Family Planning and Fertility Behavior: Evidence from Twentieth Century Malaysia

Kimberly Singer Babiarz, Jiwon Lee, Grant Miller, Tey Nai Peng, and Christine Valente

Abstract

There is longstanding debate about the contribution of family planning programs to fertility decline. Studying the staggered introduction of family planning across Malaysia during the 1960s and 1970s, we find modest responses in fertility behavior. Higher (but not lower) parity birth hazards declined by one-quarter—but imply only a 5 percent decline in the overall annual probability of birth. Age at marriage rose by 0.48 years, but birth spacing conditional on this did not otherwise change. Overall, Malaysia's total fertility rate declined by about one quarter birth under family planning, explaining only about 10 percent of the national fertility decline between 1960 and 1988. Our findings are consistent with growing evidence that global fertility decline is predominantly due to underlying changes in the demand for children.

JEL Codes: J12, J13

Center for Global Development
www.cgdev.org

Working Paper 470
December 2017

Family Planning and Fertility Behavior: Evidence from Twentieth Century Malaysia

Kimberly Singer Babiarz
Stanford University

Jiwon Lee
Pomona College

Grant Miller
Stanford University and NBER

Tey Nai Peng
University of Malaysia

Christine Valente
University of Bristol

Correspondence: Grant Miller, ngmiller@stanford.edu. We thank Sebastian Bauhoff and Ruth Levine for helpful comments and suggestions; the Center for Global Development for financial support; and the Malaysian National Family Planning Board for providing information about the history and rollout of family planning programs in Malaysia. Roxanne Oroxom and Hao Xue provided excellent research assistance. All errors are our own.

The Center for Global Development is grateful for contributions from the Bill & Melinda Gates Foundation in support of this work.

Kimberly Singer Babiarz, Jiwon Lee, Grant Miller, Tey Nai Peng, and Christine Valente. 2017. "Family Planning and Fertility Behavior: Evidence from Twentieth Century Malaysia." CGD Working Paper 470. Washington, DC: Center for Global Development. https://www.cgdev.org/publication/family-planning-and-fertility-behavior-evidence-twentieth-century-malaysia

Center for Global Development
2055 L Street NW
Washington, DC 20036

202.416.4000
(f) 202.416.4050

www.cgdev.org

Contents

1. Introduction

Slowing population growth in low- and middle-income countries became a central component of economic development strategies during the post-war era. High fertility rates were thought to trap families in cycles of poverty, dampen worker productivity, and hinder macroeconomic growth (Coale and Hoover, 1959, Ehrlich, 1968, NAS, 1971). As a result, family planning programs expanded rapidly in subsequent years, reaching more than 115 countries by the 1990s (Cleland et al., 2006). This expansion of contraceptive supply coincided with a dramatic decline in global fertility, and the most rapid declines generally occurred in Asia, where national total fertility rates fell by 25-50 percent between 1970 and 2000 (Casterline, 2001, Hirschman and Young, 2000, Lee, 2003).

Despite the general coincidence of family planning programs and fertility decline, academics have long debated the primary forces truly responsible for reductions in global fertility (Kaiser, 2011). One view largely credits family planning programs directly (Bongaarts et al., 1990, Robey et al., 1993). Others give them less credit, arguing that fertility decline is a response to economic development and industrialization (and associated changes in the demand for children), even if aided by family planning programs (Becker, 1960, Davis, 1967, Voigtlander and Voth, 2013). A recent review of more rigorous evaluations suggests that family planning programs are associated with a 5-35 percent reduction in children ever born—and that programs implemented on a large-scale to date have had more modest effects, explaining only about 10 percent of fertility decline in developing countries (Babiarz and Miller, 2016).

This paper provides new evidence on how fertility responds to family planning by studying the case of Malaysia. Malaysia's large-scale family planning programs provide an unusual opportunity for several reasons. First, Malaysia was one of the first low-income countries to provide modern contraceptives on a large scale, first introducing services in 1954 and establishing a National Family Planning Board in 1966 (Lee et al., 1973). Second, contraceptive prevalence rates in Malaysia rose rapidly during this same period, with the share of time woman who were at risk of pregnancy spent protected by modern contraceptive methods growing from just 3 percent in 1961 to 39 percent in 1975 (while total fertility rates fell from 6.2 to 4.3) (DaVanzo et al., 1986, DOSM, 2015). Third, the Malaysian Family Life Survey (MFLS), conducted in 1976 and again in 1988, provides detailed information about the timing of community-level family planning programs, detailed retrospective birth histories (including marriage and birth timing in years of program expansion), and nuanced information about household resource allocation reflecting women's status.

Specifically, we use the MFLS-2 to study changes along individual dimensions of fertility behavior in response to Malaysia's nationwide family planning scale-up, enabling us to then calculate the contribution of family planning to Malaysia's overall fertility decline. First, we use an event study framework to estimate changes in parity-specific birth hazards associated with family planning, which we also use to evaluate the identifying assumptions required by our other empirical strategies.[1] Second, we use duration models to estimate the relationship between family planning programs and age-specific risk of both marriage and first birth as well as the timing of subsequent births. Third, because we are unable to estimate changes in completed cohort fertility directly (given that we do not observe all women in the MFLS at sufficiently old ages), we instead generate regression-adjusted life tables to compute the total fertility rate (TFR) decline associated with family planning.[2]

We first find that the introduction of family planning in Malaysia is associated with a 7 percentage point decline in the annual birth hazard—but only among higher parity mothers (those at risk of fourth or higher births), a 24 percent reduction in birth hazards at these parities during the study period. Weighting by the relative share of births at these parties, these results imply that family planning reduced the annual birth hazard by only about 5 percent. Importantly, we do not observe a relationship between the introduction of family planning and pre-existing trends in fertility.

We then find reductions in marriage among young women (ages 15-17) associated with family planning, implying an overall increase in mean age at marriage of about 0.7 years. We estimate comparable age patterns of first births, with reductions at early ages and increases at older ages, suggesting that the interval between marriage and first births did not change under family planning. Third, examining birth intervals directly, we find that both the probability of parity progression and birth intervals (conditional on progression) did not change with family planning.

Finally, to understand the combined implication of these behavioral responses for overall fertility, we use a discrete-time event history model to estimate the relationship between family planning and age-specific birth hazards. Using these birth hazards, we construct regression-adjusted age-specific fertility rates—and corresponding total fertility rates—with and without family planning. We find that family planning services are associated with a TFR reduction of about 0.24 births, a decline of only about 3.2 percent, explaining only about 10 percent of Malaysia's overall TFR decline between 1960 and 1988. This modest share is highly consistent with estimates from other developing countries (Babiarz and Miller, 2016).

This paper proceeds as follows. Section 2 provides a brief background of family planning in Malaysia. Section 3 describes our sources of data and our empirical strategy. Section 4 presents our results, and section 5 then concludes.

---

[1] Our estimation framework requires that family planning programs were not systematically targeted to areas with distinct fertility trends. Our analysis of the annual birth hazard show that family planning service initiation has no relationship with preexisting fertility trends.

[2] See Section 3, Data and Methods, for details.

2. Malaysian Family Planning Programs: Historical Context

Malaysia's first family planning provider was the Malaysian Family Planning Association (FPA), a private organization established in Kuala Lumpur in 1953. By the early 1960s, the Malaysian FPA had partnered with the International Planned Parenthood Federation (IPPF) and had established regional FPAs in all 11 states of peninsular Malaysia.[3] During this period, government officials also grew more sympathetic towards family planning efforts given concerns about the economic consequences of population growth (Malaysia's total fertility rate was high—approximately 6.0-7.7 across all of Malaysia's major ethnic groups (Malay, Chinese and Indian)) (Tey, 2007). As a result, the Malaysian government also began providing family planning services through the existing network of Ministry of Health (MOH) facilities, rapidly expanding family planning services alongside the FPAs (Lee et al., 1973).

