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Socio-economic and Demographic Factors associated with Fertility – Southeast and East Asian Evidence

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Abstract

Over the last three decades, Southeast and East Asian countries have experienced a substantial fertility decline. The socio-economic and demographic determinants appear to be important in explaining the fertility transition experienced in the region. Applying a fixed-effects estimation technique on the 1990-2019 panel data, this study found that increased women's empowerment (include female education, labour force participation and wage), access to contraceptive usage, decreased infant mortality and improved living standards have a significant negative impact on childbirth rates. Female employment is the most influential factor. In addition, this paper sheds light on the government effectiveness of government policy and to what extent fertility behaviour can be affected by government intervention, by studying reforms to China's one-child policy. We utilize a regression discontinuity design and our results provide strong evidence of that government policy successfully impacted fertility rates in most provinces of China. Future research should further investigate the rates of change in fertility among different countries and the contributing factors to the level of births.

Keywords: Fertility rates, Socio-economic and demographic determinants, Southeast and East Asia, Two-child policy, Fixed-effects

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1 Introduction

The concerns about the potential negative influence on productivity and macroeconomic stability, resulting from population structure changes have been widely discussed by social economists in recent years. Although the earth seems to be already populated heavily with predicted approximate nine billion residents around 2050, the window of population dividends closed gradually in various world's major economies by stepping into an ageing process. Demographic change can influence underlying economic growth and challenge labour market performance. To find the key to unlocking the solution to the ageing problem, the first step is to find the determinants of the fertility rates and then target the policy for each.

Theoretically, demographic transformation mainly contains three stages. The pre-transition stage refers to both high birth rates and high mortality rates. The transition stage as birth rates remains high while death rates are falling. The post-transition stage appears with low fertility and low mortality. Asian countries experienced a period of high fertility with low mortality in which the population dividends were created for their offspring (Bloom & Williamson, 1998). Current population trends among countries conform with the path from the transition stage to the post-transition stages. Compared with Europe and North America, Asian countries have attained below-replacement fertility in recent decades, facing persistent lower natural birth rates and faster ageing speed which hinder future economic growth. The problem with low fertility but high life expectancy society is that it reduces population size among the young generation, producing an infundibuliform age structure that creates momentum for the future steep decline, ruining the demographic sustainability. Asia is the biggest and most populous continent in the world, it can be divided into five regions. These are Central Asia, East Asia, South Asia, Southeast Asia and Western Asia. We will focus on East and Southeast Asia in particular.

Southeast and East Asian countries have experienced a substantial fertility decline over the last three decades, with a period of rapid economic growth (Rammohan, 2004). There are several reasons for falling birth rates, including improved education, increased labor force participation, access to contraception, high cost of living and implementation of family planning programs. Due to a continuous decline in fertility, some Asian countries have policies to increase birth rates. For instance, China ended its 30-year-old policy of restricting families to one child, replaced by two-child policy to boost the number of births. Hence, the confounding factors that affect fertility can be split into two parts: proximate determinations of fertility and government

policies. The main objective of this paper is to investigate the impact of socio-economic and demographic factors on fertility in East and Southeast Asia. Due to no single factor that can fully explain fertility behavior, this study also sheds light on government policies by studying reforms to China's one-child policy.

In developing Asia, only three countries belonged to the low fertility category (total fertility rate of 2.1 or lower) during 1975-1980. This number constantly increased to eight countries during 1990-1995 and 18 during 2005-2010. While 15 out of 18 entities have been found in Southeast and East Asia. Based on this consideration, 12 sample countries in the specific region have been selected, including South Korea, Japan, China, Hongkong, Philippines, Brunei, Lao PDR, Malaysia, Cambodia, Indonesia, Myanmar and Thailand. The reason for not choosing the remaining three countries (Singapore, Timor-Leste and Vietnam) is because their data contain a 10-year vacancy which carries a risk of biased estimation. Although Taiwan and Macao are the typical ageing regions, they do not have independent data sources from the World Bank.

While several studies have investigated the influence of socio-economic and demographic determinations of fertility more generally. The empirical studies in East and Southeast Asia are relatively scarce both in numbers and in variation of methodologies. One exception is Dartanto (2009) who investigate five intermediate variables in Southeast and South Asia. The results reveal that female education, urban population, improved living standards, decreased infant mortality and income per capita are important factors influencing fertility decline. This paper contributes to the existing literature in several ways. First, this study looks at nine study variables, the important factors that influence the determinants of fertility in the area. Second, the updated longitudinal data that covers the most recent time periods has been used. Third, we separately investigate the impact of government policies by using the natural experiment that China's relaxation of the one-child policy constitutes. Consequently, this paper fills the gap in the recent literature and adds to the recent body of evidence on the possible causes of the changes in fertility.

The rest of the paper proceeds as follows. In Section 2, we introduce some relevant background and information about the selected countries. In Section 3, we review existing literature and briefly summarize theoretical predictions regarding variables of interests and fertility. In Section 4, we describe our data and empirical estimation strategy. In Section 5, we present our

major findings and empirical results. In Section 6, we provide a final discussion with some weaknesses. In Section 7, we conclude the overall findings and suggest future research.

2 Background

This chapter introduces background about fertility transition in Southeast and East Asia and policies encouraging births. The total fertility rate (TFR, hereafter) of a population is the average number of children that a woman bears over her whole time from birth until the end of her reproductive life.

Fertility decline first showed its sign in a few Southeast Asia in the late 1960s, and then moved downward, throughout the region from the 1970s to the 1990 at varying speeds. During this period, all Southeast Asian countries enacted government population programs and policies because of concerns over the population explosion since at least the 1970s (Jones, 1995). In the late 1980s, a women reproduce 3.8 children on avenge (Hirschman & Guest, 1990). While this figure may seem high in comparison to East Asia. Birth rates are now fluctuating around the replacement level of 2.1 children and continue to fall. It has drifted from 5.5 in 1970 to 2.4 in 2015 (The Economist Intelligence Unit, 2019). In recent years, Southeast Asia has enjoyed remarkable economic progress and accounted for the sixth-largest economy worldwide (OECD, 2018). However, the demographic shift leads to an aging population with greater old-age dependency. By 2050, it is estimated that 21.1% of the population in Southeast Asia will be 60 years or above which puts the workforce that has driven the region's economic growth at risk (United Nations, 2017). The rapid decline in birth rates in Southeast Asia is associated with government intervention through family planning and rise in female employment, higher school enrolment, child costs increase relative to child benefits and opportunity cost of mother's time (Rammohan, 2004).

Even if East Asia is one of the world's largest economies, they have been declared to be in the low fertility category. It indicates that the current fertility rate cannot reach the defined population replacement rate or maintain a society's population size. South Korea has reached the lowest birth rates of only 0.9 in 2021, closely followed by the Chinese Special Administrative Region Hong Kong. While this number has a similar decreasing trend statistically float around 1.4 and 1.7 in Japan and China, respectively. Historically, South Korea’s TFR fluctuated between 1.6 and 1.8 between 1985 and 1997, and further declined to 1.5 in 1998. In Japan, it remained at 1.5 between 1990 and 1994 and further declined to a record-breaking TFR of 1.3 in 1999. China’s TFR has fallen precipitously to below the replacement level since 1990 (Gubhaju & Moriki-Durand, 2003). Both South Korea and China implemented family planning programs in the last century, leading to a rapid decline in fertility.

However, socio-economic development, including rapid urbanization, increased education and economic participation of females, has facilitated the acceptance of the small-family norm and contributed to the sustained fertility decline in East Asia (Cho & Lee, 2000). Due to them being at different stages of demographic transition, the rate of birth decline is not constant across countries, although the trend is clear (Figure 1).

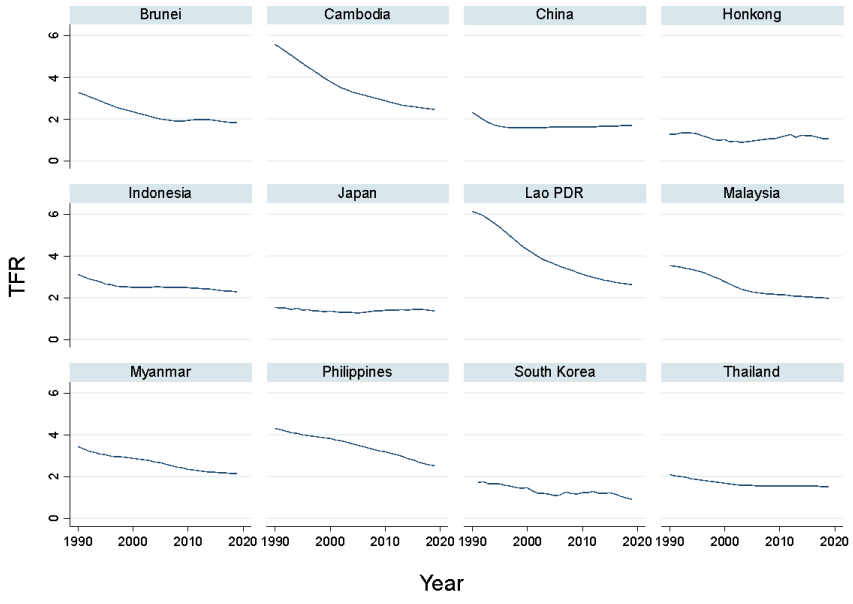
China is a unique case as unnaturally stepping into the aging process because of implementing one of the world's strictest family planning programs, the one-child policy, in the late 1970s (Feng et al., 2016). It is a family planning policy for manipulating and shaping the population structure to counter over-rapid population growth by reducing TFR. The estimate of '400 million births averted' is attributed to the population control policy. TFR has dropped significantly to a level between 1.5 and 1.7 births per woman which has remained the same until now (Goodkind, 2017; Zeng & Hesketh, 2016). In response to the country's falling birth rates, population aging, labor shortages and the pressure on social welfare programs, the relaxation of China's strict one-child policy must be implemented for the country's development and prosperity (Hesketh et al., 2005; Hesketh et al., 2015). In November 2011, the one-child policy was replaced by a universal two-child policy, implemented in all provinces until 2015 (Zeng & Hesketh, 2016). Moreover, the Chinese government announced that it would scrap the two-child policy, favouring a three-child policy to mitigate a steep reduction in birth rates in May 2021. However, some argue that the long-standing population control policy has changed people's concepts regarding marriage, birth and family and the effects of fertility promotion policies may struggle to reverse entrenched ideation (Chan et al., 2015; Li & Jiang, 2019; Cao et al., 2010).

