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Declaration

I certify that the thesis I have presented for examination for the MPhil/PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

I warrant that this authorisation does not, to the best of my belief, infringe the rights of any third party. I declare that my thesis consists of 36,888 words.

Statement of inclusion of previous work

I confirm that Chapter 2 is a heavily revised version of the paper I submitted at the end of my MRes in 2014.

Statement of conjoint work

I confirm that Chapters 2 and 3 were jointly co-authored with Professor Silvana Tenreyro of LSE and I contributed 50% of this work.

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Chapter 1

Introduction

This thesis studies two topics in the macro-labour literature: investment in human capital and fertility decisions. The thesis comprises of three chapters, the first studying the effects of private tutoring in Korea and its resemblance to a human capital rat race and the second and third investigating the rapid decline in fertility rates experienced in developing countries over the past few decades.

With many countries having reached universal primary and secondary education, parental spending on education for supplementary and enrichment purposes has begun to resemble a rat race. In many Asian countries, it is normal for students to receive some or several forms of private tutoring alongside formal schooling. However, unlike the returns to schooling or the effects of school quality on student achievement which have been widely studied, the effects of private tutoring have received limited attention. In the first substantive chapter of this thesis, I exploit exogenous variation in spending on private tutoring caused by the imposition of a curfew on the operating hours of tutoring institutes in Korea, to estimate the impact of spending on tutoring on long-term educational and labour market outcomes. The first stage estimates highlight the severity of the rat race, with curfews imposed as late as 10pm still constraining tutoring expenditure. While I do not find any significant

effects of tutoring expenditure on entering college, when I interact tutoring expenditure with parental education, I find a significant, positive effect of tutoring on attending any college for children of less educated parents, while the effect for children of more educated parents is not significantly different from zero. Given that the less educated parents spend much less on tutoring, these results indicate diminishing marginal effects of tutoring, while the lack of an effect in the specification linear in tutoring expenditure points to the average impact (local to those constrained by the curfew) being close to zero. I also find that tutoring expenditure has a positive effect on both completing a four year degree and on being employed. I place these empirical findings within an asymmetric information framework to explain how the use of test scores as a signal for ability leads to inefficiently high investments in tutoring, leading to a rat-race equilibrium.

The second paper highlights the trends in fertility rates observed in developing countries, pointing out that cross-country differences in fertility rates have fallen very rapidly over the past four decades, with most countries converging to a rate just above two children per woman. In the second substantive chapter in the thesis, my co-author and I argue that the convergence in fertility rates has taken place despite the limited (or absent) absolute convergence in other economic variables and propose an alternative explanation for the decline in fertility rates: the population-control programmes started in the 1960s which aimed to increase information about and availability of contraceptive methods, and establish a new small-family norm using public campaigns. Using several different measures of family planning programme intensity across countries, we show a strong positive association between programme intensity and subsequent reductions in fertility, after controlling for other potential explanatory variables, such as GDP, schooling, urbanisation, and mortality rates. We conclude that concerted population control policies implemented in developing countries are likely to have played a central role in accelerating the global decline in fertility rates and can explain some patterns of that fertility decline that are not well accounted for by other socioeconomic factors.

In the third main chapter of the thesis, we build on the findings presented in the previous chapter by studying a quantitative model of endogenous human capital and fertility choice, augmented to portray a role for social norms over the number of children. The model allows us to gauge the role of human capital accumulation on the decline in fertility and to simulate the implementation of population-control policies aimed at affecting social norms on family size. We also consider extensions of the model in which we allow a role for the decline in infant and child mortality and for improvements in contraceptive technologies (the second main component of the population-control programmes). Using data on several socio-economic variables as well as information on funding for family planning programmes to parametrise the model, we find that, as argued in the previous chapter, policies aimed at altering family-size norms provided a significant impulse to accelerate and strengthen the decline in fertility that would have otherwise gradually taken place as economies move to higher levels of human capital and lower levels of mortality.

