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"Gold Miss" or "Earthy Mom"? Evidence from Thailand

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Abstract

This paper investigates the impact of Thai women’s education on their marriage behavior and fertility. It first uses the panel data set from the Socio-Economic Survey to estimate the effect of education on the marriage market. The result from applying the individual fixed effect estimation indicates that obtaining a university degree decreases the probability of women’s marriage, emphasizing the rise of the “Gold Miss” phenomenon in Thailand. The cross-sectional data set from the Labor Force Survey examines the effect of education on fertility. By applying both the instrumental variable using the compulsory education reform as an instrument and pseudo-panel approaches to take into account the endogeneity of schooling, the result shows that education causally reduces fertility, which provides a convincing sequential explanation for the dramatic decline in fertility in Thailand.

Keywords: Gold Miss; Marriage; Fertility; Education; Instrumental Variable; Pseudo-panel

JEL Classification: J11; J12; J13; C23; C26; D19; Z10

1. Introduction

Population aging is a serious concern for the government and society. The continuous decline in fertility and increase in single and childless women have accelerated demographic changes. In developing countries, the fertility rates tend to be higher than in developed countries due to a lack of access to contraceptives as well as the labor force demand and traditional norms (children as parents' old-age insurance). Though the top ten countries with the lowest fertility have been developed countries, primarily in Europe, over the last few decades, after 2010, nearly half of these have been Asian (United Nation 2015). In 2017, Thailand became among the bottom ten countries with average fertility rate (Global Burden Disease 2018).

According to the Institute of Population and Social Research, the average number of births per Thai woman was six in 1964 and this number dropped to less than two in 2014, which is the fastest decline in all of Southeast Asia. Besides, the number of elderly people aged 60 years and above increased by more than seven times, from 1.4 million to 10.7 million, between 1960 and 2015 (United Nation 2015). The remarkable decline of fertility, also associated with higher elderly populations due to longer life spans, makes Thai society an aging one.

Research has demonstrated that education has played a significant role in the decline of fertility by increasing the women's age at marriage, enhancing the tie to the labor market, and changing attitudes toward childbearing. It has been acknowledged that fertility is closely associated with the marriage pattern: The reproductive time span shortens with higher marriage age for women (Coale 1992). Studies have thus found a

strong inverse relationship between marriage age and total fertility rate (Cochrane and Zachariah 1983, Choudhary 1984).

Higher-educated women tend to delay marriage, a common global phenomenon. A majority of these women on this "marriage strike" are highly educated, holding a university degree. In developed Asia, this group of single women with high socioeconomic status and education attainment, called "Gold Miss," [1] has been characterized differently compared with its Western counterparts, where women not only delay marriage, but remain single.

Under the condition that Asian immigrants in the US are culturally similar to their native counterparts in Asia, Hwang (2016) attributes the "Gold Miss" phenomenon to the rapid growth of economy associated with the intergenerational transmission of gender attitudes. As gender norms still treat women as the main provider of childcare and household labor, higher-educated women who prioritize their career development or personal life, rather than marriage or family, tend to stay single. Inspired by this argument, our study provides evidence on whether this phenomenon applies to a rapidly developing country in Asia with strong cultural background.

Previous studies have also pointed a negative relationship between the female education and fertility (e.g. Strauss and Thomas 1995; Schultz 1998; Luz and Ke 2011; Fort et al. 2016). With higher education, the opportunity cost for women to bear and rear children will increase (Becker 1981). Education also helps to improve child

[1] The term was first defined by Koreans as unmarried women with high socioeconomic status and education level.

health and lower mortality rates, encouraging fewer birth (Thomas et al 1991; Lam and Duryea 1999).

In this study, we use two datasets: the Labor Force Survey (LFS) of Thailand (1985–2017) and Socio-Economic Survey (SES) (2005–2012). We first estimate the effect of education on the marriage market using the SES panel data, focusing on the marriage probability of women with different education levels. The results under fixed effect suggest that obtaining a university degree decreases the probability of marriage for women, while lower education levels (primary and secondary) increase this probability.

As the SES panel data cover a short period and do not provide information on year of schooling, we examine the effect of education on fertility using both the instrumental variable (IV) and pseudo-panel approaches by incorporating the LFS data. We also consider the bias caused by omitted factors as well as the limitation of longitudinal data. The results under both approaches show that education causally reduces fertility, a conclusion that is consistent with previous findings in the literature (e.g. Cygan-Rehm and Maeder 2013; Fort et al. 2016) [2].

Using the compulsory education reform in Thailand, implemented in 1978 as an instrument to solve the endogeneity of schooling, this study provides a convincing sequential explanation for the dramatic decline in fertility by considering the effect of education on both marriage behavior and fertility outcomes of women. Higher

[2] In contrast to the negative impact, other studies have suggested that education lowers the fertility for teenage mothers, but has negligible impact on completed fertility (e.g. Black et al. 2008; Monstad et al. 2008; Geruso and Royer 2014). Braakmann (2011) finds a positive relationship between education and fertility.

education has produced more single women in the market, who either delay marriage or intentionally remain single (the "Gold Miss" phenomenon), an aspect neglected by previous research. Our detailed analysis on the potential channel, in particular the marriage behavior of women, causing a decline in fertility through the increase in education supports the result that education reduces fertility.