Nowadays, the reasons and the remedies vary across countries to reverse the tide in advance, but some general statements were applied. From 1990 to 2006, Japan has modified and established 6 different laws such as "Child Welfare Law" and "New Policy to Cope with Low Fertility". South Korea promulgated "The First and Second Basic Plan on Low Fertility and Aging Society" during 2006-2010 to raise fertility level (Zoubanov, 2001; Lee & Choe, 2010). Similarly, Hong Kong and Thailand also enacted plans for long-term population development. Those policies aim to support and encourage the sharing of parental leave, improve the flexibility of switching to part-time work with the right to return to a full position, expand childcare institutions and provide maternity leave and family allowances (Lee & Choe, 2010; Cho & Lee, 2000; Zoubanov, 2001). Governments support more welfare services and a better

environment for childbearing to promote fertility. But these intervention policies seem to be only able to maintain and smooth current childbirth rates rather than leading to recovery. United Nations (2013) reports that South Korea's total population could shrink to around 51.2 million in 2050 before dropping to 37.7 million in 2070.

Along with the 30 years of economic miracle among Asian societies, women's improved status accompanied by education reformation, the conflicts between women's new social values and traditional household duties division have increased steadily. The Confucianism and patriarchal family system deeply rooted in the East and Southeast Asian culture for thousands of years, women are more likely to bear unsatisfied marriages due to financial reasons, wage discrimination and social norms. Relevant evidence has shown an increasing willingness to bear more children for women in a more inclusive and open-mind society that shows no discrimination against divorce, singlehood, and reorganized family (Dahlin & Härkönen, 2013). However, even in some Asian countries which actively eliminate gender inequality, cohabitation (only accounted for 3% in Japan, and less than 1% in South Korea and China) and ex-nuptial births are still unacceptable by the mainstream (Jones, 2012). The socio-economist Easterlin tries to predict demographic trends using the relative income hypothesis, which is measured by the couple's current income (earning expectation) to the previous parents' income (material aspiration). Households will be less willing to marry and have children as more economic pressure on the couple, help explain the low birth rates among young adults in Asia in recent decades.

Figure 1 Total Fertility Rate in Southeast and East Asia



3 Literature Review

This chapter reviews previous research associated with socio-economic and demographic determinants of fertility, mainly focused on Asia, East and Southeast Asia. The prior studies regarding two-child policy are shown at the end of the section. The first systematic classification of the proximate determinants of fertility through which economic, social and cultural factors could influence fertility was proposed by Davis and Blake (1956). They showed that the framework is useful for performing comparative fertility analysis. It was further modified by Bongaarts (1987) who identified a smaller set of intermediate fertility variables such as contraceptive use and induced abortion. Based on these researches, some socio-economic and demographic factors have further been suggested as possible causes of fertility: female education, inflation, urbanization, income, female employment and infant morality (Lai et al., 2021; Manuelli & Sheshadri, 2009; Becker & Barro, 1988; Barro & Becker, 1989).

We start with the literature that investigates at least four intermediate variables in their studies and then turn to the subsection for each variable. Götmark and Andersson (2020) analyse recent fertility levels with five factors: education (mean school years for females), income per capita, religiosity, contraceptive prevalence rate, and strength of family planning programs. Based on a sample period of 2010-2015 in 141 nations with linear least square regressions, TFR correlates negatively with education, prevalence rate, and GDP per capita, and positively with religiosity in the regions of Asia. Based on data from selected Asian entities and other regions in the world from 1955 to 1985 with a covariance analysis, Siddiqui (1996) argues that the result varies significantly across countries. The aggregate income is negative and statistically significant in low-income countries but positive and statistically insignificant in middle- and high-income countries. The effect of urbanization and education (female literacy) is negatively correlated with TFR in low- and middle-income counties. While, the influence of infant mortality is positively related to TFR in most cases.

Furthermore, Pathak and Murty (1982) attempt to analyze the contribution of six socio-economic and demographic factors in determining the level of fertility based on available data for 13 Asian countries for the year 1975. By utilising path and stepwise regression analysis, the results show that income per capita, education (female literacy) and urbanization were linked to TFR decline. Female population and infant mortality were linked to TFR increase. Behrman and Pilar (2020) obtain similar results that TFR is negatively associated with female education attainment (secondary school enrolment), employment rate and GDP in Asia, by

compiling a multivariate regression analysis to a dataset from 1960 to 2015. Focused on Southeast Asia, Dartanto (2009) investigates the impact of five socio-economic and demographic factors on TFR by using panel data throughout 2003 to 2008 and the fixed-effects method. The scholar found a significant negative correlation between fertility and female education (secondary school enrolment), urban population and consumer price index. While infant mortality and income per capita have a significant positive impact on TFR in selected 12 Southeast and South Asian countries.

Income per Capita

The relationship between fertility rate and income per capita has received much attention from scholars. Bloom et al. (2010) point out that population aging driven by fertility decline may not significantly impede economic performance in Asia in the long run by employing OLS and instrumental variable estimation techniques to annual data between 1960 and 2005. However, Ha and Lee (2018) found a significant inverse association between income per capita and TFR using annual data from 1970 to 2014 with fixed- and random-effect methods. In East Asia, Song (2013) studied the link between demographic transition in which a country transitions from high fertility and mortality rates to low fertility and mortality rates and economic growth. By applying multiple regression models to annual data from 1965 to 2009, a negative correlation between growth rates of GDP per capita and TFR in all models has been found. By analyzing data from 20 different European countries between 1990 and 2012 with fixed effects models, Fox et al. (2015) propose that the relationship between fertility and income turns positive at high levels of development. A U-shaped pattern between aggregate income and fertility has been found.

Female Education Attainment

Numerous studies have shown convincingly the fertility-reducing impact of advances in female educational attainment, which is one of the key components of women's empowerment. Martin (1995) examines the effect of women's education (secondary school enrolment) using data from the Demographic and Health Survey for 26 countries with linear regression models. The results of three Asian counties, Indonesia, Siri Lanka, and Thailand, reveal that fertility levels are substantially lower among the better educated. Sheikh and Loney (2018) study the association between these two variables in South Asia. By using a systematic review technique, the researchers found a rise in education (female literacy) at the population level will contribute to a decline in fertility and population growth in a sample period running from 1970 to 2016.

Cornett (2020) examines the literature on the connection between female education (secondary school enrolment) and TFR with a focus on developing countries and concludes that the higher the level of a woman's educational attainment, the fewer number of children she is likely to bear, and this effect is shown in countries and cultures around the world.

Labor Force Participation

The remaining factors of women's empowerment are female employment and wage. Nazah et al. (2021) study the effect of female labour force participation and fertility in cross-country panel datasets from 39 Asian countries, using panel autoregressive distributed lag analysis from 1990 to 2018. The results reveal that female employment was negatively significant on fertility in the short run but not in the long run. Using a similar estimation technique, Shittu and Abdullah (2019) found a negative relationship between these two variables from seven Asian countries spanning from 1990 to 2015. The results are consistent with Abdullah and Bakar (2011) who examine the causal relationship in the four selected Asian countries covering the period of 1980-2008. After this investigation, Abdullah et al. (2013) attempt to identify the ambiguous relationship between fertility and women's labour force participation in Singapore, Thailand, Indonesia, the Philippines, Vietnam and Malaysia using panel data for 1995-2009 with Granger-causality tests. The results show that female employees do not granger-cause fertility rate in all six Southeast Asian countries. Moreover, Nakagaki (2018) found an increase in female employment and women's wage led to a decline in TFR in East Asia from 1990 to 2014 with a fixed-effects estimation method.

Female Wage

In Europe, the negative connection between female income and TFR in West Germany has been investigated by Andersson et al. (2014), applying event history techniques to German and Danish register data from 1981 to 2001. However, they found a rather positive relationship in Denmark. Still in Europe, Siegel (2012) argues that the common force behind observed trends in fertility decline covering from 1965 to 2015 and hours worked is narrowing the gender wage gap. By employing general regression models, the relatively increased female labour income leads to total home production falls. There is a limited number of evidence of Asia in determining the impact of women's wages. By analysing secondary data for the year 2006 with a multivariate analysis of covariance, Call et al. (2008) suggests that women's earnings are negatively related to fertility in Singapore. Using data from 1955 to 1980 and a time series analysis, Osawa (1988) found a very weak association between female income and fertility in

Japan. The scholar believes that the weak estimate was caused by the small number of relevant registered microdata.