The Government of Malaysia then established its National Family Planning Board (LPPKN) in 1966 to better coordinate family planning efforts with national policy priorities. With a stated goal of reducing the national population growth rate to 2 percent per year, LPPKN began promoting family planning[4] and providing free intrauterine contraceptives and sterilization surgeries, and it heavily subsidized oral contraceptives through the existing network of MOH and FPA providers (Hanna, 1971, Nortman and Hofstatter, 1978). Services were initially concentrated in urban areas, but they scaled up to include rural areas through private clinics and mobile units in four distinct phases between 1967 and 1975 (Hanna, 1971, Tey, 2007). Across all three major providers (MOH, FPA, and LPPKN), oral contraceptives were the most commonly used form of contraception (accounting for 55 percent of contraceptive prevalence in 1975), followed by sterilization and condoms (DaVanzo et al., 1986).[5] Figure 1 shows the proportion of enumeration blocks each district covered by at least one family planning provider between 1960 and 1975, with the most rapid supply-side expansion occurring between 1965 and 1975.

---

[3] Early family planning services were funded largely through foreign assistance. Funders included the Ford Foundation, the Population Council, the Swedish International Development Cooperation Agency, and the United National Children's Fund.

[4] Family planning was promoted through an extensive network of family planning officers throughout Peninsular Malaysia. These family planning officers conducted promotional campaigns, held community forums, and distributed promotional materials. Family planning workers and Ministry of Health performed outreach services in community meetings, maternity wards and through in-home visits.

[5] Intrauterine devices were relatively uncommon in Malaysia, accounting for just 1 percent of contraceptive coverage (DaVanzo et al., 1986).

3. Data and Estimation

3.1 Data

To study the effects of family planning on fertility behaviors, we use the nationally representative Malaysia Family Life Survey, Wave Two (MFLS-2), enumerated in 1988. In each household surveyed, detailed life histories were collected recording the timing of marriages and all births occurring to women sampled in the first wave, or aged 18-49 at the time of the second wave in 1988, for a total of 2,747 women. Table 1 shows summary statistics and sample sizes for those included in the study by sex and ethnic group.

In parallel with the household survey, the MFLS-2 fielded a detailed community survey which recorded the first year each type of family planning provider began providing services in each enumeration block, and the first year they began providing each type of modern contraception. Data was recorded separately for each type of provider, including FPAs, MOH providers, LPPKN providers, and other private providers. We use this community survey to determine the year in which individuals were first exposed to family planning services in their area. Our data show that family planning was first introduced into a MLFS enumeration block in 1960 and expanded slowly across blocks until the National Family Planning Board was established in 1966. In 1967 and 1968, programs were expanded rapidly, and almost all enumeration blocks had at least one family planning provider by 1980.

Using this life history and community survey data, we construct a woman-year panel data set containing information about whether or not a marriage and/or birth had taken place for each woman in each year (as well as time-invariant maternal and household characteristics). We merge these woman-year observations with dummy variables measuring the time-varying availability of family planning services in each woman's enumeration block of residence. We consider an individual to be exposed to family planning services in the first year modern contraceptives became available by any provider in their area, and all years thereafter.

3.2 Annual Parity Progression Risk

We first consider how couples' risk of parity progression evolved over time with the introduction of family planning services. Using an event study framework to exploit the staggered implementation of family planning across districts of Malaysia, we estimate equations of the following general form:

$$Birth_{iey} = \propto \; + \sum_t \beta_1^t EventYear_{ey}^t + \sum_k \beta_2^k X_i^k \; + \sum_d \beta_3^d District_e^d + \sum_y \beta_4^y Year^y + \; \varepsilon_{iet} \quad (1)$$

where $Birth_{iey}$ is an indicator for whether or not a woman *i* at parity *p* in enumeration block *e* delivered a child in year *y*; $EventYear_{ey}^t$ is vector of *t* event year indicators (time in years relative to the introduction of family planning in an individual's enumeration block); X_i^k is a vector of individual characteristics (indicators for ethnicity, highest level of education, her parents education); and $District_e^d$ and $Year^y$ represent district and calendar year fixed effects (respectively). We estimate separate models by parity, grouping together mothers at risk of a 4th and higher parity birth. We also estimate a simple before-after difference following Equation 1, replacing event year indicators with a single indicator for the presence of family planning. For all analyses, we compute robust standard errors clustered at the enumeration block level.[6] Under the assumption that changes in the probability of giving birth over time would have been the same in areas receiving early family planning services compared to areas that did not yet have family planning, β_1^t captures the causal effect of family planning on the probability of giving birth *t* years after services were first made available.

Equation (1) also provides an opportunity to evaluate the identifying assumptions required by the duration model frameworks that we describe in Sections 3.3 and 3.4 below (which compare pre- and post-program period averages). Specifically, we assume that family planning programs were not targeted to districts with differentially changing demand for children, which would be reflected in statistically significant estimates β_1^t for event years prior to a district's introduction family planning (Section 4 suggests little evidence of such program targeting). A companion paper estimating family planning effects on women's economic empowerment shows that programs were not correlated with pre-existing trend differences in education, a result also consistent with our assumption (Babiarz et al., 2017).

3.3 Age at Marriage and Age at First Birth

We then estimate the relationship between Malaysia's family planning programs and age at marriage. During our study period, there were strong social norms against sex, pregnancy, and childbearing outside of marriage in Malaysia. Abortion was illegal unless medically required to save a mother's life (Aziz and Tey, 1980). In this context, the availability of modern contraception may therefore lower the cost of postponing marriage to older ages. Alternately, family planning may delay marriage if there are strong empowerment effects among girls early in life, including increased education and human capital investments.

To measure changes in age at marriage, we use a Cox Proportional Hazard (CPH) model to estimate the relationship between family planning and the duration for which women remain unmarried. Specifically, we model the marriage hazard $h_{ie}(t)$ for individual *i* (ages 15-30 during the period of family planning scale-up)[7] in enumeration block *e* and periods *t* (survival time, measured in single years of age) as:

---

[6] There are a total of 315 enumeration blocks across 70 districts in the study sample. Cluster-robust standard errors are unbiased when the number of clusters is sufficiently large (greater than 30) (Cameron et al., 2008). Appendix 1 shows that our results are robust to the level of clustering (enumeration block and district).

[7] Because our survey only sampled women who were married at the time of the survey, we risk increasingly severe selection toward women who marry young among the youngest cohorts. We therefore restrict our analysis to cohorts born at least 30 years prior to our survey. The vast majority of women in our survey (99 percent) marry before the age of 30.

$$h_{ie}(t) =$$

$$h_0(t)exp^{(\beta_0 + \beta_1 FP_{iet} + \sum \beta_2^t FP_{iet} \times T_i^t + \sum \beta_3^j X_i^j + \sum \beta_4^d District_e^d + \sum \beta_5^c Cohort_i^c + \varepsilon_{iet})} \quad (2)$$

where $h_0(t)$ is an unspecified baseline hazard function;[8] FP_{iet} is a dummy variable for the availability of family planning services; T_i^t is a set of indicator variables taking a value of 1 if individual *i* is aged *t* in each person-year observation (and zero otherwise), X_i^j is a vector of women's characteristics as described before, and $District_e^d$ and $Cohort_i^c$ represent district and birth cohort fixed effects. The linear combination of coefficients β_1 and β_2^t captures the effect of family planning on the likelihood of a marriage occurring at age *t*, conditional reaching age *t* without already having been married.

