of BRs of pairs of predictors are above 0.60 (parallel to so-called marginal significance, a BR between 0.60 and 0.70 is denoted as marginally significant and marked with a dagger; a BR ≥ 0.70 is denoted as significant and marked with an asterisk). HA—husband's attitude towards second childbirth, i.e., whether the mother under question should reproduce a second child or not. WA—mother's own fertility attitudes. HN—family sizes in horizontal or peer social-network members (peer relatives; peer friends/colleagues). PA—attitudes of parents/parents-in-law towards second childbirth. CA—the firstborn child's attitude towards second childbirth. Age—mother's age at the time of baseline survey. D_offspring—perceived potential difficulty in rearing and educating two children. RA—peer relatives' attitudes towards second childbirth. FA—peer friends/colleagues' attitudes towards second childbirth. Background—personal and family background factors, including family settlement, mother's education, household disposable income in the last year and the firstborn child's sex. VN—family sizes in vertical or parental generation members, i.e., parents or parents in law. D_others—perceived difficulties other than that in rearing and educating two children, i.e., house and economic aspect and work-family conflict.

Based on regression analysis and dominance analysis, it can be seen that the hypotheses H1a and H5b are fully supported, but other hypotheses on fertility intentions are not. The hypothesis H1b is not supported: Husband's, mother's own, the firstborn child's fertility attitudes were not comparable in their dominance; instead, there was a clear gradient among them. The hypothesis H3a is only partly supported: Indeed, peer non-kin did not significantly influence mother's intention to have a second child; however, injunctive norms of other kin (parents/parents-in-law and peer kin) did not either. The hypothesis H3b is basically not supported: The firstborn child and parents/parents-in-law were of similar importance in influencing mother's fertility intention; also, not as hypothesized, injunctive norms of parents/parents-in-law were more important than those of peer kin (BR=0.812). By contrast, the hypotheses H4a and H4b fare somewhat better: Although the

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predictions about parents/parents-in-law were not fully supported, other predictions including those on peer kin and non-kin were fully supported. Finally, the hypothesis H5a is only partly supported, as the family sizes of parents/parents-in-law did not significantly influence mother's fertility intention.

Predictors' Effects on Fertility Behaviour and Their Relative Importance

The following predictors were found to be significantly associated with the actual second-birth behaviour during the interval between two surveys (Table 3). (1) Fertility intentions. When controlling for other predictions, for every unit increase in mother's intention not to have a second child, the probit of fertility behaviour decreased by 0.546 ($P < 0.001$). Based on the estimate, there is an intuitive way to see the effect of fertility intention: When the value of fertility intention changed from 'completely agree' to 'completely disagree,' the probability or cumulative distribution function (CDF) of having a second child would decline from 35.27% (probit = 0.168 - 0.546 × 1) to 0.520% (probit = 0.168 - 0.546 × 5), a value close to zero. (Note: 0.168 was the intercept when other predictors were controlled for at their mean values.) (2) Injunctive norms. Compared to the case when firstborn was not inquired about his/her attitude, the probit of fertility behaviour increased by 0.957 when the firstborn child thought his/her mother should have a second child ($P < 0.05$); in other words, when controlling for other predictors, the probability of having a second child would increase from 1.769% to 12.569% (see above computation of CDF). Both mother's own and husband's fertility attitudes had no significant direct effect on second-birth behaviour. (3) Descriptive norms. Compared to the case when a mother under question was an only child of her parents, the probit of fertility behaviour decreased by 0.848 when she had siblings ($P < 0.05$). (4) Perceived constraints. Compared to the case when mother perceived potential difficulty in rearing and educating two children, the probit of having a second child would increase by 0.717 when such a difficulty was not perceived ($P < 0.05$). Besides the above predictors which significantly predict actual fertility behaviour, there were also some marginally significant predictors, including mother's education, husband's number of siblings, and two perceived constraints.