Infant Mortality

One of the influential main factors is healthcare-related factors. The early research in Asia and the Pacific region has been conducted by United Nations (1985). Extracting data from the World Fertility Survey (WFS) during the 1950-1980 period in the selected ten countries with multiple classification analyses, they propose that reducing child mortality is an important factor in reducing fertility, particularly in Nepal, Bangladesh and Pakistan. Data collected from the WFS throughout 1950-1975 with a time series analysis, Benoit et al. (1984) found a positive relationship in Bangladesh, Fiji, Indonesia, Pakistan, Sri Lanka, Thailand and South Korea. Concentrated on Southeast and East Asia, Chowdhury (1988) obtains a positive causal link in Myanmar, Malaysia, Thailand, South Korea and the Philippines in a sample period from 1947 to 1983 based on Granger-causality tests. Overall, lower (or higher) infant mortality might induce lower (or higher) fertility and the two variables are most likely to move forward in the same direction.

Contraceptive Prevalence Rate

Hirschman (2001) reviews the existing literature on the link between contraceptive prevalence rate and TFR and believes that the increased use of contraceptives is the most important factor in the TFR decline in Southeast Asian countries from 1965 to 1995. United Nations (1985) presents data on contraceptive prevalence from 26 national sample surveys conducted in the Asian and Pacific regions during the 1966-1984 period. It was less than 20% in Asia and the Pacific region in the late 1960s. By the early 1980s, it had spread throughout all parts of society. The rates in some countries were over 50%. In previous research, Bongaarts (1978) has established that a rise in contraceptive use is the main proximate cause of a decline in fertility over the period of 1960 to 1970 in South Korea, estimated by means of reproductive models. Furthermore, Rabbi and Kabir (2014) re-examine the empirical relation between fertility and contraception using secondary data from 74 developing countries from Demographic Health Surveys with linear regression models. The results indicate an association between a decline in the expected level of natural fertility and an increase in prevalence rate during the period of 1981-2011 in selected Asian nations.

Urbanization and Female Population

A growing body of literature has investigated the urban-rural differentials in fertility in several non-developing countries. Skeldon (1992) investigates the relationship between fertility and mobility about Zelinsky's mobility transition hypothesis in East and Southeast Asia. By employing time series analysis, the scholar argues that fertility declined before substantial urbanization took place in Japan, South Korea, Thailand, Malaysia and China between 1955 and 1989. Moreover, Guo et al. (2012) aim to illustrate how much urbanization contributed to China's fertility decline between 1982 and 2008 by utilizing a decomposition approach. Their findings suggest that urbanization is associated with a decline in provincial-level fertility in most provinces of China. There is very little research on the female population and TFR. The increased female population can lead to a substantially higher birth rate (Laidlaw et al., 1980).

Consumer Price Index

In recent years, the most popular possibilities for fertility decline are the heavy costs of housing, education, living and the changes in people's concepts of birth in Asia (Wang & Hesketh, 2018). Therefore, many studies attempt to investigate the influence of living standards on TFR. Using annual data at the aggregate level from 1990 to 2019 in Singapore and a multiple time series analysis, Saguin (2021) found a significant negative long-run effect between fertility and the costs of living of which housing price contributes the most variations. The results are consistent with Yi and Zhang (2010) and Clark et al. (2020). They use annual data between 1971 and 2005 in Hong Kong with a cointegration analysis and annual data between 2013 and 2017 in China with a time series analysis. Regarding the child-rearing expenses, Kim et al. (2017) found a significant negative relationship between birth rates and the anticipated financial costs for raising a child in South Korea, by employing kernel matching in a sample period ranging between 1970 and 2014.

Two-child Policy

Chen et al. (2022) measure the association of China's two-child policy with changes in births by applying a difference-in-difference (DID) approach to annual data between 2008 and 2017. The results reveal that the monthly percentage of births increased by 0.24 percentage points, suggesting a significant positive impact of the two-child policy on China’s TFR. Their findings are in line with Li et al. (2019) who use the DID approach and annual data from 2000 to 2017. Lu (2018) analyses the effects of a relaxed family-planning policy to explore the impacts of this relaxation on the marriage market and the fertility effect. The probability of giving birth to a second child is positive and significant in a DID design based on annual data

covering from 1965 to 2010. And the marriage effect is stronger in urban areas where the one-child policy was previously implemented more rigorously. In contrast, Zeng and Hesketh (2016) argue that the two-child policy seems less likely to lead to a baby boom in a short time period. But the many negative effects of the one-child policy will disappear, based on a comparative study through 1950-2014. Wang and Sun (2020) apply multinomial logistic regressions to survey data to test the effects of social, demographic, behavior and cultural factors on people's intention to have more children. They found that the government policy is likely ineffective in stimulating a higher fertility rate in the short term. Family income and cultural factors exert a larger impact on Chinese people's intention.

In general, empirical studies on fertility conducted in East and Southeast Asia are relatively scarce both in numbers and in variation of methods. The main contribution of this study is a large number of explanatory variables and the updated longitudinal data (1990 to 2019). To distinguish between prior research, we employ a regression discontinuity (RD) design to study government policy. A summary of the literature review is presented in Table 1.

Table 1 Literature Review on Study Variables

Stuey Variable	Litterature Sources and Empirical Evidences
Income per Capita	Bloom et al. (2010); Ha & Lee (2018); Song (2013); Götmark & Andersson (2020); Siddiqui (1996); Dartanto (2009); Pathak & Murty (1982); Dartanto (2009); Fox et al. (2015)
Female Education Attainment	Martin (1995); Sheikh & Loney (2018); Cornett (2020); Götmark & Andersson (2020); Siddiqui (1996); Dartanto (2009); Pathak & Murty (1982); Behrman & Pilar (2020)
Female Labor Force Participation	Nazah et al. (2021); Shittu & Abdullah (2019); Abdullah & Bakar (2011); Nakagaki (2018); Behrman & Pilar (2020); Abdullah et al. (2013)
Female Wage	Andersson et al. (2014); Siegel (2012); Call et al. (2008); Osawa (1988); Nakagaki (2018)
Infant Mortality	United Nations (1985); Benoit et al. (1984); Chowdhury (1988); Siddiqui (1996); Dartanto (2009); Pathak & Murty (1982)
Contraceptive Prevalence Rate	Hirschman (2001); United Nations (1985); Rabbi & Kabir (2014); Götmark & Andersson (2020); Bongaarts (1978)
Urbanization and Female Population	Skeldon (1992); Guo et al. (2012); Laidlaw et al. (1980); Siddiqui (1996); Dartanto (2009); Pathak & Murty (1982)
Consumer Price Index	Saguin (2021); Yi & Zhang (2010); Clark et al. (2020); Kim et al. (2017); Dartanto (2009)

4 Methodology

This chapter illustrates the primary sources of data and some data analysis. The estimation techniques for socio-economic and demographic determinants of fertility and two-child policy will be modelled afterwards.

4.1 Data

This study is performed in a balanced panel data setting. All (except contraceptive prevalence) have been extracted from the World Development Indicator, which is the primary World Bank database for development data from officially-recognized international sources. The database provides data with the highest quality by using standards, methodologies, sources, definitions, and internationally accepted classifications (The World Bank, 2021b). Hence, the variables implied in this study are legitimate to be used for econometric analysis. Contraceptive prevalence rate has been obtained from the United Nations and TFR in the provinces of China from National Bureau of Statistics. The interest period is selected between 1990 and 2019, 2020-2021 are not included because the latest values are until 2019. Moreover, the pandemic (COVID-19) might negatively impact female fertility (Carp-Veliscu et al., 2022; Li et al., 2021; Wang et al., 2021). Our analysis attempts not to take additional influential factors into account. Table 2 presents the variables' names, descriptions and expected signs, which are based on previous research. We have nine study variables and one predicted outcome. Infant mortality and female population are only expected to be positively correlated to TFR.

Table 2 Description of Variables and Expected Signs

Variable Name	Variable Symbol	Variable Description	Expected Signs
Total Fertility Rate	TFR	The total number of births per woman throught her childbearing years (15-49)	Predicted variable
Real GDP per Capita	GDP	A measurement of the total economic output of a country divided by the number of people and adjusted for inflation in a given year, measured in constant USD	−
Female Education Attainment	SSERF	Secondary school enrolment, female (% of female population gross)	−
Labour Force Participation	FLFPR	Labour force participation rate, female (% of female population 15+)	−
Female Wage	FEMWAG	Wage and salaried workers, female (% of female employment)	−
Infant Mortality	IMR	The number of deaths per 1,000 live births of children under one year of age	+
Contraceptive Prevalence Rate	CPR	Women of reproductive age (15-49 years) who are currently using any method of contraception (% of total population)	−
Urban Population	UP	The number of people that are living in urban area (% of total population)	−
Female Population	FEMPOP	Percentage of total population that are female	+
Consumer Price Index	CPI	The weighted average of prices of a basket of consumer goods and services in a given year (2010=100)	−

A summary of the variables for the selected 12 Southeast and East Asian countries through 1990-2019 is shown in Table 3. Demographic variables such as TFR, contraceptive prevalence rate, infant mortality and urbanization population on average are 2.36 births per woman, 39.15%, 27.97 per 1000 live births and 53.38%, respectively. The country with the smallest total home production (0.90) is South Korea. For economic indicators, Hongkong yielded the highest GDP per capita (45284.86 USD) and the largest living costs take place in Myanmar (168.18) in 2019. Regarding the social variables, female secondary school enrolment has a relatively high value on average of which Lao PDR has the lowest number of students enrolled in secondary education (16.01) during the year 1992, meanwhile, it contributes to the highest rate of infant mortality (105.90).