An advantage of the CPH model over alternatives is that it does not require assumptions about (or explicit specification of) the underlying hazard function—or the age pattern of marriage.[9] However, the CPH requires the assumption that the ratio of marriage hazards across groups (those in areas with family planning compared to those without family planning, for example) is constant over time. Because the relationship between family planning and probability of marriage might vary with women's age, we relax this assumption by interacting family planning availability with a set of indicators for each individual year of age, T_i^t.[10]

To estimate the parameters in Equation 2, we write the joint probability of all realized marriage events (assuming independence between women) as the following partial likelihood function:

$$L(\beta) = \prod \left\{ \frac{\exp(\beta Z_i)}{\sum_{j \in R(t_j)} \exp(\beta Z_j)} \right\}^{\delta_i} \quad (3)$$

where Z_i represents independent variables shown in Equation (2) (and the unspecified baseline hazard expressions cancel out). Taking the natural log of Equation 3, we then estimate the model parameters by maximum likelihood estimation (MLE).

---

[8] Unlike other models survival models, the CPH model does not require any assumptions about the functional form of the underlying baseline hazard function $h_0(t)$, which describes the baseline pattern of duration until marriage.

[9] Another advantage of the CPH model is that it is capable of distinguishing between failure and censored observation—in this case, the difference between an individual exiting the sample because they marry and an individual exiting the sample because they are surveyed before they marry. However, in our case, we use only individuals that were married at the time of the survey and thus do not have a censoring problem.

[10] The estimated hazard ratio $exp^{(\beta_1 + \beta_2^t)}$ then captures the relative risk of getting married at age *t* for those living in areas served by family planning clinics in time *t* compared to those without available services.

To study the relationship between family planning and age at first birth, we use the same approach as we do for age at marriage, substituting age at first birth for age at marriage.

3.4 Birth Intervals

Although CPH models are also well-suited for estimating the duration of birth intervals (between marriage and first birth as well as between subsequent births), we are unable to distinguish between individuals who are surveyed before advancing in parity (but who ultimately do have another birth—i.e., individuals with censored birth histories) and individuals who choose to never advance (i.e., individuals with completed fertility). To address this difficulty, we estimate separately (a) the relationship between family planning and the probability of ever advancing in parity and (b) the relationship between family planning and the timing of subsequent births among those we observe to have subsequent births.

First, to estimate the relationship between family planning and the probability of ever advancing in parity, we limit our sample to women for whom we observe the parity progression decision with reasonable certainty. Because 96-98 percent of mothers (nulliparous women through parity 5 mothers) whom we observe to advance do so within 6 years of their previous birth, we restrict our sample to women having a *p* birth at least 6 years prior to the date of the survey. We then estimate the following model of parity progression using Ordinary Least Squares regression:

$$Advance_{ie} = \propto + \sum \beta_1^g FirstExposure_i^g + \sum_k \beta_2^k X_i^k + \sum \beta_3^d District_e^d + \sum \beta_4^c Cohort_i^c + \varepsilon_{iey} \quad (4)$$

where $Advance_{ie}$ is a dummy for whether or not woman *i* in enumeration block *e*, with a parity *p* birth goes on to have a parity $p+1$ birth at any point prior to the survey; $FirstExposure_i^g$ is a vector of dummy variables for age of first exposure to family planning (in five year age intervals); and all other variables are defined as before.

Second, among those who advance in parity prior to the survey, we then estimate the relationship between family planning availability and birth interval duration using a CPH model following the general form of Equation 2:

$$h_{ie}(t) = h_0(t) exp^{(\beta_0 + \beta_1 FP_{iet} + \sum \beta_2^t FP_{iet} \times T_i^t + \sum \beta_3^j X_i^j + \sum \beta_4^d District_e^d + \sum \beta_5^c Cohort_i^c + \varepsilon_{iet})} \quad (5)$$

in which all variables are defined as in Equation 2. We estimate separate models for parity 1-4 birth intervals, grouping fourth and higher births together. We do so using a woman-year sample of mothers entering the risk set in the year they experience a parity *p* birth, and exiting the year of their parity *p+1* birth. As before, we also allow for flexible family planning effects over time by interacting contemporaneous family planning availability with dummy variables for the number of years since entering the parity-specific risk pool.

3.5 Age Specific Fertility Rate and Total Fertility Rate Estimation

The ideal approach to estimating completed fertility effects of family planning would be to use data collected from women who had reached menopause (but were not old enough to have died at high rates) and spanned all fertile ages when family planning was introduced. However, because relatively few women in our sample had reached menopause at the time of the MFLS-2, we cannot directly observe completed fertility.

Instead, we use an econometric framework to estimate the relationship between family planning and two common measures of period fertility (age-specific fertility and total fertility rates). Loosely following the simulated life table methodology developed in Van Hook and Altman (2013), we use a pooled discrete-time event history model estimated by logistic regression (Allison, 1989) to predict changes in age-specific birth probabilities associated with family planning. However, because our sample size limits our ability to obtain stable estimates of all necessary life table inputs,[11] we instead pool births at all parities to directly estimate the unconditional probability of experiencing a birth of any parity at each age—which can be interpreted as the simulated mean number of births at each age or the age-specific fertility rate—across cohorts with and without family planning. Summing these age-specific fertility rates, we then calculate simulated total fertility rates with and without family planning services.

Specifically, we first estimate a discrete-time hazard model of the following form using logit regression:

$$Pr\left(Birth_{iey}\right) = \propto + \beta_1 FP_{ey} + \sum \beta_2^x Age_{iy}^x + \sum \beta_3^x FP_{ey} \times Age_{iy}^x + \sum \beta_4^k X_i^k + \sum \beta_5^d District_e^d + \sum \beta_6^y Year_y + \varepsilon_{iey} \qquad (6)$$

where $Birth_{iey}$ measures whether or not woman *i* living in enumeration block *e* experienced a birth in year *y*, FP_{ey} is a dummy variable for family planning, Age_{iy}^x is a vector of single year of age indicators, and all other variables are defined as before. Interactions between family planning and age dummies allow for flexible family planning effects over individuals'

[11] Van Hook and Altman (2013) propose a methodology for detailed life tables, estimating the inputs required for the estimation of parity progression ratios as well as age-specific fertility rates and total fertility rates. Theses inputs are hazard functions (q_x) (the age-specific probability of a parity *n* birth, conditional on parity *n-1* birth having already occurred, but parity *n* births not having yet occurred), survival functions (l_x) (the proportion of the population still at risk of a parity *n* birth at each age), and overall age-specific probability of a parity *n* birth (d_x) across all parities.

fertile ages. Our woman-year sample includes all women at risk of a birth, beginning at age 15 and ending either at age 40 or at the time of the survey.[12]

We then use estimates from Equation 6 to predict the log-odds of birth at each single year of age both before and after the introduction of family planning, holding all control variables constant at their mean values. Specifically, we use the following formula:

$$\log\left(\frac{p}{1-p}\right) = \hat{\alpha} + \widehat{\beta_1}\, FP_{ey} + \widehat{\beta_2^x}\, Age_{iy}^x$$

$$+ \widehat{\beta_3^x}\, Age_{iy}^x \times FP_{ey} + \sum \widehat{\beta_4^k}\overline{X_i^k} + \widehat{\beta_5^d} District_e + \widehat{\beta_6^y} Year_y \qquad (7)$$

Finally, we convert log-odds to predicted birth hazards to obtain age-specific fertility rates and TFR estimates (summing age-specific fertility rates), predicting fertility rates with and without family planning. Predicted birth hazards for age *x* and family planning availability *FP* are calculated as:

$$P = \frac{\exp(Log{-}\widehat{odds}^{x,FP})}{(1+\exp(Log{-}\widehat{odds}^{x,FP}))} \qquad (8)$$

4. Results

4.1 Annual Parity Progression Risk

Figure 2 shows estimates from Equation 1 for changes in annual parity progression risk associated with family planning. Specifically, we plot estimates and 95 percent confidence intervals for each event year coefficient (β_1^t for event years -10 to +10). Among mothers at risk of a 4th or higher birth, annual parity progression risk declines steadily following the introduction of family planning, becoming statistically significant 6 years afterwards. By the end of our study period, parity progression risk is 7.3 percentage points lower than before family planning [95 percent CI: -13.3 to -1.3], a decline of 24 percent.