The remaining paper is organized as follows: Section 2 provides the background on Thailand; section 3 is the literature review. Section 4 introduces the data source and section 5 presents our empirical approaches. Section 6 shows and discusses the results. We perform the robustness checks in section 7, and section 8 concludes the paper.

2. Background and the reform

2.1 Thailand background

What drives the dramatic decline of fertility in Thailand? Why do more women avoid childbirth? There are several possible factors that cause women to reduce the fertility. First, the cost of childrearing may delay or even cancel the decision of couples to have children. According to NESDB (2011), the average cost of parents to raise a child from 0 to 18 years is 876,872 baht, which does not include the subsidies from government. That is, the couple must spend more than 4,000 baht per month for one child until this child becomes an adult—This cost accounts for over 15% of the average income of the household, without taking any private education or extra investments into consideration. In addition, Liao and Paweenawat (2019) find a wage

penalty for parenthood in Thailand, which incurs even higher financial pressure for those who become parents.

Second, the younger generations with higher education have different attitudes toward marriage and childbearing. They are likely to prioritize their career development or personal freedom. According to the National Data of Thailand (NESDB 2015), the mean age for first marriage for women was 22.1 in 1960 and increased to 23.7 in 2010. A study by Samutachak and Darawuttimaprakorn (2014) reports that most of their respondents (student age 17 to 22) in the survey placed higher education, work, or material needs, such as buying a house, ahead of childbearing. Another survey (Isarabhakdi 2014) for young people aged 15 to 24 years finds that 14% of the respondents do not want children, because of loss of freedom, higher pressure, and burdens. Third, lack of support and protection for parents from the government and society, such as the shortage of public childcare, working flexibility, and workplace discrimination, decrease the desire for childbearing.

Using the LFS, we first present an increase in education attainments for women overtime. Figure 1 (A) shows the increase of year of schooling and Figure 1 (B) shows the increase of share of higher educational degree for birth cohorts. The share of primary level drops over 30% for post-1970 cohorts.

Figure 2 shows the percentage of single women age between 25 to 34 years by three education levels born during 1951 to 1992[3]. There are only less than 15% of single

[3] In the Thailand context, the age range tends to capture the recent development and marriage delay, considering the average age of first marriage mentioned earlier. We assign the birth year into eight birth cohorts. Each contains the average value of five birth years, or example cohort 1951 includes individuals born between 1951 to 1955; the cohort 1986 includes those born between 1986 to 1992.

women among those with primary education, while it is higher for those with secondary level and much higher for university level. The percentage of higher-educated single women has increased nearly 20% across the birth cohorts. It indicates that, with higher education, the percentage of single women increases. Figure 3 shows the average cohort fertility of women age between 25–34 years[4], which has decreased in all of the three education groups. The gap of fertility between higher-educated women and lower-educated women has not converged. This situation is similar to the findings in other countries (Martin 1995; Skirbekk 2008).

Figure 4 shows the percentage of single women with university or higher age over 35, defined as the "Gold Miss" group. As suggested by Hwang (2016), the age 35 is young enough to capture the recent development and old enough to distinguish between "marriage delay" or "marriage forgone." The percentage of "Gold Miss" in Thailand has risen by over 4% across the cohorts. While "Gold Miss" is a relatively small group and a recent phenomenon mainly driven by economic developments and increase in education, the increase in education produces more single women in their prime ages that decreases fertility. Generally, with the increase in female education attainments over time, more women choose to stay single and have less or no children.

[4] The similar trend shows under the sample age of 35 to 45 years and of 40 years. After age 35, the fertility rate of Thai women drops sharply (The Public Health Statistics 2014).

2.2 The compulsory reform

The Thai government extended compulsory education from four to six years in 1978, requiring children at the age of 8 to enroll in primary education, in compliance with the Education Development Plan (Knodel 1978; Nakavachara 2010). According to Sangnapaboworn (2007), the 1978 reform has four categories of contents. First, the Skill Enrichment Groups cover learning abilities in Thai languages and mathematics. Second, the Life Experience Promoting Group deals with problem solving in life and society, and needs for a better life. Third, the Character-Building Group develops learners' personality. Fourth, the Work and Occupational Fundamentals enhance general ability in occupational practice.

The average number of years of schooling thus increased significantly after the reform. Thailand reached almost universal primary education in the late 1980s (Hawley 2004). In 1961, only 77% of the primary school-aged children enrolled in school, while by 1990, 99% were enrolled. The secondary school enrolment also grew from 4% in 1961 to 49% in 1994; higher education enrolment also increased from 1.3% to 22% during this time (Hawley 2004).

3. Literature review

The effect of education on marriage has been addressed as an important channel for fertility with respect to the education effect (Fort et al. 2016). Previous research has suggested the difficulties of analyzing the effect of female education on both the marriage outcome and the fertility, causing by substantial bias from unobserved

heterogeneity. For marriage outcomes, this unobserved heterogeneity might arise from the joint determination of marriage and education or selection into marriage. As we do not observe the intelligence of women, higher intelligence may increase the education attainments of women and also improve marriage prospects, which generates an upward bias. Alternatively, women's attractiveness may be positively associated with the probability of marriage. Attractive women expect marriage with high-income men, and therefore lower their investment in education, which generates a downward bias (Lefgren and McIntyre 2006). Liao and Paweenawat (2018) similarly find a trend of educational hypergamy in Thailand, where wives are less educated than their husbands. Thus, we employ the panel estimation with the individual fixed effects to correct for this bias.