Table 3 Descriptive Statistics

	Obs	**Mean**	**Std. Dev**	**Min**	**Max**	**Skewness**	**Kurtosis**
Predicted Variable							
TFR	360	2.36	1.06	0.90	6.15	1.08	4.10
Study Variable							
CPR	360	39.15	14.80	7.40	69.40	0.12	2.35
GDP	360	11922.47	13602.55	183.82	45284.86	0.89	2.15
CPI	360	83.48	32.73	1.68	168.18	-0.68	3.12
FLFPR	360	57.68	11.22	43.09	81.87	0.76	2.18
IMR	360	26.31	25.23	1.29	105.90	1.13	3.36
FEMWAG	360	53.13	28.89	4.00	96.13	0.01	1.78
FEMPOP	360	50.14	1.24	47.26	54.03	0.33	3.16
SSERF	360	70.98	26.93	10.01	123.61	-0.61	2.32
UP	360	53.88	25.55	15.44	100.00	0.30	1.85

Figure 2 plots the study variables and TFR in each selected entity. There is an increasing trend of contractive prevalence rate, female education attainment, female wage, urban population, price fluctuation and GDP across 12 countries. Infant mortality and TFR have decreased in all entities, as expected. Female population is, however, remaining at a steady level in most nations and some have experienced female employment decline, for instance, Thailand, Myanmar and Lao PDR. Cambodia, Myanmar and Lao PDR have more than 50% of the population living in non-urban areas until 2019. The figure is a general overview of the variables of interest. We aim to investigate the total effects in the Southeast and East Asia rather than the effect on an individual level. Nonetheless, it is quite interesting to see their developments with broad

similarities over the past three decades. Table 4 presents the possible relationship between the intermediate fertility variables and TFR. It is positively associated with FLFPR and IMR and negatively related to others. CPR yields the strongest negative relation to birth rates, whereas IMR yields the strongest positive relationship.

Figure 2 An Overview of the Interests Variables

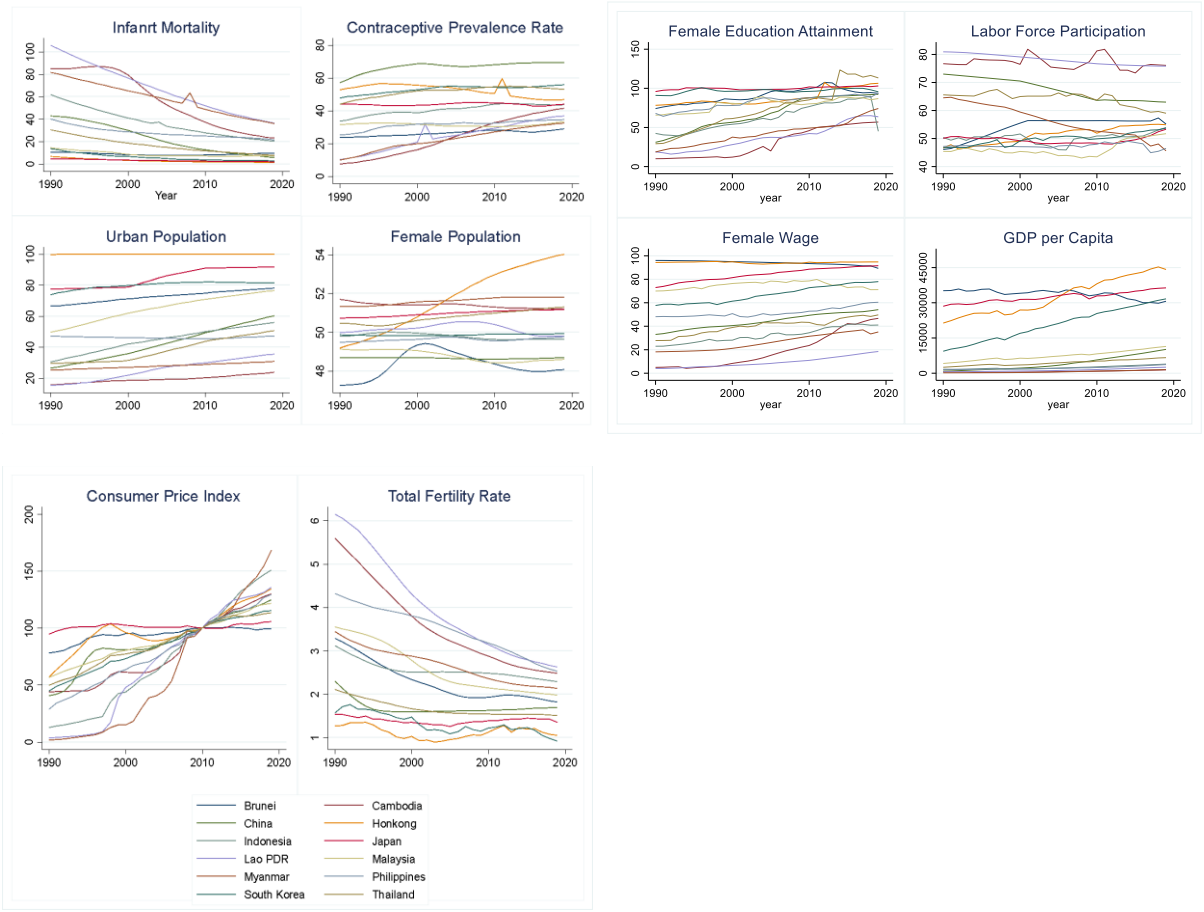


Table 4 Correlation Matrix

Variables	TFR	CPR	GDP	CPI	FLFPR	IMR	FEMWAG	FEMPOP	SSERF	UP
TFR	1									
CPR	-0.78	1								
GDP	-0.57	0.22	1							
CPI	-0.55	0.40	0.37	1						
FLFPR	0.40	-0.16	-0.41	-0.20	1					
IMR	0.80	-0.63	-0.66	-0.64	0.62	1				
FEMWAG	-0.63	0.33	0.86	0.45	-0.68	-0.87	1			
FEMPOP	-0.05	-0.10	0.05	0.00	0.19	0.23	-0.20	1		
SSERF	-0.52	0.35	0.62	0.54	-0.55	-0.72	0.70	-0.11	1	
UP	-0.68	0.41	0.87	0.41	-0.66	-0.82	0.92	-0.07	0.73	1

4.2 Research Design

This study proposes an econometric panel data model for estimating Southeast and East Asia fertility. The use of panel data allows us to control unobservable country-specific characteristics that may be correlated with fertility behaviour, whereas a time series or cross-section study cannot.

There are three approaches for estimating this panel: fixed-effects (FE), random-effects (RE) and pooled OLS estimation. The selection of estimation method depends on the treatment on the individual effect (α_i), taken to be constant over time *t* and specific to the individual cross-section unit *i*. Both FE and RE can capture unobserved time-invariant characteristics. However, the crucial distinction between fixed- and random-effects is whether the unobserved individual effect contains elements that are correlated with the regressors in the model, not whether these effects are stochastic or not (Greene, 2008, p.183). Hausman test is the main diagnostic test used to decide between fixed- or random-effects. Breusch and Pagan Lagrangian Multiplier (LM) test should be performed to distinguish between RE and OLS. The main benefit of FE estimations is that the potential sources of biases in the estimations are limited compared to pooled OLS and RE (Collischon & Eberl, 2020). The FE regression model is presented as:

$$\mathrm{T}FR_{it} = \beta_1 X_{1,it} + \cdots + \beta_k X_{k,it} + \alpha_i + \varepsilon_{it} \quad (1)$$

where entity i =1, ..., 12, time t =1, ..., 30 and the number of study variables *k* = 1, ..., 9. $X_{k,it}$ is the proximate determinants of fertility, α_i represents entity-specific intercepts that apprehend heterogeneities across countries and ε_{it} is the error term.

Unlike the FE, the RE model allows variations across entities to be random and uncorrelated with the predictor or independent variables. An advantage of RE estimation is that time-invariant variables can be included. In the FE model, these variables are absorbed by the intercept. The RE regression model is presented as

$$\mathrm{T}FR_{it} = \beta_1 X_{1,it} + \cdots + \beta_k X_{k,it} + \alpha + u_{it} + \varepsilon_{it} \quad (2)$$

where u_{it} is between-entity error and ε_{it} within-entity error.

The log-log linear regression model is applied to FE, RE and OLS. Take the natural logarithm on both sides of the equation to interpret coefficient estimates as an expected percentage change in the predicted variable when explanatory variables increase by some percentage.

In policy-relevant studies, "Regression Discontinuity in Time" (RDiT) allows modifying the running variable to be an exact threshold time of treatment. Some types of empirical analysis such as environmental economics, international trade or public policy adoption are hardly practiced within a normal RD or DID without available cross-sectional variation in specific policy implementation. RDiT is conceptually similar to the normal RD but changes the running variables to time-series data in a certain geography region. In the typical RD framework, the causal average treatment effects are identified by comparing the consequences in control and treatment groups after introducing a randomly assigned subject. Equation 3 demonstrates the concepts mathematically. When treatment variable x_i jumps over the threshold x_0, treatment status D_i equals to 1 as the treatment occurs on one side; otherwise, it will be 0. In our RDiT model, the units are treated by policy for all year $t > x_0$. The units are not treated by policy for all year $t < x_0$.

Model 4 is used for RDiT regression analysis. For the first RDiT regression, we use the year 2000-2011 as the pre-treatment period (before the announcement of the child policy) and the year 2012-2019 as the post-treatment period (after the announcement of the child policy). For the second RDiT regression, we use 2000-2014 as the pre-treatment period (before the policy has spread throughout all provenience of China) and 2015-2019 as the post-treatment period (after the policy has spread throughout all provenience of China). We aim to investigate the influence of government policy on national fertility rate and fertility rates of various Chinese provinces. RD graphs are plotted to provide a compelling source of information about the treatment effect.

$$D_i = \mathrm{D}(X_i) = 1[x_i >= x_0] \tag{3}$$

$D_i = 1$ if $x_i >= x_0$

$D_i = 0$ if $x_i < x_0$

$$TFR_{it} = \alpha_i + f(x_{it}) + \rho D_{it} + \eta_{it} \tag{4}$$

where entity i =1 and time t =1, ..., 20. D is the binary treatment variable that “turns on” when x crosses the threshold, $f(x_{it})$ is the forcing variable function denoting the distance from the threshold and η_{it} is the error term. Here we choose a linear forcing variable function as the basic foundation and apply log-linear model to time series data.