Chapter 2

The Rat Race for Human Capital: Evidence and Theory

2.1 Introduction

Educational attainment has shown tremendous improvements in most parts of the world over the past few decades, building up the stock of human capital and spurring economic growth. However, as more and more countries pass the milestones of universal primary and secondary education, the acquisition of education is beginning to resemble what Akerlof (1976) described as a "rat race", with parents spending increasing amounts to ensure that their children attend the best schools and universities. In some countries this type of behaviour is limited to households belonging to the higher income brackets, but in many countries, particularly those in Asia, it is much more widespread. According to the OECD Programme for International Student Assessment (PISA) results from 2009, 43 percent of 15 year old students surveyed from 65 countries participated in mathematics classes after school. However, this average masks wide variation between countries and regions. For instance, more than 75 percent of students in Japan or Korea take supplementary classes, whereas only around 15 percent in Sweden or Finland do so (OECD 2010). Interestingly,

the correlation between a country's per capita GDP and the percentage of students engaging in supplementary maths classes in the country is negative but there is substantial variation within income groups. Even in the group of high income countries (as classified by the World Bank), 62 percent of students in Asian countries attend private tutoring, whereas in Europe and North America the participation rates are 33 and 20 percent, respectively.

While the returns to years of schooling and effects of school quality on student achievement have been widely studied, the effects of spending on supplementary education including private tutoring have received limited attention.[1] The identification of these effects is challenging as these expenditures are likely to be related to many unobserved factors such as parental ambitions for their children or the motivation and ability of the child. Within the literature that investigates the effects of private tutoring, many papers ignore the endogeneity of the private tutoring decision, while the papers that do not, study the effects of tutoring on test scores or self-assessed academic ability. In this paper, I exploit exogenous variation in spending on private tutoring caused by the imposition of a curfew on *Hagwon* (private institutes operating outside of formal schooling offering private tutoring) in South Korea, to obtain causal estimates of the effects of expenditure on tutoring on longer-term outcomes such as college entrance and completion, and employment.

Korea consistently ranks very highly on international standardised tests such as the PISA tests administered by the OECD. At the same time, the importance placed on test scores for college admissions and the intense competition to enter prestigious universities have resulted in Korea having the highest rate of participation in private tutoring in the world. In 2015, 68.8 percent of all students attended after-school or weekend classes and expenditure on tutoring accounted for 5.5 percent of average household spending (KOSIS 2017a, 2017c).

[1]The type of spending depends on the nature of the competition - education systems characterised by high-stakes entrance examinations for secondary schools or universities are accompanied by high levels of participation in private tutoring whereas in systems placing more emphasis on individuality parents may spend more on extra-curricular activities. In this paper, I will be focusing on private tutoring obtained at a fee.

Over the past few decades the state has made several attempts to regulate the private tutoring sector, one of the more recent being the curfew on operating hours of *Hagwon*.

In this paper, I use data from the Korean Youth Panel (YP) which follows around 10,000 individuals aged between 15 and 29 for eight years starting in 2007. For a sub-sample of 2,710 individuals (belonging to five high-school graduation cohorts) who are still attending high school during the survey period, I observe data on monthly spending on tutoring in their final year of high school as well as what they do after leaving school, in particular, whether they go to college or not. An individual's exposure to the curfew is determined by the region in which they attend school as well as the year in which they graduate from high school. After controlling for region and year fixed effects, exposure to the curfew is plausibly exogenous and is used as an instrument in the analysis. To estimate the impact on longer term outcomes such as degree completion and employment, I combine the Youth Panel data on private tutoring expenditure with data from a sub-sample of 18,908 individuals from the 2016 Regional Labour Force Survey (LFS) to conduct a two-sample two stage least squares (TS2SLS) estimation.

I first explore the effect of the curfew which was imposed at either 10pm or 11pm in seven of the sixteen provinces in Korea. I find that the 10pm curfew significantly reduced spending on tutoring. Using time use data for high school students, I also find that the 10pm curfew led to significant increases in sleeping hours, confirming my first stage estimates. The very fact that a curfew was imposed to control excessive spending on tutoring together with the fact that students appear to be trading off sleep for additional tutoring provide an indication of the severity of the college entrance rat race in Korea.