Studies that have focused on the effect of education on marriage market have yielded different results across countries. Currie and Moretti (2003) find that higher education increases the probability of women's marriage in the US; they used two approaches to account for unobserved characteristics of women. One is by constructing the panel data; the other is by using the availability of women's county in the 17^{th} year as the instrument for education. Leo (2004) suggests that the effect of education on marriage is insignificant in the US; the author used compulsory schooling reform as the instrument. This insignificant result is also obtained by Lefgren and McIntyre (2006) for the US and Braakmann (2011) and Anderberg and Zhu (2014) for the UK.

Despite the literature on the causal impact of one more year of schooling on women's marriage outcomes (e.g., Behrman et. al 2002; Lefgren and McIntyre 2006) or the educational positive assortative mating (e.g., Becker 1991; Weiss 1997; Pencavel

1999), few have fully explored the effect of different education levels on women's choice of marriage, especially in developing countries.

Theoretically, the effect of education on fertility depends on the joint action of income effects and substitution effects. First, education can affect fertility through the marriage market. With higher education, under positive assortative mating, women tend to find an appropriate partner, increasing income through the spouse-related multiplier effect (Behrman and Rosenzweig 2002, Cygan-Rehm and Mader 2013). With higher earning through the spouse, the income effect may dominate the substitution effect, which increases the fertility. In addition, more education makes women more open-minded, knowledgeable, and flexible, which increases their chances of marriage in the mating market. Lefgren and McIntyre (2006) suggest that college completion is a strong predictor for marital status.

Second, education increases the opportunity costs of childbearing and childrearing, indicating that the substitution effect should decrease fertility. Education also increases permanent income, suggesting this income effect would increase fertility as families can afford more children (Becker et al. 1960). The income effect may be weakened if parents invest more in the quality of rearing their children (Becker and Lewis 1973). Moreover, education increases the bargaining power of women in the marriage (Mason 1986) and improves the knowledge of contraception (Rosenzweig and Schultz 1989), which may lower the probability of childbearing.

Similar to the estimation of education on marriage, the possible reverse causality between education and fertility and the unobserved characteristics (e.g., family

preferences, individual ability, or community resources, which is associated with both schooling and fertility choice) bias the results. Recent studies have addressed these problems by instrumenting for education, which requires that the observed variation determining women's education attainments does not correlate with fertility. We use the compulsory schooling reform in Thailand as the instrument for education, which has been used by several recent studies (e.g. Black et al. 2008; Geruso and Royer 2014; Kan and Lee 2018). In addition, we complement the traditional IV approach with a pseudo-panel approach considering the lack of longitudinal data, especially in developing countries.

For the effect of women's education on fertility, Black et al. (2008) suggest a reduction of teenage birth because of the increase in education in Norway and the US. Geruso and Royer (2014) suggest that education reduces teen pregnancies without affecting the complete fertility in the UK. Cygan-Rehm and Maeder (2013) find a significant negative relationship between education and fertility using the mandatory reform of compulsory schooling in West Germany as the instrument. Fort et al. (2016) also find a negative relationship of education and fertility in England, but this result does not stand for Continental Europe.

4. Data and variables

We first use the SES panel to examine the effect of obtaining university degree or higher on the marriage outcomes (single status vs. others, include married, widow, divorce and separate) of women. The data were developed by the National Statistical

Office (NSO) of Thailand for 2005, 2006, 2007, 2010, and 2012, which provide the household and individual information.

The individuals are assigned to three mutually exclusive education groups: primary level (with none, some, or completed primary education); secondary level (with some, or completed secondary education); and university level (with some, completed, or higher university level education). The drawback of the SES panel is that it does not report exact years of schooling, only the level of education, with a relatively small sample size.

Table 1 presents that marriage rate of women in three education levels in different time periods for the ages between 25 to 34 years. The marriage rate is highest for primary level and decreases with higher level of education. For university level, only around 40% of women married at ages 25 to 34 years. Table 2 reports the mean of key variables in our sample for 2005 to 2012. Here, 54.7% of women obtained primary education, 20.3% had secondary education, and 25% had university education or higher. The average number of children is 1.05 and 24.7% of the sample is unmarried.

Considering the drawbacks of the SES panel mentioned above, we use the annual LFS of Thailand from 1985 to 2017, conducted by the NSO, as the primary data source to examine the relationship between women's education and fertility. Our sample is restricted to women at ages 35 to 45[5]. As the children in the household may not be the women's biological children, overestimating the fertility, we only include nuclear

[5] The Public Health Statistics (2014) show that the fertility rate of Thai women is highest among those women with ages between 20 to 29 years during 1990 to 2014, but gradually decreases with the age growth. For age group 35 to 39, the fertility rate drops to around 3%, and after 40 years, it is less than 1%.

households to obtain a large majority of children belonging to the household head. To mitigate the problem of sampling, we re-estimate the model with only the sample age 40. Table 3 shows the summary statistics for LFS separated into whether the women are affected by the reform or not. Women affected by the reform are born later than their counterparts. As expected, those affected by the reform obtained a higher level of education and have fewer children. For those affected by the reform, more than half obtained secondary or higher education, compared with their counterparts, the 70% in the primary level.