Estimating the mean change in average parity progression risk associated with family planning, we find that family planning is associated with a 3.7 percentage point decline [95 percent CI: -0.07 to -0.01] in relative risk. Weighting by the relative share of births occurring at each parity, these results imply a 1.6 percentage point reduction in the overall risk of parity progression, a decline of about 4.5 percent relative to the mean prior to family planning.[13]

---

[12] We restrict our analysis to births occurring prior to age 40 to ensure adequate cell sizes at each age for stable model estimation.

[13] To calculate the percent change in overall risk of parity progression, we first calculate the overall risk of parity progression in the pre-family planning years by summing the total number of births observed across all parities, and dividing by total person-years of risk exposure ($\frac{1675}{4746} = 0.3529$). We then estimate the number of births

We find no statistically significant reductions in annual parity progression risk among lower parity women.

Because a natural concern with our estimation framework is that the timing and location of family planning programs is related to time-varying local demand for children, we also highlight that we do not find a systematic relationship between pre-existing fertility trends (in event years prior to year 0) and the introduction of family planning. This finding is consistent with our identifying assumption that there was not systematic program targeting to changes in demand, an assumption required by our subsequent analyses as well.[14]

4.2 Age at Marriage and Age at First Birth

Figure 3 then shows results from our CPH model of marriage timing obtained from Equation (2), plotting hazard ratios $exp^{(\beta_1 + \beta_2^t)}$ for each age (*t*) 15-26.[15] Each age-specific hazard ratio estimate reflects the change in relative risk of marriage, conditional on reaching age *t* without yet marrying, associated with family planning. We find that the introduction of family planning is associated with relative risk reductions of approximately 30-60 percent among girls ages 15-17 (hazard ratios: 0.40 for those age 15, 0.56 for those age16, and 0.63 for those age 17 [95 percent CIs: 0.27-0.59, 0.41-77, 0.46-0.86]). Using the proportion of women marrying at these ages prior to family planning, the implied overall increase in mean age at marriage associated with family planning is 0.70 years, rising from 18.91 to 19.61.

Similarly, Figure 4 plots age-specific hazard ratio estimates for maternal age at first birth (also obtained from Equation (2)). Although less precisely estimated, these results suggest that changes in the age pattern of first births may be consistent with the pattern of changes in age at marriage, with reductions in relative risk at younger ages. Specifically, we find reductions in the relative risk of a first birth occurring at age 16-17 by 30-48 percent 3 (0.54 for those age 16 year-olds, and 0.71 for those age 17 [95 percent CIs: 0.36-0.80, 0.49-1.03]), increasing the mean age at first birth from 20.9 to 21.23. Together with the age at marriage estimates in Figure 3, our results imply that although family planning may have allowed later

---

predicted to occur after family planning, assuming no change in risk of parity progression at lower parities and factoring in implied reductions in the risk of 4th and higher parity births—our results imply that the risk of these higher parity births falls from $(Risk^{PreFP} \times PersonYears^{PreFP}) = 678$ to $(\widehat{Risk}^{PostFP} \times PersonYears^{PreFP}) = 603$. We sum predicted post-family planning births (implied by our model), and divide by the pre-family planning person-years of risk exposure ($\frac{1600}{4746} = 0.3371$). The overall risk of parity progression thus decreases by $(0.3529 - 0.3371) = 0.1578$, a 4.5 percent reduction.

[14] A companion paper estimating family planning effects on women's economic empowerment finds that programs were not correlated with pre-existing trend differences in education, a result also consistent with our assumption (Babiarz et al., 2017).

[15] Although we estimate family planning effect on marriage hazards up to age 30, estimates after age 24 become imprecise due to the very limited number of women in our sample who are not yet married by age 24.

marriage, some couples appear to have compensated by having their first child sooner after marriage, resulting on balance in smaller changes in the timing of first births.[16]

4.3 Birth Intervals

To estimate the relationship between family planning and the timing of births, we estimate separately (1) the relationship between family planning and parity advancement and (2) the relationship between family planning and birth spacing among couples who do advance. Table 2 shows estimates of the relationship between family planning and the probability of ever progressing by parity obtained from Equation (4). Overall, we do not generally find evidence of a meaningful relationship between family planning exposure at most ages and the probability of advancing to a higher order birth (the point estimates are statistically insignificant). The exception is that we find that lifelong family planning exposure (first exposure at birth) is associated with a 10.3 percentage point reduction in the probability of a third parity birth.[17] These results imply that although fewer couples advance past third parity, those that do have at least three children are no more or less likely to continue childbearing after family planning.

Turning to the second part of our birth interval estimation, we consider the relationship between family planning and birth intervals from parity p to $p+1$ (marriage to first birth and subsequent intervals up to a fifth birth), conditional on reaching parity $p+1$. Figure 5 shows hazard ratio estimates obtained from Equation (5). Although the pattern of estimates is weakly suggestive of small increases in birth spacing across parities (reductions in the likelihood of a birth within the first three years and increases later in the interval), the estimates are statistically insignificant and quantitatively small.

4.4 Age-Specific Fertility Rates and Total Fertility Rate

Table 3 shows predicted log-odds and corresponding marginal probabilities of birth by age-group obtained from Equation (6) before and after the introduction of family planning (i.e., taking the difference between the pre-FP and post-FP period averages). Because the resulting estimates are noisy, Figure 6 shows smoothed predicted birth hazards using a 3-year moving average (Appendix Table 1 shows equivalent unsmoothed results yielding nearly identical results). Overall, both before and after the introduction family planning, fertility peaks between ages 19 and 25 and then steadily declines thereafter. We find slight increases in age-specific fertility associated with family planning at younger ages (up to age 25), followed by meaningful reductions in fertility after age 30. These results are consistent with other research suggesting that women may relax precautionary fertility behavior at younger ages if they believe that they will be better able to stop childbearing after reaching their target number of births (Gupta and Rajani, 2017). Finally, summing over all age-specific fertility rates, we find that family planning is associated with a decline in the predicted total fertility

[16] As Section 4.3 describes, however, we are unable to detect significant changes in birth spacing.

[17] These results do not imply differential fertility trends prior to the introduction of family planning, but rather point to potential effects of family planning on human capital investments early in life.

rate (TFR) from 7.64 to 7.40, [18] a reduction of 0.24 births (or 3.2 percent)—explaining about 7.7 percent of Malaysia's TFR decline during these years.[19]

5. Conclusion

Malaysia was one of the first low-income countries to provide modern contraceptives on a large scale (in 1954, and expanding rapidly in 1966 (Lee et al., 1973), providing an unusual environment to study how fertility behavior responds to family planning programs (independent of background changes in the demand for children).[20] We find that family planning reduced the annual risk of higher-parity births (fourth and up) by 24 percent, explaining 5 percent of the decline in annual birth hazards at any parity. Average age at marriage also rose by 0.7 years under family planning, largely due to postponement of marriage among girls at young ages (15-17), but subsequent birth intervals remained unchanged.