The estimated effects of tutoring expenditure on educational and labour market outcomes vary significantly depending on the outcome considered. Estimates from a regression model which is linear in tutoring expenditure do not show any significant effects on college entrance. However, when I interact

tutoring expenditure with parental education, I find a significant, positive effect of tutoring on attending any college for children of less educated parents, though the effect for children of more educated parents is still not significantly different from zero. Given that the more educated parents spend significantly more on tutoring for their children, these results indicate diminishing marginal effects of tutoring, while the lack of an effect in the model linear in tutoring expenditure points to the average effect being close to zero. Given that two-stage least squares (2SLS) captures the Local Average Treatment Effect (LATE), which, in this case, is the effect on those whose spending was high enough to be constrained by the curfew, this result is not surprising. With regards to the longer-term outcomes, the two-sample 2SLS results show that tutoring expenditure has positive effects on both college completion and on being employed.

While my identification of the effects of tutoring does not allow me to distinguish between signalling and human capital explanations for the choice of tutoring, the Korean college admissions system which relies heavily on test scores, the imposition of a curfew to curb private tutoring, and my results from the first stage are strongly indicative of a rat race. Therefore, I explain my findings within a simple, asymmetric information framework where students signal ability using test scores, which then determines college entrance. Test scores are a function of innate ability, tutoring, and formal schooling, with high ability students having a comparative advantage in transforming tutoring into test scores. Under these conditions, a separating equilibrium emerges in which the high types spend more on tutoring than they would under perfect information, leading to an inefficient level of expenditure - a rat-race equilibrium. I then show how a higher college premium and, under certain conditions, improvements in school quality, could further drive up the spending of the high types, leading them to experience lower and lower returns to spending on tutoring.

The remainder of the paper is organised as follows. In the following section,

I discuss the contribution of this paper in relation to the literature - both empirical and theoretical. In Section 2.3, I provide some background into the private tutoring sector in Korea and briefly discuss attempts by the state to regulate the sector. I describe the data in Section 2.4 and discuss the estimation strategy in Section 2.5. Section 2.6 presents the first stage estimates while Section 2.7 presents the estimated effects of spending on tutoring on college entrance as well as longer term outcomes. Section 2.8 presents some robustness checks and Section 2.9 lays out the theoretical model used to reconcile the findings with economic theory. Section 2.10 concludes.

2.2 Related literature

In this section, I discuss the contribution of this paper in relation to the empirical and theoretical literature on the subject. While there are many papers that discuss the impact of tutoring with no attempt to account for the endogeneity of the choice of tutoring, I focus here on those papers that make explicit efforts to address this issue.

2.2.1 Empirical work

Unlike the returns to schooling and effects of educational inputs such as school quality on academic achievement on which there exists a rich literature, the body of work on the impact of tutoring is much smaller, with no consensus on the effectiveness of tutoring. Several studies investigating the effect of private tutoring on academic achievement find positive associations between tutoring and test scores but most of these papers either ignore or do not convincingly address the endogeneity of private tutoring (for a review of this work, see Bray and Lykins 2012). Given that spending on private tutoring is strongly affected by family, school and individual characteristics, many of which are unobserved, the bias in estimates that treat the consumption of

private tutoring as exogenous could be large. Therefore, in this section, I focus on studies that make explicit efforts to address the issue of endogeneity.

A few papers examine the impact of remedial programmes targeted at low-performing students under experimental or quasi-experimental settings. Bannerjee, Cole, Duflo and Linden (2007) analyse the effects of a randomised experiment in India in which remedial classes were provided to primary school students lagging behind in basic numeracy and literacy skills and find that the programme had significant effects on the students' test scores. Lavy and Schlosser (2005) evaluate the effects of a remedial programme for underperforming high school students in Israel using a differences-in-differences strategy and find that the programme improved enrollment rates while Jacob and Lefgren (2004) find positive effects of summer school programmes on the test scores of low-performing primary and middle school students using a regression discontinuity design. A key difference between these papers and this paper is their focus on targeted remedial programmes which are provided free of charge for low-performing students. In contrast, this paper focuses on the effects of spending on tutoring, which is chosen at the discretion of the student or parents and is not restricted to low-performing students. Another difference is that students in Korea already spend more than 30 hours a week in formal schooling, more than in any of the countries analysed in these papers.[2]