The formal dominance analysis indicates the ranking of relative importance of predictors of actual fertility behaviour in the current sample, which was basically robust as can be seen from bootstrap resampling (Figure 4). Fertility intentions were evidently the most important predictor of mother's actual fertility behaviour. Following it, there were two other important predictors: perceived difficulties in family economy and house and work-family balance; background factors. Bootstrap resampling indicated that these two categories of factors were similarly important. Following them, there were four important predictors: the firstborn child's fertility attitude, perceived difficulty in rearing and educating two children, husband's attitude, and mother's own attitudes; they were similarly important predictors of fertility behaviour, as relative importance or dominance between any pair of them in the sample was not reproducible in more than 60% of bootstrap samples. Finally, consistent with GLM regression analysis, non-significant predictors were also least important predictors of actual second-birth behaviour between two surveys: norms of friends/colleagues, norms of peer relatives, norms of parents/parents-in-law, and family sizes in peer relatives and friends/colleagues.

Based on regression analysis and dominance analysis, it can be seen that the hypothesis H6 is supported. At the stage of second-birth intention, only perceived difficulty in rearing and educating two children was a significant predictor; it was ranked the seventh one among the predictors analysed and accounted for about 5.931% of total R^2. However, at the stage of actual fertility behaviour, all three perceived difficulties or constraints were significant or marginally significant predictors; they were ranked second and fourth ones (with parallel ranks); together, they accounted for about 15.733% of total R_M^2. The hypothesis H2a is partly supported: Only the firstborn child's but not husband's fertility attitude significantly affected mother's actual second-birth behaviour. Finally, the hypothesis H2b is not supported: There was no sufficient evidence, in terms of a reproducibility of relative importance higher than 60% in bootstrap samples, that injunctive norms

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of husband and the firstborn child were more important than mother's own fertility attitudes in predicting mother's actual fertility behaviour.