5. Methodology

5.1 Effect of education attainment on marriage outcomes

With the binary outcome of marriage, we employ the fixed effect logit model (FE-logit) to correct for the individual heterogeneity. The probability that women choose to get married is as follows:

$$\Pr(y_{it} = 1 | z_{it}, x_{it}, \beta, \gamma, \alpha_i) = \Lambda(\alpha_i + z_{it}\beta + x_{it}\gamma) \quad (1)$$

where y_{it} is an indicator that equals 1 if woman *i* is married at period *t* and 0 otherwise. z_{it} is a dummy variable, indicating the women obtained university degree or higher (or obtained secondary level; primary level), thus taking the value of 1 and 0 otherwise; x_{it} is a set of control variables including age, age square, and regional dummies. α_i is the individual specific effects, the unobserved heterogeneity in individual preferences for marriage. β represents the impact of having a university degree or higher on marriage. Thus,

$\Lambda(\theta) = \exp(\theta)/[1 + \exp(\theta)]$.

5.2 The effect of education on fertility

5.2.1 Instrumental variable approach

We consider the following models for identifying the causal effect of education on fertility:

$$y_i = \beta_0 + \beta_1 S_i + \beta_2 X_i + \varepsilon_i \ (2)$$

$$S_i = \alpha_1 R_i + \alpha_2 X_i + \varphi_i \ (3)$$

where y_i is the dependent variable representing woman *i*'s fertility. S_i is the year of schooling, and X_i is a vector of controlling variables, including marital status and five regional dummies. ε_i is the random error term. The ordinary least squares (OLS) estimates for equation (2) are likely to be biased because of the unobserved characteristics in ε_i, such as the individual preferences, which correlate with both fertility and education. Therefore, we use the exogenous change in education induced by the compulsory school reform as the instruments to identify the effect of education on fertility.

Applying the 2SLS approach, we first estimate the year of schooling, S_i, as a function of a dummy variable (R_i), indicating the reform status. If it equals to 1, the individual is affected by the reform, but 0 otherwise. Then, in the second stage (2), using the predicted value from (3), we obtain the IV estimates[6].

The basic estimation contains asymmetric windows of birth cohorts around the first cohort that was affected by the reform. The result may be affected by the sample

[6] We performed the test of endogeneity of education, the appropriateness of the instrument and weak instrument, indicating the instrument is valid.

selection criteria. Previous studies have suggested that despite the drawback of reducing the sample size, using the symmetric window guarantees similar sample size in the treatment and excludes the effects of other potential reforms as well as reduces the effects of unaccounted confounders (Monstad et al. 2008; Brunello et al 2009; Brunello et al 2013; Cygan-Rehm and Maeder 2013; Fort et al. 2016). Thus, we also estimate the model using individuals born up to ten years before and after the reform and up to five years before and after the reform.

5.2.2 Pseudo-panel approach

The approach under the RCS data is limited in correcting the unobserved heterogeneity across individuals, but the lack of longitudinal data, especially in developing countries, motivates us to use an alternative approach to solve the problem. To check the validity of the 2SLS estimates, we construct a pseudo-panel using the LFS to eliminate individual heterogeneity. According to Deaton (1985), by dividing the sample into cohorts basing on a time-invariant characteristics for individuals, like year of birth, we can estimate a fixed effect model from RCS. Our pseudo-panel is based on birth year and age, interacting with the time periods (Blundell, Duncan and Meghir 1998; Banks, Blundell and Preston 1994). We pool the data from eight- of five-year birth cohorts and 31 survey years for 248 cohort-year observations.

The observations in the pseudo panel are the average of each cohort members. Thus,

$$\overline{y_{ct}} = \beta_0 + \beta_1 \overline{S_{ct}} + \beta_2 \overline{X_{ct}} + \overline{\alpha_{ct}} + \overline{\varepsilon_{ct}} \quad (4)$$

where $\overline{y_{ct}}$ is the mean of woman's fertility in cohort *c* at time *t*. $\overline{\alpha_{ct}}$ is the average fixed effect for the women in cohort *c* at time *t*. It is possible that $\overline{\alpha_{ct}}$ may correlate with $\overline{S_{ct}}$ in small samples that yield biased results.

Verbeek and Nijman (1992) argue that the small sample bias will be substantial. However, when the cohort sizes are large enough—over 100—the sample bias will be small. Devereux (2007) also suggests thousands of observations needed per group to have a small bias.

The literature on estimating pseudo-panel data from RCS is usually characterized to three main asymptotic sequences by Verbeek (2007). Consistency in this paper refers to Type 1 asymptotics, with large individual observations, fixed number of cohorts, and large number of observations per cohort (Moffit 1993; Verbeek and Vella 2005). We choose Type 1 because it is the most suitable asymptotics for our data and it is a convenient choice to obtain a consistent estimator. As $\overline{\alpha_{ct}} \approx \alpha_c$, we obtain

$$\overline{y_{ct}} = \beta_0 + \beta_1 \overline{S_{ct}} + \beta_2 \overline{X_{ct}} + \alpha_c + \overline{\varepsilon_{ct}} \quad (5)$$

The weighted least square (WLS)[7] is applied to account for the heteroscedasticity of different observations in each cohort (Pencavel 1998; Paweenawat and McNown 2018).