The decision on spending on private tutoring depends on many factors - aside from the characteristics of the child, the aspirations of the parents for that child as well as the financial circumstances of the family matter. As such, isolating a source of exogenous variation in spending on tutoring is challenging. Papers which make an attempt to identify such variation include work by Suryadarma, Suryahadi, Sumarto and Rogers (2006), Dang (2007), Kang (2007), Ryu and Kang (2013), and Zhang (2013). These studies are carried out in East Asian countries in which private tutoring is highly prevalent and

[2]The PISA results for 2015 show that 15 year olds in Korea spend more than 30 hours per week on average in regular lessons; 3 hours more than the OECD average, 2.5 hours more than the US average and 2 hours more than the Israeli average (OECD 2016b).

identify the impact of tutoring on academic achievements using instrumental variable (IV) methods.

Dang (2007) follows a strategy similar to that used in this paper and uses the state-regulated, average price of tutoring charged by schools in the commune as an instrument for hours spent on private tutoring for elementary and middle school students in Vietnam. The author finds that tutoring leads to a significant improvement in a self-reported measure of academic ranking, with larger effects for lower secondary school students.

Other papers in the literature use individual level instruments for identification. Suryadarma et al. (2006) use the proportion of peers participating in tutoring as an instrument for participation in tutoring among primary school students in Indonesia while Zhang (2013) employs both peer participation in tutoring and proximity of the student's home to private tutoring centres as instruments for participation in tutoring among high school students in the Jinan province in China. Kang (2007) and Ryu and Kang (2013) consider birth order as an instrument for spending on private tutoring among high school and middle school students in Korea. These papers find that the effect of tutoring on academic achievement is modest at best.

Using peer participation as an instrument could be problematic in the event of spillover effects or if peer groups are formed on the basis of participation in tutoring while birth order could possibly influence other types of parental investments which also affect academic achievement. These studies also focus on test scores as the measure of academic achievement (Suryadarma et al. (2006) and Ryu and Kang (2013) use scores from tests administered as part of the survey from which data is collected, while Zhang (2013) and Kang (2007) consider university entrance examination scores) and do not find much of an effect of tutoring.

The key contribution of this paper is the focus on outcomes such as college entrance and completion, and employment, which are arguably more objec-

tive than test scores or self-assessed measures of academic achievement. The only related work which considers labour market outcomes is Ono (2007), who examines the impact of *Ronin*, the practice of taking additional years (after leaving high school) to prepare for college entrance examinations, on earnings of male graduates in Japan. The author does not consider explicitly the cost of time or money on tutoring that students engage in to prepare for the examination during these additional years but finds that taking these additional years to prepare increases the quality of the college eventually attended which translates into higher earnings.

2.2.2 Theoretical work

There is a growing literature on the economics of the college admissions process, mostly based on the United States. Bound, Hershbein and Long (2009) document evidence of increased competition for admission into top universities in the US and there are several papers that examine the college's admission problem and compare different admissions rules such as affirmative action or centralised vs decentralised college application systems in which the Scholastic Aptitude Test (SAT) score is the costly signal invested in by students (see Fu 2003, Bodoh-Creed and Hickman 2016, Hafalir, Hakimov, Kubler and Kurino 2016). More relevant to this paper is work by Ramey and Ramey (2010) who argue that college-educated women are spending more time on childcare despite rising college premia as a result of the intensification of the college admission's competition. They then model the efforts expended by parents and students in the competition for limited college places when there is asymmetric information.

In a similar vein to Ramey and Ramey (2010), I borrow from the literature on asymmetric information to build a simple model that can reconcile the empirical findings with economic theory. The key intuition behind the model presented in this paper is that the lack of information about students' ability

faced by colleges gives rise to a rat race where test scores are used as a signal causing higher ability students to spend more on tutoring. The framework is based on the seminal work on rat-race behaviour by Akerlof (1976) and Spence's (1973) model of job-market signalling.