Overall, Malaysia's family planning programs explain only about 10 percent of its TFR decline between 1960 and 1988, a reduction of 0.24 births. Although modest, this finding is consistent with studies in other lower income countries during this period. For example, Miller (2010) shows that family planning programs in Colombia reduced the number of children ever born by about 0.25-0.33 births, accounting for 6-7 percent of the overall decline between 1965 and 1993. Similarly, Gertler and Molyneaux (1994) show that family planning programs in Indonesia account for between 4 and 8 percent of overall decline in the quarterly birth hazard between 1982 and 1987. Our results are consistent with growing evidence that global fertility decline is predominantly due to these underlying changes in the demand for children (Babiarz and Miller, 2016, Pritchett, 1994).

[18] Importantly, we note that these simulated total fertility rates are larger than true TFRs during this period for two reasons. First, our rates are standardized in that all control variables and fixed effects are held at their sample means and thus diverge from observed values. Second, our fertility rates are estimated using a sample of women who have by construction had at least one birth, excluding women who do not have any births prior to the survey.

[19] Between 1960 and 1988, the TFR had fallen from approximately 6.1 to 3.58, a 41.3 percent decline. Thus family planning-related declines of 3.2 percent account for 3.2/41.3 = 7.7 percent of the overall fertility rate decline.

[20] Family planning programs may interact with changes in the demand for children in potentially important ways, but we do not study potential interactions (nor does our study design isolate plausibly exogenous variation in the demand for children).

References

ALLISON, P. D. 1989. *Event history Analysis: Regressions for Longitudinal Event Data,* Newbury Park, CA, Sage.

AZIZ, N. L. & TEY, N. P. 1980. Malaysia. *Studies in Family Planning,* 11**,** 330-334.

BABIARZ, K. S., LEE, J., MILLER, G., TEY, N. P. & VALENTE, C. 2017. *Family Planning and Women's Economic Empowerment: Incentive Effects and Direct Effects among Malaysian Women,* Stanford University, Unpublished Working Paper.

BABIARZ, K. S. & MILLER, G. 2016. Family Planning Program Effects: A Review of Evidence from Microdata. *Population and Development Review,* 42**,** 7-26.

BECKER, G. S. 1960. An economic analysis of fertility. *In:* NBER (ed.) *Demographic and economic change in developed countries.* New York: Columbia University Press.

BONGAARTS, J., MAULDIN, W. P. & PHILLIPS, J. F. 1990. The Demographic-Impact of Family-Planning Programs. *Studies in Family Planning,* 21**,** 299-310.

CASTERLINE, J. B. 2001. The pace of fertility transition: National patterns in the second half of the twentieth century. *Population and Development Review,* 27**,** 17-52.

CLELAND, J., BERNSTEIN, S., EZEH, A., FAUNDES, A., GLASIER, A. & INNIS, J. 2006. Family planning: the unfinished agenda. *Lancet,* 368**,** 1810-1827.

COALE, A. J. & HOOVER, E. M. 1959. Population growth and economic development in low-income countries. *American Economic Review,* 49**,** 436-438.

DAVANZO, J., ANN, T. B., OTHMAN, R. & PETERSON, J. 1986. *Determinants of Contraceptive method Choice in Peninsular Malaysia, 1961-1975,* Santa Monica, CA, RAND Corporation.

DAVIS, K. 1967. Population policy: will current programs succeed? . *Science,* 158**,** 730-739.

DOSM 2015. Total Fertility Rate 1958-2015. *In:* DEPARTMENT OF STATISTICS MALAYSIA (ed.).

EHRLICH, P. 1968. *The Population Bomb,* New York, Ballantine Books.

GERTLER, P. J. & MOLYNEAUX, J. W. 1994. How Economic-Development and Family-Planning Programs Combined to Reduce Indonesian Fertility. *Demography,* 31**,** 33-63.

GUPTA, N. & RAJANI, I. 2017. *Lifecycle Fertility and the Impact of Family Planning Programs: Evidence from Southern Africa,* SSRN Working Paper.

HANNA, W. A. 1971. Family Planning in Malaysia: Programs and Prospects. *American Universities Fieldstaff Reports,* 19**,** 1-11.

HIRSCHMAN, C. & YOUNG, Y. J. 2000. Social context and fertility decline in Southeast Asia: 1968-70 to 1988-90. *Population and Development Review,* 26**,** 11-39.

KAISER, J. 2011. Does Family Planning Bring Down Fertility? *Science,* 333**,** 548-549.

LEE, E., ONG, M. & SMITH, T. E. 1973. Family Planning in west Malaysia: The Triumph of Economics and Health over Politics *In:* SMITH, T. E. (ed.) *The Politics of Family Planning in the Third World.* London: George Allen & Unwin.

LEE, R. 2003. The demographic transition: Three centuries of fundamental change. *Journal of Economic Perspectives,* 17**,** 167-190.

MILLER, G. 2010. Y Contraception as Development? New Evidence from Family Planning in Colombia. *Economic Journal,* 120**,** 709-736.

NAS 1971. *Rapid Population Growth: Consequences and Policy Implicatons,* Baltimore, National Academy of Sciences Office of the Foreign Secretary.

NORTMAN, D. L. & HOFSTATTER, E. 1978 *Population and Family Planning Programs,* New York, The Population Council

PRITCHETT, L. H. 1994. Desired Fertility and the Impact of Population Policies. *Population and Development Review,* 20**,** 1-55.

ROBEY, B., RUTSTEIN, S. O. & MORRIS, L. 1993. The Fertility Decline in Developing-Countries. *Scientific American,* 269**,** 60-67.

TEY, N. P. 2007. The Family Planning Program in Peninsular Malaysia. *In:* ROBINSON, W. C. & ROSS, J. A. (eds.) *The Global Family Planning Revolution: Three Decades of Population Policies and Programs* Washington DC: The World Bank.

VAN HOOK, J. & ALTMAN, C. 2013. Using Discrete-Time Event History Fertility Models to Simulate Total Fertility Rates and Other Fertility Measures. *Population Research and Policy Review,* 32**,** 585-610.

VOIGTLANDER, N. & VOTH, H.-J. 2013. How the West "Invented" fertility restriction. *American Economic Review,* 103**,** 2227-64.

Figure 1: Family Planning Program Expansion in Peninsular Malaysia

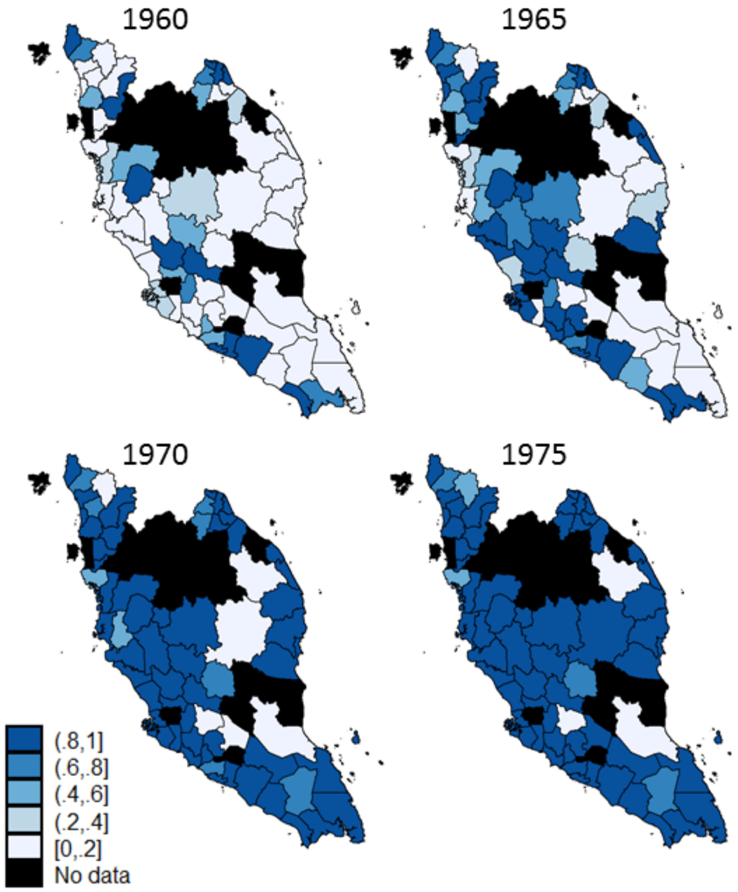

Figure shows the expansion of family planning providers over time based on the Malaysian Family Life Survey: Community Survey. Within each district, we calculate the share of enumeration blocks with at least one provider of family planning services (including Ministry of Health, National Family Planning Board, Family Planning Association or other providers).