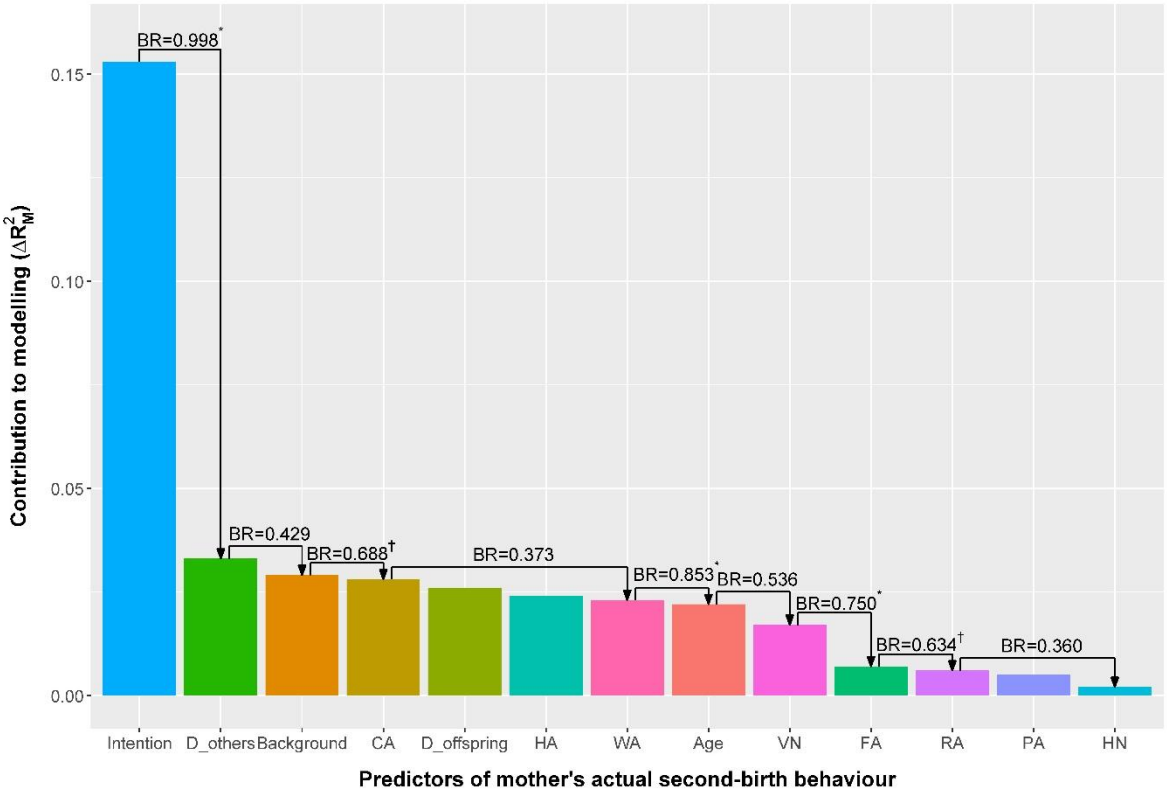

Figure 4. The relative importance or dominance of predictors of actual fertility behaviour in terms of their contribution to the GLM regression model (the sum of each predictor's contribution $\sum\left(\Delta R_M^2\right)$ = the model's McFadden's R_M^2 = 0.375). BR—reproducibility of relative importance of given predictors in 1,000 bootstrap samples; the predictor on the left was dominant over the one on the right; when more than two predictors are included under a BR connection line, none of BRs of pairs of predictors are above 0.60 (parallel to so-called marginal significance, a BR between 0.60 and 0.70 is denoted as marginally significant and marked with a dagger; a BR ≥ 0.7 is denoted as significant and marked with an asterisk). Intention—mother's intention to have a second child at the time of baseline survey. D_others—perceived difficulties other than that in rearing and educating two children, i.e., house and economic aspect and work-family conflict. Background—personal and family background factors, including family settlement, mother's education, household disposable income in the last year and the firstborn child's sex. CA—the firstborn child's attitude towards second childbirth, i.e., whether the mother under question should reproduce a second child or not. D_offspring—perceived potential difficulty in rearing and educating two children. HA—husband's attitude towards second childbirth. WA—mother's own fertility attitudes. Age—mother's age at the time of baseline survey. VN—family sizes in vertical or parental generation members, i.e., parents or parents in law. FA—friends/colleagues' attitude towards second childbirth. RA—peer relatives' attitude towards second childbirth. PA—attitudes of parents/parents-in-law towards second childbirth. HN—family sizes in horizontal or peer social-network members (peer relatives; friends/colleagues).

Discussion

From evolutionary perspectives, e.g., kinship, parental investment and cultural evolution, we raise a series of theoretical predictions of relative contributions of different fertility-related factors to women's second-birth behaviour and the longitudinal survey data fully or partly support eight of 11 predictions. The findings from our study have important implications for understanding low-fertility behaviour in modern societies.

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Firstly, the relationship between fertility intention and actual fertility behaviour has two contrasting implications. On the one hand, fertility intention was the central predictor of fertility behaviour and substantially mediated the effects of some key predictors such as age and descriptive norms of peer relatives and friends/colleagues, which were mainly significant and important at the intention stage (Table 3). Thus, it is helpful to analyse fertility intentions or motivation in behavioural analysis: Significant predictors of a mediator have a higher power to be detected than those of ultimate response (Kenny and Judd 2014). In other words, if we just focus on fertility behaviour itself, many important predictors might be hard to detect. For example, husband's fertility attitude was even not a significant predictor of fertility behaviour, but it was the most important predictor of fertility intentions. In the light that motivation analysis were mainly conducted in population studies, some anthropologists have called for an effort to reach an evolutionary understanding of the motivational mechanisms underlying human fertility (e.g., McAllister et al. 2016; Međedović 2023). The current study represents a small step towards the goal. On the other hand, fertility behaviour is generally not completely intention driven or under volitional control (Ajzen 1985); thus, important predictors of intentions and actual behaviour may differ. Consequently, it is also not advisable to substitute the analysis of fertility intentions for that of fertility behaviour. Rather, it is better to have a comprehensive analysis of both fertility intentions and behaviour.