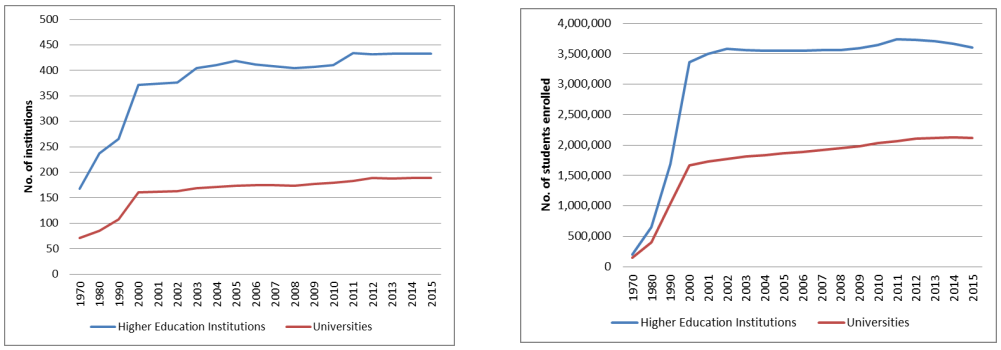
The theoretical analysis of Hopkins and Kornienko (2010) is closest in spirit to the model presented in this paper. They present a generalised tournament model in which there is a continuum of types as well as a continuum of rewards, where rewards are awarded assortatively based on the rank of an observable signal. They describe a unique, fully separating equilibrium in which the signal is increasing in type and show that this equilibrium is socially sub-optimal. The authors then discuss the implications of changes in the distribution of types and rewards to show how reducing the inequality of rewards lowers effort while reducing the inequality of types results in higher effort. My model adapts this framework into a much simpler, stylized model of private tutoring and college entrance.

2.3 The Korean context

South Korea witnessed remarkable economic growth over the past five decades, jumping from a per capita GDP below US$1300 in the early 1960s to over US$25,000 in 2015. A large part of this growth is attributed to the huge strides in educational attainment with average years of schooling of the adult population going from an average of roughly 3 years in 1960 to over 13 in 2015.[3] Korea displays some of the highest rates of completion of upper secondary education and enrollment in tertiary education in the world and consistently ranks very highly on internationally administered tests of skills and knowledge such as those run by PISA and TIMSS (Trends in International Mathematics and Science Study).

[3]Statistics on GDP per capita are in constant 2010 US$ and are taken from the World Bank's World Development Indicators (WDI) database and statistics on years of schooling are from Barro and Lee (2013).

Figure 2.1: Trends in no. of students enrolled in and no. of tertiary education institutions



(a) No. of institutions (b) No. of enrolled students

Source: Korean Education Statistics Service 2017

Key to this remarkable growth in educational attainment were large expansions in upper secondary and tertiary education over the recent decades, the latter through the loosening of regulations governing the establishment of these institutions. The number of Korean universities grew from 71 in 1970 to 189 in 2015 while the number of students enrolled in universities jumped from 146,000 in 1970 to over 2 million in 2015 (KESS 2017a, 2017b). The growth in other higher education institutes, which include technical and industrial colleges as well as universities of education (universities specialising in teacher training and educational research), has been equally dramatic (see Figure 2.1). At present, around 80 percent of universities and 95 percent of other higher education institutions are privately owned.

The increased supply of educational opportunities in Korea was driven by the strong reverence for education observed in Korean society. Indeed, current concerns about a crisis of over-education in Korea (dubbed "education fever") stems from this notion that education is an essential determinant of social mobility (Grubb, Sweet, Gallagher and Tuomi 2009). The "education fever" is visible in the heavy reliance of tertiary education on private funding - the heaviest such reliance in the OECD. The fervor for education, together with a long tradition of competitive examinations, has also led parents in Korea to incur large expenditures on private tutoring to ensure that their children enter

the best schools and universities. It is even conjectured that the unusually low fertility rates observed in Korea (Korea demonstrated the world's lowest total fertility rate of 1.2 in 2014) are a consequence of an extreme quantity-quality trade-off with huge investments made by parents for the education of their children (Anderson and Kohler 2013).