To clarify, we employ log-log models in panel data to investigate the percentage change in fertility as proximate determinants of fertility change by some percentage. Due to dummy variables being incorporated in RDiT regression, we apply log-linear models to identify the estimated percentage change in fertility after enacting government policy.

5 Empirical Analysis

This chapter presents and analyses the choice of models, diagnostic tests, empirical results of the fertility intermediate variables and government policy. Statistical analysis was performed using Stata v. 16.

5.1 Model Selection

The choice of model in panel data is based on the individual specific components and the exogeneity of the explanatory variables. By identifying the presence of endogeneity in the study variables, the Hausman test is used to test whether the fixed- or random-effects model is appropriate, as shown in Table 5. The null hypothesis is that the preferred model is random effects (errors are uncorrelated with the regressors) against the alternative the fixed effects (errors are correlated with the regressors). The Hausman test yields a large Chi-square statistic numerical value of 31.31 (df = 9, p-value = 3×10^{-4}). Reject the null and conclude that FE models are more favourable in this case.

Table 5 Hausman Test

	(b) Fixed	(B) Random	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
LOG CPR	-0.474	-0.449	-0.026	0.029
LOG GDP	-0.049	-0.051	0.002	0.014
LOG CPI	-0.022	-0.010	-0.013	0.004
LOG FLFPR	-1.264	-1.050	-0.213	0.034
LOG IN	0.107	0.086	0.021	0.009
LOG FEMWAG	0.037	0.015	0.022	0.020
LOG FEMPOP	2.681	1.625	1.057	0.088
LOG SSERF	-0.102	-0.083	-0.019	0.010
LOG UP	-0.013	-0.118	0.105	0.018
Test:	H_0: difference in coefficients not systematic Chi2(9) = [(b-B)(V_b-V_B)^(-1)](b-B) = 31.31 Prob > Chi2 = 0.0003 V_b-V_B is not positive definite			

To determine whether we choose RE or pooled estimation, Breusch and Pagan Lagrangian Multiplier (LM) test is applied, shown in Table 6. The null hypothesis is zero variances across entities (i.e., no panel effect). The LM Breusch-Pagan test reports a large Chi-square statistic numerical value of 1051.84 (df = 1) and $p < 0.01$ (p-value = 0). Reject the null and conclude

that random effect is more appropriate than a simple OLS. This is, evidence of significant differences across countries. It suggests that FE is the most appropriate model followed by RE and OLS.

Table 6 Breusch and Pagan Lagrangian Multiplier (LM) test

	Var	sd = sqrt(Var)
LOG TFR	0.185	0.430
e	0.007	0.082
u	0.017	0.130
Test:	Var(u) = 0	
	Chi-square Statistics = 1051.84	
	Prob > Chi-square Statistics = 0.0000	

5.2 Diagnostic Tests

Several tests should be performed before conducting our analysis. It usually assumes that regression disturbances are homoscedastic with the same variance across time and individuals. Heteroscedasticity in FE models results in biased standard errors of the estimates and makes them less precise. To test for heteroscedasticity, the modified Wald statistic is performed. Robust standard errors should be computed correcting for the possible presence of heteroskedasticity. Time dummies are the standard method for longitudinal data to control for unobserved time unit-specific effects. Using the command testparm to observe whether time fixed effects should be incorporated. We conclude that time fixed effects are needed in this scenario. Despite we focus on two Asian regions, the diversity of cultures within Southeast Asia and across the nation is great, which affects fertility behavior. FE would be more efficient in using all possible variations to tackle culture differences than RE in this case.

5.3 Empirical Results

The empirical results of the panel estimates are shown in Table 7. Column 1 reports the estimation results for Model 1 (FE), column 2 reports the results for Model 2 (RE) and column 3 for pooled OLS. Looking at the results of the FE estimation (most favoured specification), the signs of all study variables are as expected and in line with the theoretical expectations. It shows a negative impact with significance at 10% level for Female Education Attainment and Female Wage and with significance at 5% level for Labour Force Participation, Contraceptive Prevalence Rate and Consumer Price Index. Infant Mortality is statistically positively correlated to TFR at 5% level. The remaining variables such as urban and female population

have an insignificant relationship with TFR. In total, six of nine explanatory variables are statically significant. The regression analysis for Model 1 reveals an R^2 of 0.86 which means that 86% of the variation in TFR is explained by the variables included in the study. Furthermore, errors are negatively correlated with the regressors in the FE model.

Turning to RE specification, four of nine explanatory variables are statically significant. The signs of fertility intermediate variables (except infant mortality and price fluctuation) are consistent with FE and the R^2 is 0.80. Labour Force Participation and Contraceptive Prevalence further document their negative and significant (p-value < 0.1) association with the predicted outcome. Infant mortality is in contrast with the expectation at 10% level. Regarding the economic indicator, GDP is only significant in the regression analysis for Model 2. The remaining variables in the categories of empowerment and inhabitant have an insignificant relationship with TFR. Moreover, the intradass correlation is relatively low. F-statistic in both FE and RE shows significance at 1% level and this leads to the rejection of the null hypothesis which states that all the coefficients of variables are jointly equal to zero. Although most estimated coefficients are significant at conventional levels and a high R^2, the pooled OLS specification is not good for modelling this data set based on the LM Breusch-Pagan test.

Female education and female income are statistically significantly positive associated with fertility under FE but not RE. The results reveal that TFR will decrease by 0.102% and 0.187% if female education and wage increase by 1%. Labour force participation rate has obtained a significant negative sign under all three models. It suggests that TFR will reduce by 0.784% with a 1% increase in female employment. The coefficient estimates of infant mortality are significant and positive, except for pooled estimation. TFR increases by 0.23% among women as the infant mortality rate increases by 1%. Contraceptive prevalence rate under all three models yields significant positive signs where a 1% increase in contraceptive usage lowers fertility by roughly 0.47%. A 1% increase in the urban and female populations will lower fertility by 0.013% and boost fertility by 1.955%, respectively. But the estimations are statistically insignificant. Income per capita is negatively correlated with birth rates but is statistically insignificant in the regression analysis for Model 1. The estimates under RE yield the largest negative coefficient. Consumer price index as an indicator for the cost of living has a significant negative relationship with fertility under FE but an insignificant and positive correlation under RE. A 1% increase in CPI will reduce TFR by approximately 0.13%.

Table 7 The Impact of Socioeconomic and Demographic Determinants of TFR

Variable	Model (1) FE	Model (2) RE	Pooled OLS
Empowerment			
Female Education Attainment	-0.102*	-0.062	-0.100
	(0.06)	(0.06)	(0.03)
Labour Force Participation	-0.784**	-0.894***	-0.631***
	(0.33)	(0.24)	(0.11)
Female Wage	-0.187*	-0.126	-0.131***
	(0.09)	(0.12)	(0.03)
Health			
Infant Mortality	0.230**	-0.178*	0.037
	(0.10)	（0.10)	(0.03)
Contraceptive Prevalence Rate	-0.474**	-0.258*	-0.516***
	(0.19)	(0.15)	(0.02)
Population			
Urban Population	-0.013	-0.082	-0.206***
	(-0.15)	(0.14)	(0.07)
Female Population	1.955	1.422	-4.487***
	(1.47)	(1.34)	(0.56)
Economy			
Real GDP per Capita	-0.139	-0.156**	-0.045*
	(0.08)	(0.08)	(0.02)
Consumer Price Index	-0.128**	0.046	0.121***
	(0.09)	(0.05)	(0.02)
Constant	2.370	2.599	24.254***
	(7.30)	(5.87)	(2.56)
N	360	360	360
R-squared	0.86	0.80	0.88
F-statistic	125.76***	1090.53***	295.98***
rho	0.98	0.79	-
corr(u_i, X)	-0.18	0.00	-

Robust standard errors in parentheses ***p < .01, **p < .05, * p < .1

5.4 Two-child Policy in China

In this subsection, we aim to observe whether two-child policy significantly influences fertility (national level and provincial level). China implemented a strict family planning program in the late 1970s, leading to a substantial decline in birth rates. As China's fertility level has continuously declined over the past decades, the government designed pronatalist policies to increase births. Due to no single factor that can fully explain fertility behavior, we shed light on the effectiveness of government policy and to what extent fertility behaviour can be affected by government intervention, by studying reforms to China's one-child policy. The specific implementation of the two-child policy and the corresponding timing are as follows. In November 2011, the first phase of the two-child policy was implemented across China. The policy states that families in which one or both parents are only children, or registered as rural residents, or divorced and reconstituted families or living in special autonomous regions can apply for permission to have a second child. Penalties for the birth of a second child are removed simultaneously. In 2015, the second phase of the two-child policy was implemented. It abolished the one-child policy for all people and initiated benefits such as free childcare for the second child to encourage childbirth.