Furthermore, according to Warunsiri and McNown (2010), the sample bias in (4) can be corrected by using IV estimation (WLS-IV), which is comparable to the estimates in (5). Therefore, we also estimate the pseudo-panel data with the IV approach. We rewrite the first stage of 2SLS estimation (3) under the pseudo-panel estimation:

[7] The weights are the square root of number of the sample size in each cohort (Dargay 2007).

$$\overline{S_{ct}} = \alpha_1 \overline{R_{ct}} + \alpha_2 \overline{X_{ct}} + \overline{\varphi_{ct}} \quad (6)$$

where $\overline{R_{ct}}$ is the cohort mean of R_i. We compare theses alternatives (pseudo-panel with fixed effects and pseudo-panel with IV) to the basic IV estimation to see the effects of using the different methods to control for the individual heterogeneity.

6. Results

6.1 The effect of high education attainments on marriage outcomes

Table 4 shows the results of university degree or higher attainments on the marriage outcomes using logit model with fixed effect. Besides the coefficients, we present the predicted probability to facilitate the interpretation. There exists a statistically significant negative impact of obtaining university degree or higher on the choice of getting married for women, while a positive impact of obtaining secondary and primary education. The predicted probability indicates that the probability for women's marriage is 28.7%. The result confirms our hypothesis that high education discourages women from marriage, which acts as an alternative channel to reduce the fertility.

The results of education on marriage from previous studies vary by countries. For example, Fort et al. (2016) find that education increases the probability of women's marriage in Continental Europe, but decreases in England, after taking the endogeneity into consideration. Kan and Lee (2018) suggest that education does not have any causal effect on marriage in Taiwan.

It should be noticed that the negative result supports the idea that, with the increase of education attainment of women, the “Gold Miss” phenomenon in Thailand is on the rise (Figure 3). As predicted by Hwang (2016), this phenomenon is more likely to arise in the economies that have experienced rapid growth. Although this group currently does not account for a large percentage of the population, with limited contribution to the decline of fertility overall, this group should be the focus of observers because, unlike other women who delay their marriage, the “Gold Miss” intentionally avoids marriage and does not want children. With the development and further increase in education, the rise of the “Gold Miss” may deepen the fertility problem.

6.2 The effect of education on fertility

In Table 5, both the OLS and IV estimates indicate a negative association between year of schooling and fertility under different samples. After considering the possible selection into education, the magnitude of the effect becomes larger under all the specifications. The negative results are robust under different selection of birth cohorts, corresponding with the symmetric window of the reform (five-year window and ten-year window). Our main result for the full sample age of 35 to 45 years under the IV approach suggests that one more year of schooling reduces the fertility by 0.081, which is robust under sample age 40 (-0.103).

Table 6 presents the pseudo-panel results of the effect of year of schooling on the fertility. Comparing with Table 5, the WLS and WLS-IV results are also larger than the OLS regressions with individual data. This implies that the individual or cohort-

specific unobserved characteristics incur a downward bias of the effect of education on fertility. The magnitude of the bias is substantial with the effect being underestimated by 70% to 78% compared with using OLS with individual data to WLS/WLS-IV with pseudo-panel data. Comparing the IV estimates with individual data and IV with pseudo-panel data, using the individual data also causes a downward bias (comparing -0.081 to -0.137). Generally, the pseudo-panel and IV approaches produce similar results, suggesting the success of correcting the bias caused by the unobservable heterogeneity in the individual data.

The pseudo-panel approach captures the changes of fertility behavior across generations and time periods. Younger generations with higher education tend to have fewer children on average. Besides the channels, such as contraceptive use and labor force, attitudes toward childbearing have changed among generations in Thailand. For example, Samutachak and Darawuttimaprakorn (2014) provide evidence to show that Generation Y in Thailand prioritizes work and material achievement, which results in delaying childbearing, and thus a reduction in fertility. Moreover, younger generations in Thailand have a greater acceptance toward lesbian, gay, bisexual, and transgender relations than older generations (Isarabhakdi, 2015).

Our finding is consistent with previous studies. For example, Fort et al. (2016) find that the effect of education on fertility is much larger under 2SLS than simple OLS in both England and Continental Europe. Similarly, Cygan-Rehm and Maeder (2013) find that the effect of education on fertility under OLS is around -0.02 and under IV is around -0.15, and the downward bias shows in different specifications.

The negative relationship between year of schooling and the unobservable individual preferences generate the downward bias in our study. Women with large family-size preference tend to reduce education attainment to get married and have children. Alternatively, education optimization for women motivated by greater financial independence or earlier career may reduce schooling and increase work experience. Similarly, women who have low education expectations tend to decrease schooling time, and get married earlier to attain motherhood (Upchurch et al. 2002).

7. Robustness check

As the number of children cannot be a negative integer, we employ the count data regression using the Poisson model (Brand and Davis 2011; Fort et al. 2016). The model functions under the assumption that the education effect is homogeneous, corresponding to the OLS estimates. The Poisson results are presented in Table 4, which are similar to the OLS results. They evidence a downward bias caused by the unobserved heterogeneity. The regression confirms the previous finding that the effect of education is negative on fertility in all specifications.