Figure 2: Effect of Family Planning on the Annual Birth Hazard, Parity 1 – 4

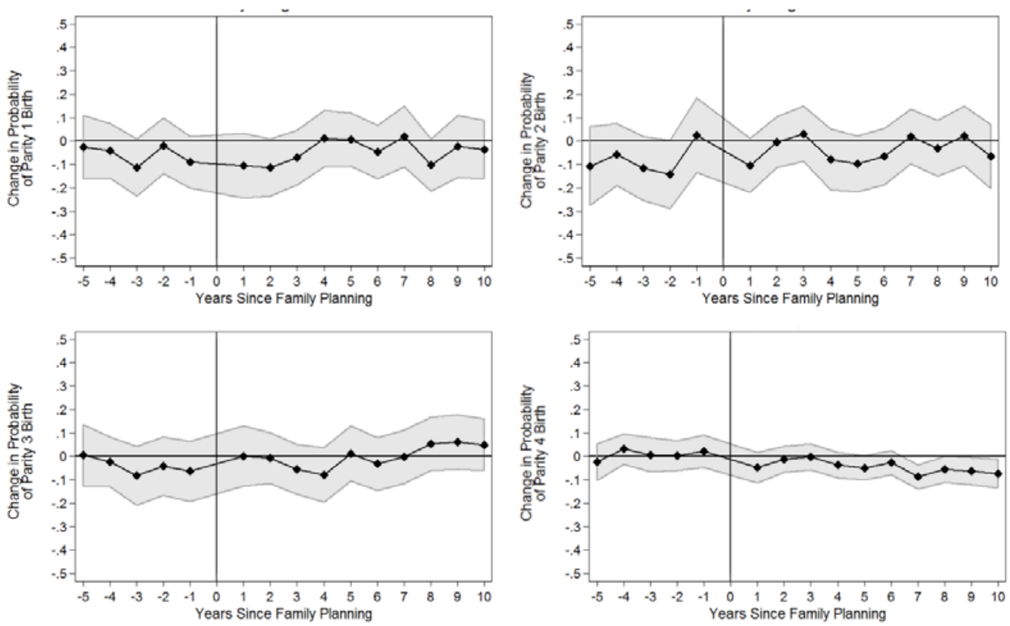

Figure shows point estimates and 95 percent confidence intervals from Equation 1, each measuring the effect of years since family planning introduction on the annual risk of parity advancement for women at risk of parity 1-3 births, as well as 4th and higher parity births (relative to the year of family planning introduction). Data from Malaysian Family Life Survey are used to estimate a Ordinary Least Squares event study regressions stratified by parity with indicators for years relative to the introduction of family planning services, controlling for individual characteristics, district and birth cohort fixed effects. Standard errors are clustered at the enumeration block level.

Figure 3: Effect of Family Planning on the Age-Specific Risk of Marriage

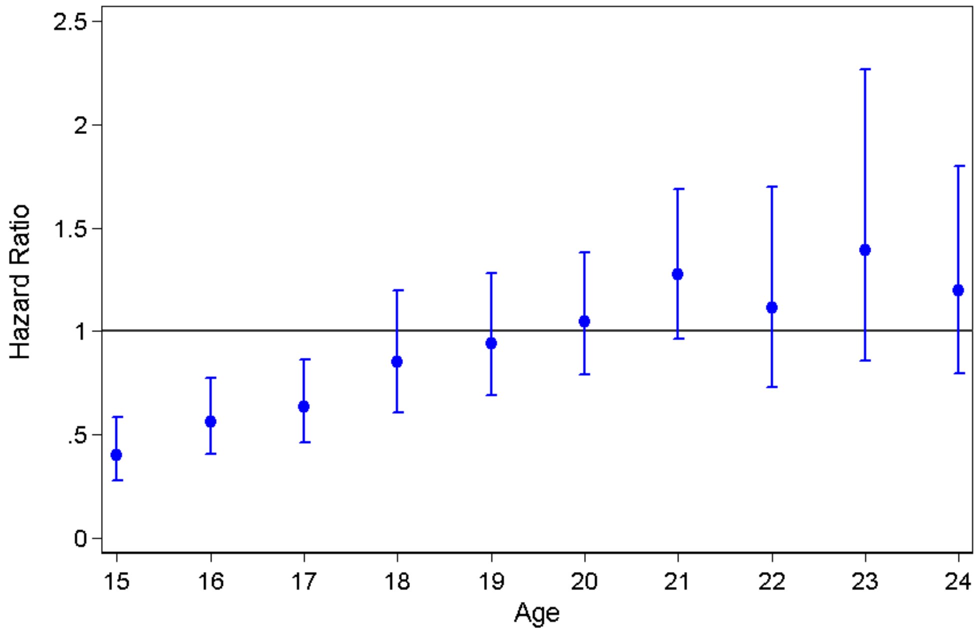

Figure shows the hazard ratios and 95 percent confidence intervals associated with contemporaneous family planning availability on the probability of marriage in each year of age. Data from Malaysian Family Life Survey are used to estimate a Cox Proportional Hazards Model with time-varying family planning service availability indicators fully interacted with single year of age indicators, controlling for individual characteristics, district and birth cohort fixed effects. Analytic sample is composed of person-year observations with individuals entering the sample at age 15 and exiting in the year of their marriage. Standard errors are clustered at the enumeration block level.