5.4.1 Threshold and Bandwidth Selection

Due to the announcement of policies differ among provinces, municipalities and autonomous regions, some local governments may be late in responding. The implementation of the two-child policy was completed across China in 2015. Given that it usually takes about a full year from family planning conception to the natural birth of a child, we choose 2011 as the threshold for the first RDiT design and 2014 for the second. Regarding the bandwidth selection, we selected the yearly fertility rates from 2000 to 2011 and from 2000 to 2014 as the pre-policy period for the first and second regression, respectively. To exclude the pandemic effects, we selected the post-policy from 2011 to 2019 and 2015 to 2019. The reason for not choosing 1990 and onwards is that fertility provided by the National Bureau of Statistics of China is from 2000. Usually, in RD designs, researchers conduct a test of manipulation related to continuity of the running variable density function. However, time-series data are applied in RDiT models with the policy year as the threshold, we skip the test of the density and continuity of the forcing variable in this particular case.

5.4.2 Regression Discontinuity Plots

Our RD plots consist of two parts. We first analyse the trend of fertility rates after the two-child policy in China. Then, we carry out a separate RD graph in 6 typical regions and provinces, taking into account each province's inevitable initial demographic, economic and local policy differences. Figure 3 illustrates the general impact of government policy at the national level. There was a clear “jump” but a year-on-year decline followed this increase. It may be due to the policy's propaganda effect, which encouraged people who already had the desire to have children to give birth. But the effect remained shortly and did not prevent fertility from continuing to reduce.

Figure 4 shows the response to the two-child policy in 6 most densely populated provincial administrative regions and municipalities directly under the central government. It includes the capital–Beijing, the economics centre–Shanghai and the other four provinces, Henan, Sichuan, Shandong, Guangdong, located in the central, southwestern, north-eastern and south-eastern regions, respectively. Almost every province experienced some degree of birth rates increase within one or two years after implementing the two-child policy. Sichuan and Henan have the most significant changes. The yearly birth rates in Sichuan province increased by nearly 11% after 2011, and similarly, Henan's birth rates increased by about 1.5 percentage points, even if the rates dropped two years later. Meanwhile, it continued to rise year after 2011 in Guangdong and Shandong, although there was no significant "jump" immediately around the threshold. Such a phenomenon illustrates that there might be lag effects in responding to child policies in some provinces.

For Beijing and Shanghai, the results of implementing the two-child policy in these two cities are similar. Unlike the other provinces, a modest effect on fertility can be observed. It experienced a little increase and then dropped back at pre-child policy levels. One plausible explanation is that Beijing and Shanghai, as the cities with the highest house prices and consumption index in China at the moment, result in extremely high costs of raising children. Moreover, prior to implementing the two-child policy, more high-income earners could effortlessly afford the fine for having more children. Therefore, a proportion of the high-income population already had more than one child, mitigating the impact of the two-child policy to some extent.

Figure 3 The Effect of the Two-child Policy (China Total)

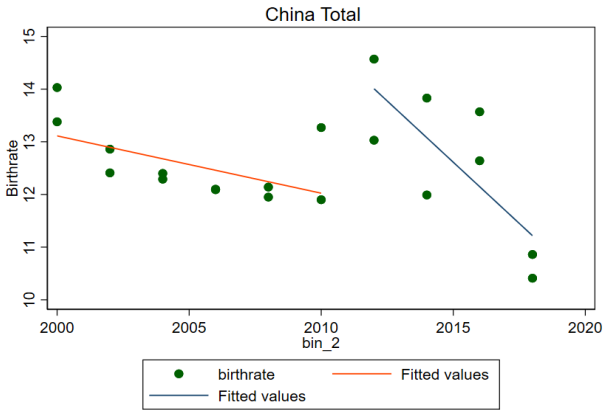
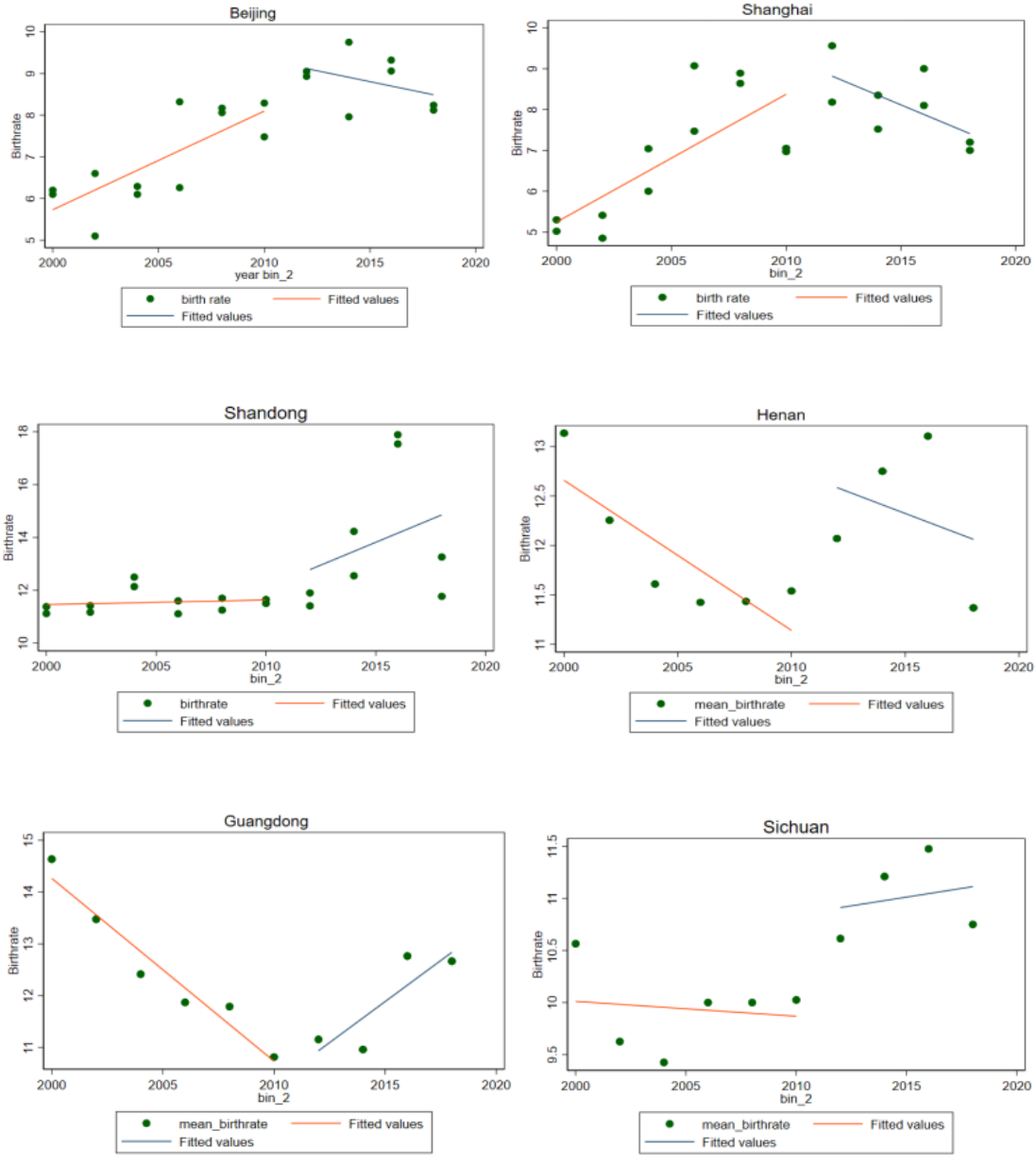


Figure 4 The effect of the Two-child Policy in Different Province



5.4.3 Regression Discontinuity Results

Due to differences in the stringency and timing of policy implementation by each local government, the policies in the model are divided into Phase 1 and Phase 2, labelled policy2011 and policy2014, respectively. The district started implementing policies in 2011 if policy2011 is significant. policy2014 is significant, suggesting that the district was not affected until the second stage policy was implemented. For simplicity and ease of understanding, only the second stage results (policy2014) are shown in the table if the results of the first stage are insignificant. The first stage results (policy2011) will be reported given that none of them is significant.

Table 8 presents the results of the log-linear model with dummies. Column 1 to column 3 display the second child fertility rates at different age levels. The rate of women having a second child increases significantly across all age groups after implementing the second stage of the comprehensive two-child policy. The increase is most pronounced in the 20 to 24 age group, implying a 7.576%[1] increase in the total number of second births. Column 4 reports the policy impact on the national fertility rates. The policy shows its effect after the first stage, which has resulted in a significant increase by 0.237%[2]. Table 9.1 and Table 9.2 present the influence of the two-child policy in 11 provinces. There are 31 provinces in China (exclude Hong Kong, Macao and Taiwan). The impact of the government policy in the remaining provinces is shown in the Appendix.

Similar to the findings of the RDiT scatterplot, the two-child policy has generally led to a positive impact on fertility in most provinces, with only a few regions such as Beijing and Shanghai experiencing very limited growth. Yunnan, Shandong, Guangdong and Liaoning, the four provinces that responded most positively to the two-child policy. While Tianjin being the only region to show a counterfactual downward trend. Some ethnic minority autonomous regions (Guangxi, Ningxia and Inner Mongolia) have not been significantly affected, possibly because the population of these provinces have been exempted from the strict family planning policy. Couples of ethnic minority origin can legally have multiple children in defiance of the one-child policy). Thus, imposing the two-child policy has only affected non-ethnic minority

[1] If D switches from 0 to 1, second childbirth rates among age20-24 will increase by $e^{(2.149)}$ -1 percentage.
[2] If D switches from 0 to 1, national fertility rates will increase by $e^{(0.213)}$ -1 percentage.

groups which occupied a low population proportion in these regions. Overall, the policy shows its positive impact in 20 provinces.