In addition to the LFS, we show that the negative impact of education on fertility is robust under the SES panel, controlling for the cohort fixed effects. As the SES does not provide year of schooling, we explore the effect of education level and university degree dummies on fertility. The education levels in the SES are classified into eight categories in ascending order: 1=below primary; 2=primary school; 3=secondary school; 4=tertiary school; 5=vocational school; 6=bachelor's degree; 7=master's degree; and 8=doctorate. Our results are limited in terms of interpretation when we

only use these education categories. Thus, we also use the dummy variable to indicate whether the individual obtained university degree or higher to estimate the effect of higher education on the fertility.

Table 7 presents the effect of education on fertility using the SES panel with two different dependent variables related to education under the fixed-effect regression with the instrumental variable (FE-IV). Both the results show a negative effect of education on fertility, confirming our main results.

8. Conclusion

In this study, we examined the impact of women's education on fertility. We first discussed the effect of different education attainment on women's marriage behavior using the SES panel. The results show that obtaining university degree or higher have a negative effect on marriage, while secondary and primary level have a positive effect on marriage.

Next, we studied the causal effect of year of schooling on fertility using the LFS from 1985 to 2017. We exploited the 1978 Compulsory Reform in Thailand as the exogenous variation in education. We then ran the estimations under individual and pseudo-panel data. Our results show a negative relationship between year of schooling and fertility. A downward bias is shown to exist in the estimations based on individual data, not controlling for individual characteristics such as family preferences and education propensity. Several specifications and robustness tests were presented. Based on our results, one additional year of schooling reduces the fertility by 0.08 to

0.14. Our estimation structure was built despite limited data availability, which contributes to the study in developing countries.

Although we have witnessed the success of policies in promoting women's education, our study presents several matters that must be prioritized. First, higher-educated women tend to stay single and lower-educated women tend marry earlier. In recent decades, the "Gold Miss" phenomenon has grown in developed Asian countries such as Korea, Japan, and Singapore, which also have strong traditional culture and are undergoing rapid development (Hwang 2016). Our study shows that Thailand, having made remarkable progress in social and economic development recently, has seen a dramatic decline in fertility as well as a rise in the "Gold Miss" phenomenon.

Second, the effect of education on fertility varies by country and institutional settings, which may affect women's opportunity cost of childbearing. Our negative results may reflect a high opportunity cost of childbearing for women under the labor market condition or traditional cultures, such as flexible working arrangements not commonly offered in Thailand (Global Workforce Roundtable 2007), shortage in public childcare, and the traditional role of women as managers of household work. The World Bank's (2019) Having Children indicator, which includes factors likely to affect women's economic decision to start a family (such as laws on maternity and parental leave), ranks Thailand 20 out of 100. Thus, the government should provide more assistance to women for childbearing and childrearing.

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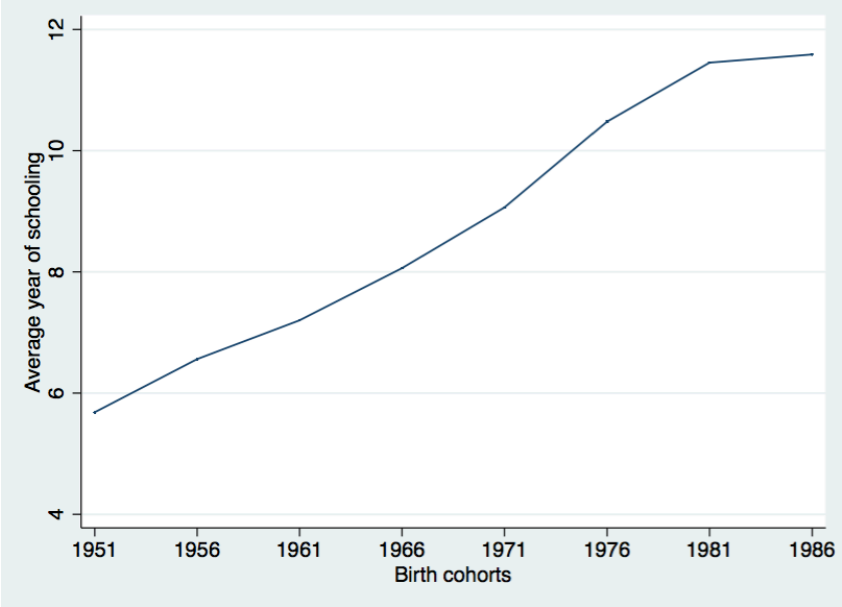
Figure 1. The education attainments of women by year of schooling and degree