Secondly, the current study substantiates both theoretically and empirically the idea of collective decision-making in family reproduction. Previously, Smith's anthropological study of Igbo-speaking Nigeria well illustrated "fertility decision-making…cannot be understood as individual or even dyadic, because a much wider spectrum of voices and interests have a say and must be considered in the social reproduction of families" (Smith 1999). Unfortunately, although economists and demographers have noticed collective decision-making in fertility, their focus has been mainly on couples (Thomson et al. 1990; Browning and Chiappori 1998; Testa and Bolano 2021). For example, Browning and Chiappori (1998) raised a model on (two-person) household behaviour such as fertility, savings and portfolio choice; according to this model, intra-household collective decision-making was a process of maximization of the sum of two persons' utility weighted by their decision-making power, which was a response to external economic environment like relative income. By contrast, our treatise of collective decision-making in family reproduction takes an inclusive view and considers more stakeholders of reproduction from both genetic benefit and parental-investment cost perspectives. Evidently, the investment-cost perspective won more support from empirical data: A given stakeholder's decision-making power seemed to be correlated with his/her parental investment; investing more means larger power in reproductive decision making and investing nothing means no power. For example, in affecting mother's fertility intention, injunctive norm of parents/parents-in-law—who generally make some investment in grandchildren—was of similar importance as that of the firstborn child and evidently more important than that of peer relatives and friends/colleagues, who basically invest nothing in one's children in China's current context (Figure 3; Table 1). Previously, a related framework of multiple decision-makers in family reproduction was raised from the perspective of intra-family conflicts (sexual conflict, parent-offspring conflict, etc.), i.e., husband, mother herself and the firstborn child might have different interests/preferences (Liu and Lummaa 2019). Evidently, the current work adds to that by expanding the scope of stakeholders and extending the qualitative theoretical argument, i.e., who will have *an influence*, to a partly quantitative one, i.e., who will have *a larger influence* than others. It is suggested here that the collective decision-making framework might also apply to other societies, regardless of their fertility levels; surely, further study is warranted to check the prediction.

There is an original finding as a corollary of the framework of collective decision-making in family reproduction: Already-born children played a major role both in reproductive intentions and in actual behaviour, which matched or was even more important than e.g., that of age and education, two factors emphasized by demographers. It has been noticed for a long time that children should have a position in family decision-making, but they do not have one in reality: "Children are customarily excluded from the set of decision-making agents in the family, though they may be

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recognized as consumers of goods chosen and provided by loving or dutiful parents." (Lundberg and Pollak 1996) As can be seen from dominance analysis, the firstborn child had an important role at the stage of fertility intention, but the role was evidently less important than that of mother and her husband (Figure 3). Only at the stage of actual fertility behaviour, the firstborn child's role matched that of his/her parents; in other words, at the stage of planning a further birth, couples did not consider sufficiently fertility attitude of the child, but they were forced to do so at the latter stage, presumably owing to larger age and consciousness of the child as well as some tactics played by it (Trivers 1985; Liu and Lummaa 2019). The finding on the firstborn child's role in family reproduction has an important implication for understanding the demographic transition in humans. As shown in Table 1, the investment cost of further reproduction incurred for an already-born child would increase with the decline in total number of already-born children. In other words, with the progress of the demographic transition, already-born children especially the firstborn one would act more and more as a player of the game of fertility limitation, besides husband and wife (see e.g., Liu and Lummaa 2014). By contrast, in a time of natural fertility when a family generally had a large size and inter-birth interval was less than 3 years (Henry 1961; Sear and Mace 2008), a firstborn even did not speak at the time of second-child birth and thus had no chance to express his/her attitude towards further reproduction; even if he can speak later, his role was not as large as the case analysed in the current study for the reason just discussed, as his role was discounted by total family size.

Thirdly, our study helps to clarify kin influence on women's fertility and its role in human demographic transition. Newson et al. (2005) once raised an influential hypothesis: Social development promoted more contact with non-kin, who generally tended to give less pronatal advice (i.e., injunctive norms), which through the process of cultural evolution promoted declining fertility in modern societies. Their key idea about pronatal kin and less pronatal non-kin was somewhat reflected in the following statement: "people bias what they SAY about reproduction, depending on who is LISTENING and whether or not they are genetically related." According to the framework of collective decision-making, the more reasonable logic seems like this: "people bias what they LISTEN about reproduction, depending on who is SAYING and whether or not the speaker would invest in their children." In other words, through injunctive norms, kin influence surely matters, but might not work exactly in the way as proposed by these scholars. Actually, the sample in the current study showed no sufficient empirical evidence for that kin were more pronatal than non-kin in their injunctive norms: The proportions of supportive norms were similar in peer relatives and friends/colleagues and both were about 50%, a value higher than that in the inquired firstborn children (Table 2). Presumably, Newson et al. (2005) mainly considered common genetic interests between kin in reproduction, but did not give sufficient attention to possible conflicts (e.g., Ji et al. 2013; Liu et al. 2017; Sear 2018; Du et al. 2023). To conclude, our study does not fully support either theoretically or empirically the pronatal kin hypothesis for fertility decline in the demographic transition.