Table 8 Two-child Policy Effects on Fertility Rates and Second Child Birth Rates by Women Age Groups

	(1)	(2)	(3)	(4)
Variables	**Age20-24**	**Age25-29**	**Age30-34**	**Fertility Rates**
year	0.048	-0.008	-0.007	-0.020***
	(-0.03)	(-0.03)	(-0.04)	(0.00)
policy2014	2.149***	1.761**	1.727**	
	(-0.64)	(-0.62)	(-0.72)	
policy2011				0.213***
				(-0.05)
Constant	-90.342	22.444	21.401	43.192***
	(-58.86)	(-51.37)	(-72.05)	(-9.02)
N	20	20	20	20
R-squared	0.71	0.50	0.45	0.55

Robust standard errors in parentheses ***p < .01, **p < .05, * p < .1

Table 9.1 Two-child Policy Effects in Different Province

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**Liaoning**	**Chongqing**	**Beijing**	**Shanghai**	**Sichuan**	**Hainan**
year	-0.023**	-0.003	0.020**	0.034**	-0.003	-0.007**
	(-0.01)	(-0.01)	(-0.01)	(-0.01)	(-0.01)	(0.00)
policy2014	0.177**					
	(-0.08)					
policy2011		0.133***	0.067	-0.159	0.143***	0.036*
		(-0.05)	(-0.09)	(-0.15)	(-0.05)	(-0.02)
Constant	48.821**	8.259	-37.223**	-66.306**	8.897	16.179***
	(-17.33)	(-10.10)	(-14.83)	(-26.01)	(-10.28)	(-5.11)
N	20	20	20	20	20	20
R-squared	0.53	0.54	0.65	0.44	0.56	0.51

Robust standard errors in parentheses ***p < .01, **p < .05, * p < .1

Table 9.2 Two-child Policy Effects in Different Province

	(1)	(2)	(3)	(4)	(5)
Variables	**Zhejiang**	**Jiangsu**	**Guangdong**	**Tianjin**	**Jilin**
year	-0.001	0.004***	-0.019***	0.010***	-0.008
	(0.00)	(0.00)	(0.00)	(0.00)	(-0.01)
policy2014	0.083**	-0.033*	0.180**	-0.216***	
	(-0.03)	(-0.02)	(-0.07)	(-0.07)	
policy2011					0.003
					(-0.08)
Constant	4.716	-5.559**	41.165***	-18.622**	18.790
	(-4.22)	(-2.03)	(-8.55)	(-6.86)	(-16.65)
N	20	20	20	20	20
R-squared	0.40	0.33	0.48	0.46	0.21

Robust standard errors in parentheses ***p < .01, **p < .05, * p < .1

6 Discussion

This chapter provides a final discussion regarding the proximate determinates of fertility and two-child policy. A number of caveats are illustrated afterwards.

Empowerment

The socio-demographic analysis of determinants of birth rates show that the higher the educational level of women, the lower the level of fertility, which is in line with Dartanto (2009) who suggest a significant negative relationship between female education and fertility in Southeast Asia. A higher level of education is more likely associated with a higher salary. Women with high education face a decreased ability to participate in the labour force after reproduction and the resulting opportunity costs because working men have comparative advantages in terms of childbearing and related issues. Hence, raising children is the more expensive option for females because of the income forgone. Moreover, due to the increased women's bargaining power on family size and their financial independence empowers them to make decisions on their fertility, the improved social status that comes with higher education could decrease the desire for kids. In addition, educated women have more knowledge of different birth control methods, which helps lower their fertility and leads women to get married later in life. Generally, women are now more likely to obtain a secondary or higher education degree negatively impacts birth rates in East and Southeast Asia.

Women in labour market participation emerge as the most important determinant of fertility out of all other empowerment indicators. Female employment responds significantly to a negative change in home production, which is consistent with Nakagaki (2018) who propose a significant negative impact of female labour force on TFR in East Asia. Similar to education, increased fertility corresponds to certain opportunity costs in labour supply. Females tend to prolong or discontinue work to stay home without accessible and affordable childcare. When childcare costs are comparable to a parent’s income, the opportunity cost of continuing in the labour market is high, leading to one specializing in earning family income and one in child and household chores. Furthermore, the inverse relationship may be traced to the changes in the value of female time and relative economic status. The effective time can be reallocated from childbearing and rearing to investment in human capital if they decide not to give birth, which, presumably, would raise their earnings relative to men. Hence, higher total fertility is associated with lower female labor force participation in developing Asia.

Falling childbirth rates have often been linked to rising female wages. The results display a significant negative correlation, which is similar to Nakagaki (2018) who find a significant negative relationship between women's wage and TFR in East Asia. More women are encouraged to enter the workspace as wage increases, inducing income and substitution effects on fertility for a working woman. According to the labor supply theory, a wage increase is likely to increase labour supply at low wages as the substitution effect dominates over the income effect. Fertility would drop considerably for new entrants as labor-supply increases from no work to full-time work which induce a negative correlation between birth rates and female income. However, a further increase in wages creates a direct income effect, resulting in an increased demand for children. Females have more ability to take care of their kids with a high quality of life without leaving the workforce for a long time. But the high level of wage may also induce them to continue working without reproducing more children. The income effect on fertility is therefore dualism. Moreover, wages are not only a represent of a woman's worth, it also contributes to the valuation of skills and time. Their income improves their families' economic prospects as well as social status. Generally, an increase in female income would result in lower fertility rates.

Health

According to the estimation result, infant mortality (under one-year mortality rate) plays a significant positive role in influencing the increase in fertility rate in Southeast and East Asia, which is in accordance with Dartanto (2009) who state a significant positive association between the two factors in Southeast Asia. This positive correlation suggests that decreased child mortality reduces the demand for children by improving the chances of survival to adulthood. Contrariwise, households will increase total home production to ensure at least one child survives if there is a high risk of child death before growing up. Several reasons could explain why high fertility rates have resulted in high infant mortality rates in developing Asia. First, infant mortality was high in the 1990s because of an underdeveloped health care system and inadequate health professionals, leading to less effective treatment of illness and disease. Until 2019, countries such as Myanmar, Cambodia and Lao PDR have more than 50% of the population living in non-urban areas. It is difficult to provide a strong network of health services to meet the needs of mothers, newborns and children. Second, a family's income plays an important factor. More siblings disadvantage a recent birth by increased competition for family resources. Parents can devote more time and resources to their kids if they produce fewer children and hence low infant mortality. Third, higher fertility among higher-risk

mothers at the youngest and oldest ages could lead to a higher chance of losing children. A young mother may have fewer childbearing skills and women with high maternal age may have an inverse relation with child health.

Contraceptive prevalence under all three models emerges as an important determinant of fertility. The results demonstrate a significant negative association, which is as reported by Hirschman (2001) who believe a negative link between the use of contraceptives and fertility exists in Southeast Asia. During the last three decades, it has increased from 7.4% to 69.4% among women aged 14-49 in Southeast and East Asian entities. One reason behind contraceptive usage rising is family planning programs. Most countries in the Southeast Asia region have improved access to modern contraceptive methods by providing direct support through government-run facilities and indirect support to non-governmental activities. It aimed to stabilize the region's population. China is the country that has put a strong family planning program effort into doing it. The other reason is associated with demand satisfied regarding family planning and women's empowerment. In recent years, households have determined not to increase home production by reducing unintended pregnancies. It addresses women's sexual and reproductive health needs meanwhile achieving desired family size. In addition, women have increased their ability to take household decisions on contraception and more educated women might have less childbearing. Women's unwillingness to give birth and increase effective and affordable modern contraceptive methods have resulted in a fertility decline in East and Southeast Asia.

Population

The estimation for the urban population is negatively but insignificantly related to fertility, which is in contrast with Dartanto (2009) who investigate a significant negative relationship between urban population and births in Southeast and South Asia. One possible reason is that fertility decline appears before substantial urbanization took place in the selected East and Southeast Asian countries. Looking at Figure 2, the trend of urban population has increased slowly in most selected Asian countries compared to other increased trends such as female education and labour force participation, contributing to a moderate impact on total home production. The expectations are that the higher the population shift from rural to urban areas, corresponding to a decrease in fertility rates. Generally because the rise of non-agricultural employment, increases the costs of raising children and the probability of gaining higher education. People have a large chance to make self-development and are more likely to improve

their quality (life and living) rather than quantity (fertility) by moving to urban areas. Furthermore, urban residents have better access to modern birth control that allows urban residents to more effectively reduce childbearing on any desire. Additionally, urbanization may be associated with ideational change. The attitudes toward fertility and childbearing may differ from rural-based men and women.

Theoretically, a higher female population would yield higher reproduction in a country, assuming that all females are willing to give birth and get married. Estimations under all three models show this whereby the coefficient of the female population is positive, but not statistically significant. The increasing female population does not necessarily imply that more children will be born. One possible reason is that a greater share of women will, everything is equal, leave a greater share of women without a partner and hence decrease demand for kids. The other possible reason is gender revolution. As the role and status of women increase, they are given equal chances for education and employment. Women start participating in paid work and continue responsible for housework. While working men do less household chores than their counterparts, leading to the persistence of gender inequality division of household labor. Women tend to delay childbirth to manage their increased workload and to cope with conflictual situations. Other confounding factors such as sterility could also result in less home production. Those with sterility and related issues may not seek interventions due to financial, medical, and cultural constraints to suppress fertility. Generally, the urban and female population do very little to boost births in East and Southeast Asia.