A) Average year of schooling



B) The share of graduates by education levels

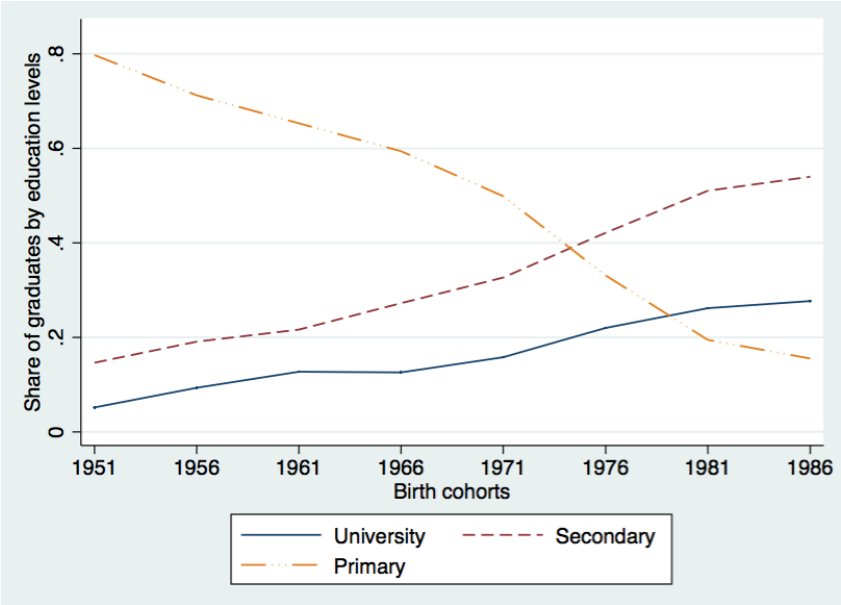


Figure 2. The percentage of single women age between 25 to 34 by education levels

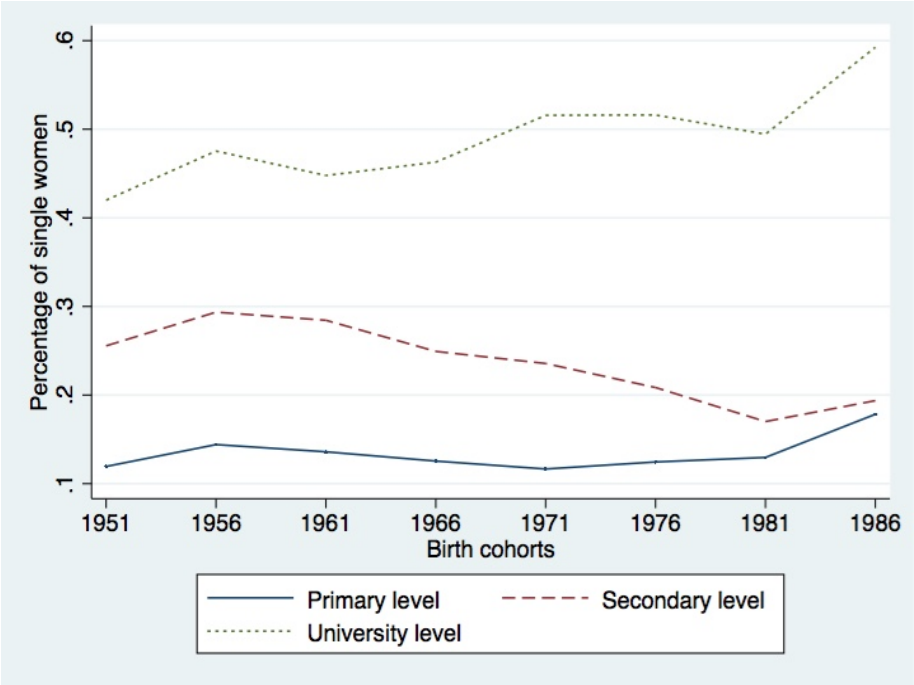


Figure 3. The average cohort fertility of women age between 25 to 34 by education levels

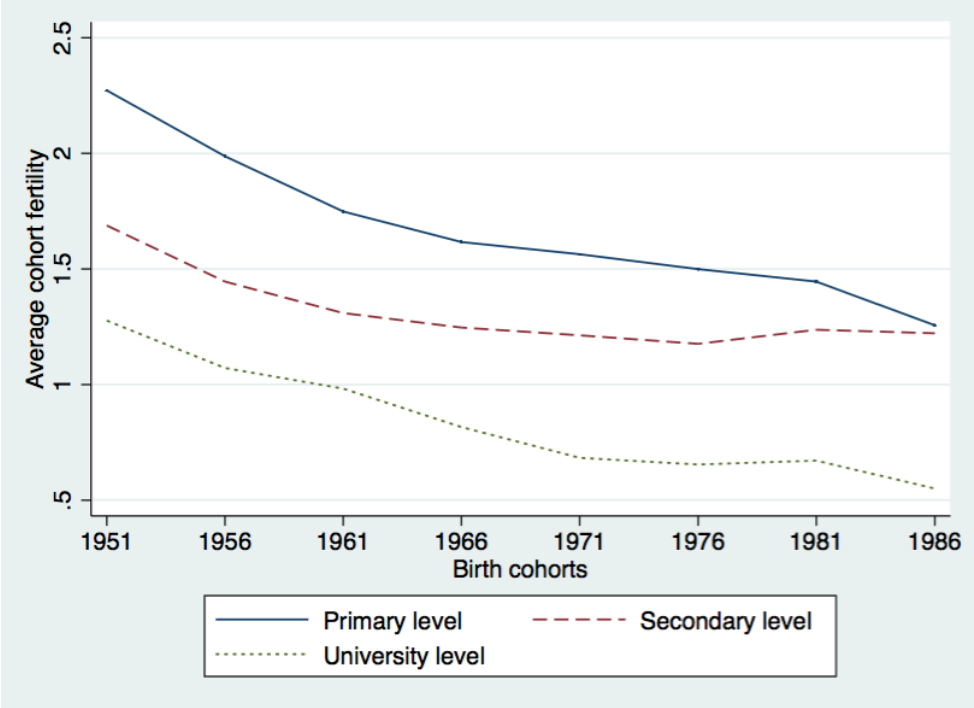


Figure 4. The percentage of single women with university or higher age over 35 ("Gold Miss" phenomenon)