Figure 4: Effect of Family Planning on the Age-Specific Risk of First Childbirth

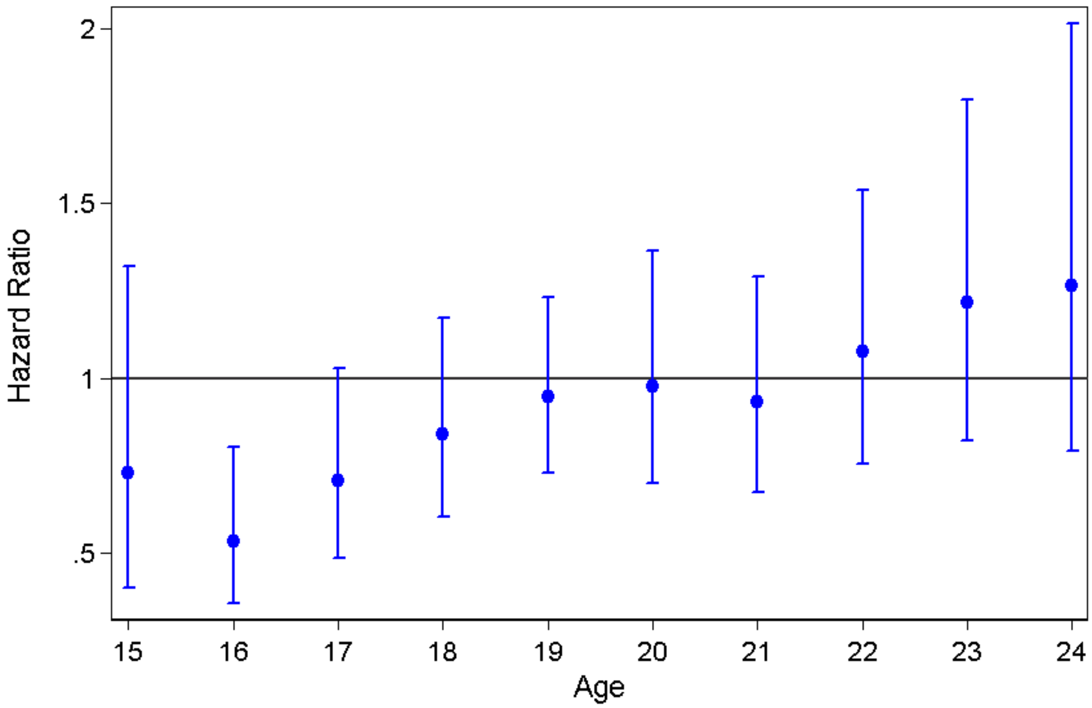

Figure shows the hazard ratios and 95 percent confidence intervals associated with contemporaneous family planning availability on the probability of first birth in each year of age. Data from Malaysian Family Life Survey are used to estimate a Cox Proportional Hazards Model with time-varying family planning service availability indicators fully interacted with single year of age indicators, controlling for individual characteristics, district and birth cohort fixed effects. Analytic sample is composed of person-year observations with individuals entering the sample at age 15 and exiting in the year of their first birth. Standard errors are clustered at the enumeration block level.

Figure 5: Effect of Family Planning on the Birth Intervals

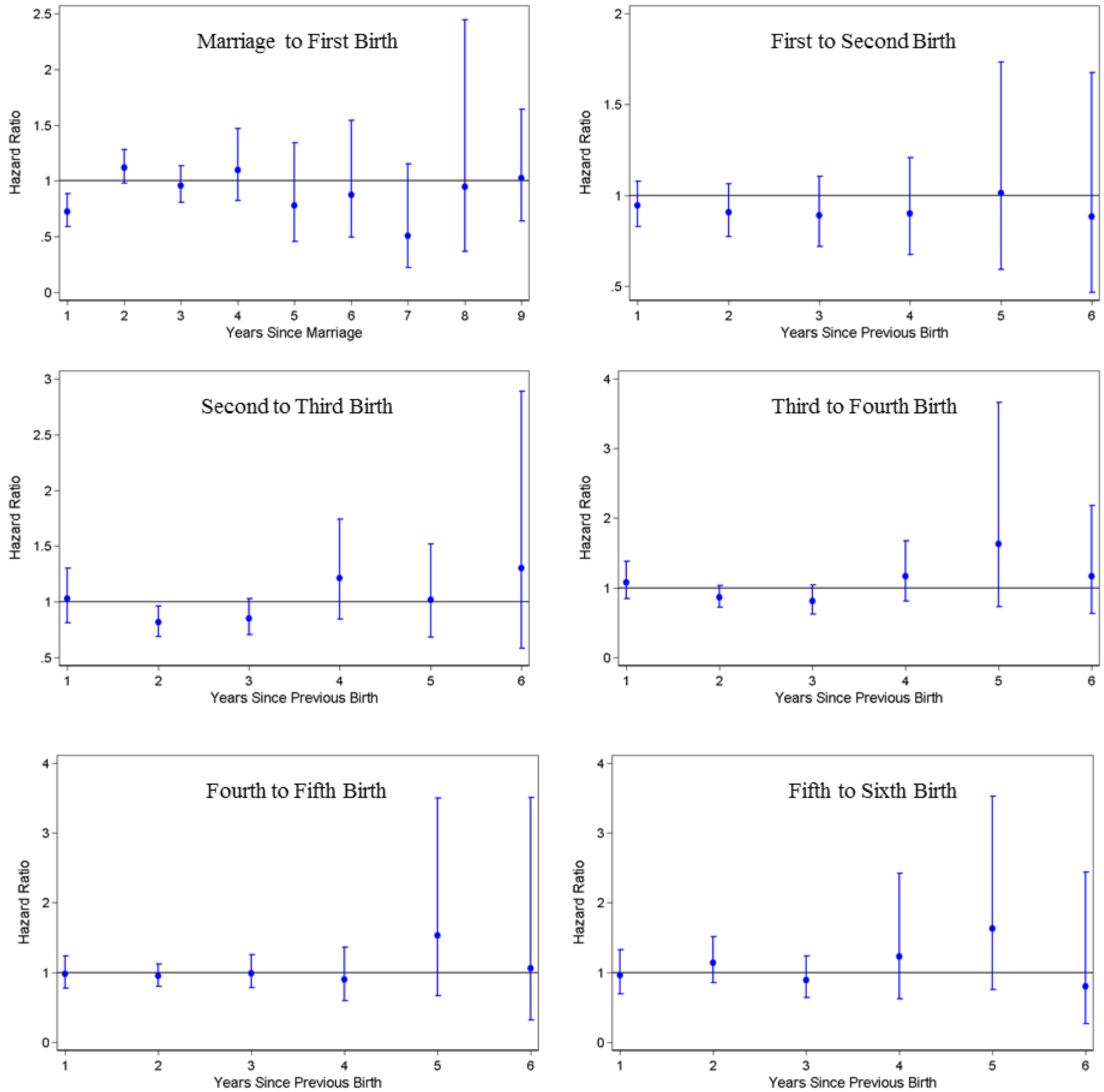

Figure shows the hazard ratios and 95 percent confidence intervals associated with contemporaneous family planning availability on the probability of having a first child in each year following a marriage. Data from Malaysian Family Life Survey are used to estimate a Cox Proportional Hazards Model with time-varying family planning service availability indicators fully interacted with years since marriage or the previous birth, controlling for individual characteristics, district and birth cohort fixed effects. Analytic sample is composed of person-year observations with individuals entering the sample in the year of their marriage or previous birth and exiting in the year of their next birth. Standard errors are clustered at the enumeration block level.

Figure 6: Predicted Age Specific Fertility Rates With and Without Family Planning