Economy

Higher-income is negatively correlated with fertility under all three models. It is, however, not statistically significant under the fixed-effects model. The results are in contrast with Song (2013) who suggest a significant negative association between fertility and economic growth in East Asia. One possibility of the insignificant factor is that the economy in East Asian countries was growing rapidly but in most selected Southeast Asian countries was growing annually. It has not yet reached a threshold that could significantly influence birth rates, leading to a conclusion that current per capita income is not related to current fertility. It does not necessarily imply that income is irrelevant to births. If households consider income an important factor for reproduction, it takes at least one year from time decision to childbearing. In this case, the current decision on giving birth is influenced by previous income. This postponement effect seems like a vital mechanism that links trends in economic development

to changes in infertility. Moreover, fertility declines with the acceleration of economic growth in East and Southeast Asia. There is a possibility to generate positive correlations between income and fertility in the case of countries at a high level of economic development. A U-shaped pattern between fertility and development exists (Fox et al., 2015).

We found a significant inverse relationship between fertility and standard of living in Southeast and East Asia, which is in line with Dartanto (2009) conducted in Southeast and South Asia. The cost of raising children (include food, clothing, education, etc) is an important factor affecting couples' fertility decisions. CPI has increased rapidly over the past three decades compared to the growth of the economy. The purchasing power decline discourages people from engaging in activities, getting married and giving birth because of poor family income. Even if the selected countries differ in culture, religion, language and ethnicity, they have broad similarities in childrearing. Usually, Asian parents have high academic standards for their kids, boosting the demand for education and hence education expenses. Moreover, high housing prices seem to be a widespread concern for consideration in fertility decisions (Saguin, 2021; Yi & Zhang, 2010; Clark et al., 2020). An adverse effect of high housing costs on the fertility of non-homeowners may exist. In addition, the cultural values make strong economic burdens of children that young people tend not to bear, leading to fertility decline. Unlike Asian entities, direct money expenditures parents make in raising their children from birth up to some specified ages are limited in Western countries. They are encouraged to live independently at university and work to be self-sufficient. The governments support some costs with high social welfare systems that reduce the financial burden on families of children.

In summary, six of nine intermediate variables have significant impact on births. Women's empowerment has been credited as one of the most influential factors in determining fertility levels.

Two-child Policy

Turn to government policy, the results show a significant positive effect on national fertility and fertility rates in most Chinese provinces, which is in accord with prior studies (Chen et al., 2022; Lu, 2018; Li et al., 2019). Besides government intervention, cultural factors play an important role in influencing people's intention to have more children. For instance, individuals from a large family (with more siblings) are more likely to have a large family. Son preference has been singled out as the most salient cultural factor among Chines people's decision on more kids (Wang & Sun, 2020). The decision to have a second child also weighs heavily on the

different opinions of individuals within the family. In traditional Chinese culture, the decision involves lengthy discussions between the couple, the couple's parents, and whoever else would be impacted by the arrival of a second child into the family. The varying input from the multiple family members involved in the reproductive decision can create conflict and tension.

Moreover, rising living standards and lack of social and financial support for families would be additional factors that influence a household's consideration of having two or more. Even if the traditional belief of 'the More the Children, the More the Fortune' was found in every Chinese family, it seems difficult for couples who are highly concerned about childcare costs and who have long working hours to appreciate and practice. The old belief may have less influence on the younger generations. In addition, it is less likely to increase childbearing if individuals found that more kids will not make them happier or bring positive consequences relative to a child-free and fewer kids' lifestyle. Although two-child policy shows its positive impact on national births, fertility increase or decline is not only a result of interventionist government policies. Here we argue that other factors such as socio-economic, culture, beliefs and norms play important roles in facilitating our understanding of fertility decision-making in people.

Our analysis found a unidirectional relationship between fertility and its determinates; however, reverse causality may exist. For instance, lower fertility rates could conceivably contribute to higher female wages. Reverse causality violates the core assumption of both FE and RE models in that strictly exogenous variables cannot be correlated with past, present and future values of the error term. Therefore, the presence of reverse causality introduces bias to estimates from both models. Granger causality and Dumitrescu Hurlin causality are the two methods for testing causality in panel data. Whereas methodological literature has suggested various alternative solutions to tackle endogeneity (e.g., bi-directed between variables). A cross-lagged panel model with fixed effects has been suggested as a way to offer protection against bias arising from reverse causality and omitted variables issues. This approach is commonly a valid technique to identify causal relationships from panel data. However, it might still limit its usefulness in empirical applications due to the approach depends on certain assumptions, such as stationarity.

A number of caveats should be pointed out before concluding. The important fertility intermediate variables, including induced abortion, mean age at marriage, frequency of sexual intercourse and family planning, have not been included. Moreover, we cannot rule out that

fertility decisions have a strong cultural aspect and the past realization of proximate fertility determinants will impact current fertility. In addition, observation period of government policy is generally of short. Researchers using FE regressions and RD designs should at least be aware of issues regarding external validity. The findings might not be generalized to and across other contexts, especially, developed countries. Despite these limitations, the study results are valid and useful for informing policy and practice and a basis for more research on the level of births in East and Southeast Asia in particular.

7 Conclusion

Fertility levels have declined substantially in East and Southeast Asia in the last three decades. This paper investigates socio-economic and demographic factors which explain the fertility transition experienced in the region. By applying a fixed-effects method to panel data from 1990 to 2019, our findings suggest that increased women's empowerment (include female education, labour force participation and wage), access to contraceptive usage, decreased infant mortality and improved living standards have a significant negative impact on childbirth rates. Female employment is the most influential factor. While the remaining proximate determinants of fertility show moderate effects. In addition, this paper sheds light on the government effectiveness of government policy by studying reforms to China's one-child policy. We employ a regression discontinuity design and our results provide strong evidence of that government policy successfully impacted fertility rates in most provinces of China. The percentage of those choosing to have a second child increases significantly for women in their prime childbearing years (20 to 24 years old).

In general, this analysis based on macro-level data observes that large declines in fertility have occurred during periods of greater female labour force participation and higher schoolings levels. Improvement in living standards has further reinforced these trends. The opportunity cost of mother's time and the substitution towards better educated children leads to smaller family sizes. Meanwhile, child costs (both direct and indirect) have risen and benefits from children are therefore low. From a policy point of view, fertility decline appears to be highly exposed to changes in demand factors. The desire for fewer kids has resulted in actual declines. Supply factors are effective only to ensure that efficient infrastructure and family planning services back them. For a long-term demographic purpose, particularly in developing Asia, government should reallocate its budget to providing better health facilities and financial support for families to reduce the burden of childrearing. Future research should further investigate the rates of change in fertility among different countries and contributing factors to the level of births. Whether child policies have a long-term impact or short-term influence of baby boom should be examined shortly.

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Appendix

Table 1.1-1.4 Two-child Policy Effects in Different Province

	(1)	(2)	(3)	(4)	(5)
Variables	**Guangxi**	**Anhui**	**Hubei**	**Shandong**	**Hunan**
year	0.004	0.004	0.0123**	0.000	0.010***
	(0.00)	(0.00)	(-0.01)	(0.00)	(0.00)
policy2014				0.222***	
				(-0.07)	
policy2011	-0.028	-0.008	0.110**		-0.070
	(-0.02)	(-0.03)	(-0.05)		(-0.04)
Constant	-4.758	-5.767	-22.522*	3.366	-16.729**
	(-4.55)	(-8.11)	(-11.12)	(-6.26)	(-6.42)
N	20	20	20	20	20
R-squared	0.14	0.14	0.85	0.54	0.23

Robust standard errors in parentheses ***p < .01, **p < .05, * p < .1

	(1)	(2)	(3)	(4)	(5)
Variables	**Shaanxi**	**Tibet**	**Ningxia**	**Mongolia**	**Xinjiang**
year	0.012***	0.007**	0.009***	-0.006*	-0.025*
	(0.00)	(0.00)	(0.00)	(0.00)	-0.01
policy2014	0.042*	0.085**			
	(-0.02)	(-0.03)			
policy2011			0.066*	-0.055	0.090
			(-0.03)	(-0.03)	-0.09
Constant	-21.363***	-10.441*	-15.018**	14.336**	52.61*
	(-6.22)	(-5.16)	(-5.90)	(-6.12)	-26.32
N	20	20	20	20	20
R-squared	0.84	0.84	0.87	0.57	0.39

	(1)	(2)	(3)	(4)	(5)
Variables	**Henan**	**Hebei**	**Yunnan**	**Gansu**	**Fujian**
year	-0.010**	0.006	-0.033***	-0.010***	0.003
	(0.00)	(-0.01)	(0.00)	(0.00)	(0.00)
policy2014	0.124**				
	(-0.05)				
policy2011		-0.054	0.218***	0.020	0.128***
		(-0.06)	(-0.06)	(-0.03)	(-0.03)
Constant	22.376**	-8.614	68.021***	23.055***	-4.312
	(-8.11)	(-12.41)	(-8.21)	(-4.60)	(-4.61)
N	20	20	20	20	20
R-squared	0.31	0.05	0.80	0.62	0.79

Robust standard errors in parentheses ***p < .01, **p < .05, * p < .1

	(1)	(2)	(3)	(4)	(5)
Variables	**Heilongjiang**	**Qinghai**	**Jiangxi**	**Guizhou**	**Shanxi**
year	-0.013***	-0.023***	-0.010***	-0.028***	-0.004**
	(0.00)	(0.00)	(0.00)	(-0.01)	(0.00)
policy2014		0.140***	0.041**	0.177***	0.069**
		(-0.03)	(-0.02)	(-0.06)	(-0.03)
policy2011	-0.070				
	(-0.05)				
Constant	28.588***	49.263***	21.801***	58.074***	10.559***
	(-6.60)	(-5.37)	(-3.81)	(-10.70)	(-3.00)
N	20	20	20	20	20
R-squared	0.81	0.88	0.71	0.71	0.35