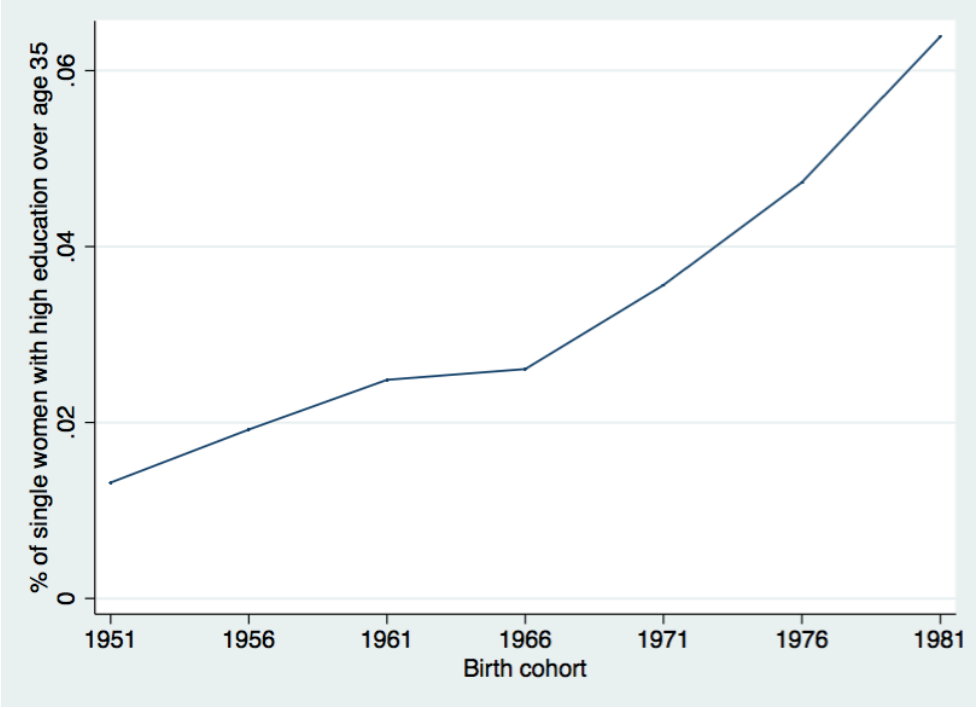


Table 1. Marriage rate of women by education levels using SES

	2005	2006	2007	2010	2012
All	0.739	0.735	0.712	0.674	0.642
University level	0.417	0.418	0.399	0.407	0.408
Secondary level	0.741	0.785	0.785	0.796	0.768
Primary level	0.881	0.887	0.873	0.838	0.858

Table 2. Summary statistics for SES panel	
Education level:	
Primary level	0.547
Secondary level	0.203
University level	0.250
No. of children	1.050
Currently married	0.651
Never married	0.247
Observations	23,529

Table 3. Summary statistics for LFS

	Affected by the reform	Not affected by the reform
Year of schooling	9.210	6.688
Primary level	0.481	0.709
Secondary level	0.337	0.192
University level	0.153	0.094
No. of children	1.675	1.923
Observations	145,076	339,429

Table 4. The effect of education attainments on marriage outcome (FE-logit)

	University level	Secondary level	Primary level
The effect of obtaining the level of education on marriage outcome	-1.094***	0.471***	0.553**
	(0.208)	(0.170)	(0.225)
Age	1.560***	1.563***	1.602***
	(0.074)	(0.074)	(0.075)
Age square	-0.0172***	-0.0173***	-0.0177***
	(0.001)	(0.001)	(0.001)
Predicted probability of getting married		0.2867	
Observations		3,892	

Standard errors in parentheses

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

Table 5. The effect of the year of schooling on the fertility

	Sample1 (age 35 to 45)			Sample2 (age 40)		
	5-year window	10-year window	Full sample	5-year window	10-year window	Full sample
OLS	-0.0145***	-0.0151***	-0.0300***	-0.0104***	-0.0135***	-0.0301***
	(0.001)	(0.000)	(0.000)	(0.002)	(0.001)	(0.001)
IV	-0.0214***	-0.0373***	-0.0811***	-0.0484***	-0.0604***	-0.103***
	(0.002)	(0.002)	(0.001)	(0.008)	(0.007)	(0.004)
Poisson	-0.00824***	-0.00852***	-0.0162***	-0.00596***	-0.00755***	-0.0160***
	(0.001)	(0.000)	(0.000)	(0.002)	(0.001)	(0.001)
Observations	89,323	152,631	317,200	10,485	17,667	36,032

Standard errors in parentheses

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

Table 6. Pseudo panel results: Effect of education on fertility

WLS	-0.0932***
	(0.008)
WLS-IV	-0.137***
	(0.020)
Cohort-year observations	248
Individual observations per cohort:	
-Max	83,761
-Min	326

Standard errors in parentheses

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

Table 7. The effect of education on fertility using SES panel using education levels and university degree attainments

	Education levels	University degree or higher
FE-IV	-0.316***	-1.594**
	(0.121)	(0.780)
Observations	1,307	1,334

Standard errors in parentheses

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