Results of the Private Education Expenditure Survey (PEES) provide an overview of the prevalence of private tutoring in Korea. The total spending on private tutoring was estimated to be around KRW 17.8 trillion in 2015, roughly 2 percent of the country's GDP. Household Income and Expenditure Surveys reveal that around 5.5 percent of average household expenditure was accounted for by expenditure on private education other than regular schooling. Given that this is an average across all households, for households with school-going children the fraction is likely to be much higher. 68.8 percent of all students participated in private tutoring in 2015, spending around 6 hours per week in these additional classes, on average. The main mode of receiving private tutoring is attending private institutes or *Hagwon* (which are widely known for their role as cram schools but which also offer classes in non-academic subjects) followed by a much lower prevalence of one-to-one or small-group tutoring. There is also a strong positive correlation between participation in and expenditure on private tutoring and household income though private tutoring is by no means rare among the lower income groups - around a third of children living in households earning less than KRW 1 million a month (average household income was 4.3 million KRW) participated in private tutoring in 2015 (KOSIS 2017c).

State attempts to regulate the private tutoring sector

The importance of the private tutoring industry in Korea has raised concerns about equity and efficiency leading to several attempts by the state to regulate the sector either directly or indirectly. Aside from steps taken to enhance

the quality of schooling in general, measures have been taken to reduce the emphasis on competitive examinations as a means of entry into schools and universities. The middle school and high school equalisation policies enacted in 1968 and 1973, respectively, were among the earliest of such measures aimed at relieving the examination burden on children and the financial burden of private tutoring on parents. In the regions in which the policies were implemented, entrance examinations to middle schools and high schools were abolished and students assigned to schools randomly based on area of residence. While it is believed that these policies have reduced the pressure on families at lower secondary level, it is argued that the competition has now shifted to university entrance instead (Lee, Lee and Jang 2010). As such, the state has also engaged in several reforms of the college admissions system including the introduction of a centralised entrance examination called the College Scholastic Ability Test (CSAT), increasing college quotas to reduce competition among students, and encouraging universities to extend their admissions criteria beyond CSAT scores to making use of home-school records and implementing admissions officer systems (Choi and Park 2013).

In addition to these indirect measures, there have also been direct attempts to control the private tutoring market. The most drastic of these measures was the *7.30 Educational Reform* implemented in 1980 under which the government banned all forms of private tutoring of a commercial nature. However, given the difficulty of enforcing the ban, it was gradually relaxed during the 1980s and 1990s. In 2000, the Korean Constitutional Court ruled that the ban was unconstitutional, after which the state shifted its focus to enhancing the quality of schools and regulating the operation and management of *Hagwon*. Alongside the establishment of standards on qualifications of instructors and a mandate to make class fees public information was the regulation on the hours of operation of *Hagwon* (Choi and Cho 2016).

The regulation of operating hours of *Hagwon* falls under the purview of provincial education offices. The imposition of the curfew on closing times of *Hagwon*

Table 2.1: Curfew imposed on *Hagwon* operating hours for high school students

Province	Curfew imposed	Year of imposition	New closing time
Seoul	Yes	2007	10pm
Busan	Yes	2008	11pm
Daegu	Yes	2011	10pm
Daejun	No	-	-
Incheon	Yes	2012	11pm
Gwangju	Yes	2011	10pm
Ulsan	No	-	-
Gyeonggi	Yes	2011	10pm
Gangwon[a]	No	-	-
Chungbuk	No	-	-
Chungnam[a]	No	-	-
Jeonbuk	Yes	2009	11pm
Jeonnam	No	-	-
Gyeongbuk	No	-	-
Gyeongnam	No	-	-
Jeju	No	-	-

Note: The table summarises the imposition of the curfew by province including the year of imposition and the time at which the curfew was set.
[a] Restriction to close by 10pm was introduced in 2012 but was not implemented
Source: Provincial Ordinances

was therefore implemented in different provinces in different years. The curfew initially varied by the level of school (elementary, middle or high school) though the goal was to eventually settle on a curfew of 10pm for all students. Prior to the curfew, the official closing time in all provinces was midnight though it is reported that classes went on well beyond this limit. Table 2.1 outlines the implementation of the curfew by province for high school students.