Fourthly, the analysis of the 2×2 cross of kin vs. non-kin in one dimension with injunctive norm vs. descriptive norm in the other one, illustrates cultural evolution of Chinese women's fertility and further suggests the necessity of multi-approach to low fertility. At the time of baseline survey, two years had passed since the implementation of universal two-child policy in 2016 and a few mothers had been surrounded by two-child peers (Table 2). It is not strange that mothers then made second-birth decisions not completely by asocial learning but partly by referring to peers; in other words, horizontal transmission, through frequency-dependent or conformist bias, played a role in diffusing the new two-child norm. Although in a reverse direction, such diffusion was similar as that of fertility-limitation norms during the demographic transition (Colleran 2016). Notice that the significance and importance of number of sibling in predicting fertility behaviour might not be due to vertical cultural transmission; rather, the negative effect could be due to sibling competition for grandparental help in child care (Table 3; Figure 4; see also Zhang et al. 2022).

The above findings lead to some preliminary conclusions on the relevance and relative explanatory power of different evolutionary approaches to reproductive behaviour in modern

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societies. If we see fertility attitudes partly stemmed from evolved psychology and collective decision-making pattern was the response to (ecological) constraints from other stakeholders, our study essentially support evolutionary anthropologists' argument that evolutionary psychology, behavioural ecology and cultural evolution all make sense for understanding the fertility transition (Borgerhoff Mulder 1998; Smith 2000; Newson et al. 2005; Shenk et al. 2013; Colleran 2016; Mattison et al. 2018; Micheletti et al. 2022; Brown and Lala 2024). In the current study, there was a rough correspondence between three approaches and the levels of their focus: evolutionary psychology—individuals (e.g., attitudes); behavioural ecology—family level (e.g., offspring quality-quantity trade-off; economic or housing constraints on reproduction; constraints from other stakeholders especially nuclear-family members on reproduction); cultural evolution—social-network or social level (e.g., norms of friends or colleagues). The dominance analysis preliminarily suggests that **the behavioural ecology approach has the largest explanatory power for mother's fertility behaviour in the context, followed by evolutionary psychology and cultural evolution**.

Finally, the findings in this study have clear implications for population policies and help to solve the debate mentioned at the beginning: What are really important factors underlying low-fertility behaviour? Both perspectives—ideational factors vs. constraints in raising children—make some sense; however, neither one is inclusive. On the one hand, mother's own fertility ideology was just one of the important predictors of her fertility intention and it cannot explain most of variance either in fertility intention or in fertility behaviour. On the other hand, the frequently mentioned constraints in raising children were also not the most important predictors of fertility intentions; e.g., the firstborn child's attitude explained more variance, but it has not received sufficient attention from either scholars or policy-makers. It is reasonable to say that the biases in two perspectives all stem from omitting-variable problem, which further illustrates the merit of integrating three evolutionary approaches to low fertility issue and its counter-measures. Seeing from such an integrated perspective, all the important factors relevant to either fertility intentions or fertility behaviour should be given sufficient attention; only in this way, so-called fertility-friendly policies can be said both inclusive and potentially effective in easing the challenge of the lowest-low fertility.

There are some limitations with the current study. Firstly, our sample was not large, which could have limited the power of statistical inferences, e.g., that in testing the hypothesis H4a. Secondly, looking from a long-term perspective, a 2.5-year follow-up study is essentially a cross-sectional one; thus, it is hard to capture the dynamics of relative importance of fertility-related factors with time. The fertility transition—either to lower fertility or to higher fertility—has three different stages, i.e., origin, spread and maintenance (Colleran 2016); as a result, some factors—e.g., the family planning norm—that have only a limited effect on fertility at the stage of origin might have a major effect at later stages (Kramer et al. 2021). Hopefully, future studies can expand our findings, based on longitudinal data across a longer period.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org.

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