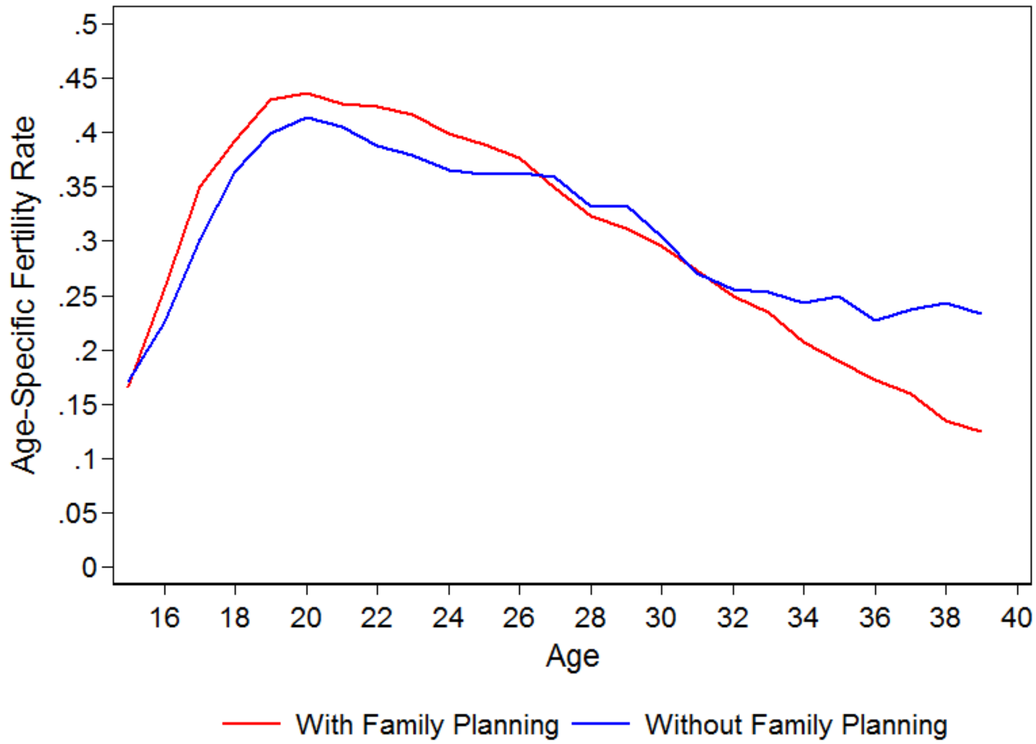

Figure show three-year moving average of Age Specific Fertility Rates (ASFR) (probability of a experiencing a birth at a given age) for each age 15-40, with and without family planning. ASFRs are calculated using inputs from Equation 6, calculating predicted log-odds of a birth at each single year of age both before and after family planning, holding all control variables constant at their mean values. We then convert log-odds to predicted birth hazards following the methodology developed in Van Hook and Altman (2013).

Table 1: Summary Statistics

		Birth Cohort							
	Overall	1930-1934	1935-1939	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969
Sample Size	2764	102	158	294	364	518	552	483	196
Children Ever Born (in survey year)	4.51	8.19	6.80	6.12	5.49	4.67	3.87	2.63	1.84
Age at Marriage	19.85	17.74	18.37	19.34	20.05	20.64	20.45	20.40	18.30
Completed Education									
Less than Primary	18.9%	71.6%	54.4%	35.0%	21.2%	11.0%	8.2%	4.8%	5.6%
Primary	44.8%	27.5%	39.2%	50.7%	59.3%	56.2%	48.0%	29.0%	33.2%
Secondary	31.5%	0.0%	5.1%	12.9%	17.3%	29.2%	37.1%	57.3%	59.7%
Above Secondary	4.2%	1.0%	1.3%	1.4%	2.2%	3.7%	6.7%	8.9%	1.5%
Ethnic Group									
Malay (%)	55.9%	52.0%	55.7%	47.6%	49.5%	55.0%	56.9%	65.8%	62.8%
Chinese (%)	25.4%	38.2%	29.1%	37.4%	31.6%	26.3%	23.0%	15.5%	13.3%
Indian (%)	16.8%	8.8%	15.2%	14.3%	17.9%	17.6%	18.7%	16.6%	21.4%

Sample means calculated for each birth cohort from analytic sample. Source: Malaysian Family Life Survey

Table 2: Effect of Family Planning on the Probability of Ever Advancing in Parity

Age of First Exposure to Family Planning Services	Conditional Probability of Ever Advancing in Parity		
	2nd Parity Birth	3nd Parity Birth	4th and Higher Parity Birth
At Birth or Prior	-5.13	-10.33*	-4.90
	(-13.884 - 3.622)	(-21.909 - 1.249)	(-17.265 - 7.457)
Age 1-4	1.12	-8.31	-3.71
	(-7.483 - 9.723)	(-19.427 - 2.805)	(-14.729 - 7.316)
Age 5-9	2.85	-3.43	-2.59
	(-5.071 - 10.770)	(-13.688 - 6.821)	(-12.640 - 7.454)
Age 10-14	0.51	-4.46	-5.44
	(-7.292 - 8.318)	(-13.831 - 4.920)	(-14.804 - 3.929)
Age 15-19	0.65	-1.54	-6.61
	(-7.343 - 8.648)	(-10.439 - 7.357)	(-15.610 - 2.396)
Age 20-24	-0.27	-0.96	-3.74
	(-6.679 - 6.132)	(-7.887 - 5.965)	(-12.503 - 5.020)
Age 25-29	1.42	0.75	-2.51
	(-3.654 - 6.495)	(-4.319 - 5.821)	(-10.683 - 5.656)
Age >= 30	1.94	-0.53	-1.59
	(-2.348 - 6.227)	(-5.940 - 4.890)	(-8.291 - 5.113)
Constant	106.53***	104.99***	105.25***
	(99.572 - 113.492)	(92.668 - 117.307)	(97.430 - 113.067)
Observations	2,739	2,409	4,027
R-squared	0.246	0.200	0.118

Table shows the effects of family planning on the conditional probability of advancing to a given parity birth by age of exposure to family planning programs. Column 1 shows the effect of family planning on the probability of advancing to a second parity birth, conditional on having a first birth. Column 2 shows the effect on the probability of advancing to a third parity birth, conditional on having a second birth. Column 3 shows the family planning effect on the probability of advancing to a higher parity birth, conditional on being at risk (with mothers entering the data set separately for each parity p birth for which they are at risk). Because the vast majority of women who ever advance in parity do so within 6 years of their previous birth, the analytic sample is restricted to those entering the risk set for each parity-specific birth at least 6 years prior to the survey. Regressions are estimated using Ordinary Least Squares, controling for individual characteristics (indicators for ethnic group, educational attainment, and parent's education), as well as both district and cohort fixed effects (not shown, but available upon request). Standard errors are clustered at the enumeration block; robust 95% confidence intervals are given in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

Table 3: Predicted Age-Specific Fertility Rates and Total Fertility Rates With and Without Family Planning

	Predicted Log-Odds		Age-Specific Fertility Rate	
Age	Without Family Planning	With Family Planning	Without Family Planning	With Family Planning
15	-1.930	-2.650	0.127	0.066
16	-1.306	-1.344	0.213	0.207
17	-0.849	-0.617	0.300	0.351
18	-0.564	-0.434	0.363	0.393
19	-0.428	-0.300	0.395	0.425
20	-0.335	-0.260	0.417	0.435
21	-0.402	-0.289	0.401	0.428
22	-0.452	-0.312	0.389	0.423
23	-0.480	-0.343	0.382	0.415
24	-0.594	-0.403	0.356	0.401
25	-0.528	-0.446	0.371	0.390
26	-0.600	-0.517	0.354	0.374
27	-0.581	-0.620	0.359	0.350
28	-0.682	-0.737	0.336	0.324
29	-0.698	-0.795	0.332	0.311
30	-0.892	-0.877	0.291	0.294
31	-0.953	-0.977	0.278	0.274
32	-1.116	-1.108	0.247	0.248
33	-1.083	-1.179	0.253	0.235
34	-1.115	-1.377	0.247	0.202
35	-1.129	-1.429	0.244	0.193
36	-1.266	-1.619	0.220	0.165
37	-1.142	-1.648	0.242	0.161
38	-1.329	-1.885	0.209	0.132
39	-1.443	-2.069	0.191	0.112
40	-1.870	-2.219	0.134	0.098
		Implied Total Fertility Rate:	7.649	7.407

Cells show three-year moving average of predicted log-odds and corresponding probability of a experiencing a birth (ASFR) for each age 15-40, calculated using the results of Equation 6. Theses inputs are hazard functions (qx) (the age-specific probability of a parity n birth, conditional on parity n-1 birth having already occurred, but parity n births not having yet occurred), survival functions (lx) (the proportion of the population still at risk of a parity n birth at each age), and overall age-specific probability of a parity n birth (dx) across all parities. We use estimated coefficients from Equation 6 to predict log-odds of a birth at each single year of age both before and after family planning, holding all control variables constant at their mean values. We then convert log-odds to predicted birth hazards (qx) (the age-specific probability of a parity n birth, conditional on parity n-1 birth having already occurred, but parity n births not having yet occurred), which we aggregate to obtain age-specific fertility rate and TFR estimates (summing age-specific fertility rates), predicting fertility rates with and without family planning.