The curfew has been the topic of heated public debate with the key criticism being levelled against it being the lack of regulation of other types of tutoring such as one-to-one tutoring. This means that students are able to switch to alternative forms of tutoring, which would further exacerbate social inequality given that these alternative forms of tutoring are usually more expensive (Choi and Choi 2015). However, proponents of the policy argue that the ordinance

addresses two major social problems by reducing expenditure on private tutoring and improving students' health by guaranteeing more sleeping hours (Choi and Cho 2016). The effects of the curfew are discussed further in Section 2.6.

2.4 Data

This paper uses data from the second wave of the Korean Youth Panel (YP) collected by the Korean Employment Information Service (KEIS) to estimate the impact of spending on private tutoring on college entrance outcomes. The second wave of the YP began in 2007 with a nationally representative sample of 10,206 individuals aged between 15 and 26 in 2007. This sample was followed every year for eight years (until 2014). The survey collects detailed information on individual employment, income and education (including detailed information about current education of students and the education history of those adults) as well as information on expenditure on private tutoring by subject and background characteristics of the household including household income, parental education, etc.

Using this data I compile a sub-sample of around 2,700 final year, high school students (roughly 2,200 of these individuals attend general high schools) aged 17 or 18 in their final year of high school, for whom information on private spending on tutoring and college entrance outcomes for the following year are available. This covers five cohorts: the high school graduating cohort of 2007 to the high school graduating cohort of 2011. While spending on tutoring over the total high school period would be the most relevant measure for assessing effects on college entrance, obtaining this information from the YP dataset would result in the sample shrinking to 1,320 students. Therefore, for the analysis, I consider average monthly spending on tutoring in the final year of high school (in constant 2010 KRW) as the measure of tutoring expenditure. (Consequences of using this measure are discussed in detail in Section 2.8.) Since students from vocational or technical high schools (as opposed to general

high schools) are less likely to participate in private tutoring and more likely to attend different types of tutoring classes and higher education institutions than the general high school students, in the analysis that follows, I consider separately the full sample and the sub-sample consisting solely of general high school students. Finally, I consider two different outcomes of college entrance. These are the enrollment of the student in any higher education institution (which includes two year colleges, technical or vocational colleges as well as four year academic universities) and enrollment in a four year college.

The summary statistics for this sample are presented in Table 2.2. As the table indicates, 53 percent of students in the sample participate in tutoring during their final year of high school with average spending of roughly KRW 283,000 a month (these figures are comparable to the statistics published in KOSIS 2017c). Among those who participate in tutoring, average spending is closer to KRW 530,000. In terms of college outcomes, 78 percent of the sample attend some type of college in the year after graduating from high school, with 51 percent enrolling in four year colleges. More than 80 percent of the sample attend general high schools while 42 percent of the students have at least one parent who has obtained some higher education.

Given the short length of the YP survey and the relatively recent implementation of the curfew, many of the original sample were still engaged in undergraduate studies in 2014 (the last year of the survey). As a way of identifying the effect of tutoring on longer term outcomes, I use the most recent Regional Labour Force Survey (for 2016) to obtain education and labour market outcomes for a different but much larger sample of 18,908 individuals, belonging to the same province-year of birth cohorts represented in the YP sample.[4] This allows for a Two-Sample 2SLS approach which imputes spending on tutoring in the LFS dataset using first stage estimates from the YP at the province-year of birth level. The key drawbacks of using this dataset are the lack of fam-

[4]Since the youngest cohort in the YP sub-sample used in the main analysis attended their final year of high school in 2011 it is reasonable to assume that most of the cohorts in the YP sample have completed their undergraduate studies by 2016.

Table 2.2: Descriptive statistics

Variable	Mean	Std. Dev.
A: Youth Panel sample (N=2,710)		
Participates in tutoring	0.53	0.50
Monthly spending on tutoring	28.26	40.36
(in constant 2010 KRW 10,000)		
Attends any college	0.78	0.42
Attends four year college	0.51	0.50
Exposed to curfew	0.29	0.45
At least one parent with higher education	0.42	0.49
Male	0.55	0.50
First born child	0.47	0.50
Mother employed	0.58	0.49
Father employed	0.94	0.23
Attended general high school	0.82	0.38
B: Regional Labour Force Survey sample (N=18,908)		
Completed four year degree	0.35	0.48
Completed any higher education	0.54	0.50
Employed	0.56	0.50
Monthly wage before tax	165.71	70.58
(in constant 2010 KRW10,000) (N=9,958)		
Exposed to curfew	0.38	0.48

Note: The table presents descriptive statistics of the samples used from the YP and LFS.
Sources: Youth Panel, Regional LFS

ily background information and the inability to identify exactly the year and province in which the respondent completed high school. The issues arising as a result of these drawbacks and some attempts to address them are described in the section on robustness checks.

Aside from the YP and LFS data, I use three other datasets to provide robustness checks for my main analysis: the Korean Youth Risk Behaviour Web-Based Survey (KYRBS), which provides information on time use among high-school students; the Private Education Expenditures Survey (PEES), which provides information on spending on different types of tutoring for high school students; and the Korean Education and Employment Panel (KEEP) survey, which includes detailed information on schools and students, including spend-

ing on tutoring. The first two datasets are used to further investigate the impact of the curfew on tutoring expenditure while the third is used to get a better understanding of the determinants of private tutoring expenditure.

The KYRBS is a national, cross sectional survey carried out annually, starting from 2005, by the Centre for Disease Control and Prevention to assess health-risk behaviours among middle and high-school students. Close to 25,000 high school students are surveyed each year, answering questions related to lifestyle and health. Particularly useful for this study are the responses on the hours of sleep and internet usage. The data on hours of sleep are recorded using a categorical variable in 2005 and 2006, after which the hours of sleep are recorded as a continuous variable. Information on time spent using the internet is collected from 2008 onwards. The survey also includes information on the students' backgrounds including parental characteristics and type of high school. I use the KYRBS to assess the impact of the curfew on hours of sleep and internet usage of high school students as a means of validating the first stage from my main analysis and confirming that the curfew was indeed binding.

PEES is a national, cross-sectional survey which, starting from 2007, is carried out every year, though information on province of residence is available only from 2009. The survey is administered on parents of students in elementary, middle and high school, covering information on money and hours spent on private tutoring for each child as well as some background characteristics. The dataset also includes expenditure broken down by type of tutoring. PEES covers a large sample of more than 40,000 high school students each year, of which roughly 80-85 percent are from general high schools, though the data does not specify the age or year of high school the student is in. I use this data to investigate whether any substitution between different types of tutoring arose as a result of the curfew.

Finally, KEEP is a longitudinal survey that follows two cohorts of students, 2,000 students in the final year of general high school and 2,000 students in the

final year of middle school, starting from 2004 and going on for eight years. The survey collects extensive information on students including student aspirations and attitudes towards education, assessments of individual student ability by homeroom teachers, family background characteristics and school information. Given the longitudinal design of the survey, the study also follows students through to university or employment. While the dataset is richer than the YP, its lack of time variation does not allow for its use under my identification strategy. However, it can provide some insights as to the type of student who obtains private tutoring and would be most affected by the curfew, which is useful in interpreting the 2SLS results. Descriptive statistics for these three supplementary datasets are given in Appendix A1.

Who receives tutoring?

To better understand the characteristics of the students who obtain tutoring, this section provides some descriptive evidence using the YP and KEEP data, regressing spending on private tutoring on a set of individual, parental and school characteristics. These results are presented in Table 2.3.

Qualitatively, the results are fairly similar between the two datasets. Household income and parental education have strong positive associations with spending on private tutoring in both datasets. The parental employment dummies are not significant in the YP regressions, though this can be explained by the inclusion of household income as an explanatory variable. The dummies for being male and being the first born child, which are significant in the KEEP regressions, are not significant in the YP regressions though they share the same sign. The impact of school characteristics can be observed through the KEEP dataset. Unsurprisingly, the pupil-teacher ratio is strongly positively correlated with private tutoring as is attending a public school.

The KEEP data also includes an assessment by the previous year's homeroom

Table 2.3: Determinants of private tutoring expenditure

Monthly spending on tutoring (in KRW 10,000)	(1)	(2)	(3)	(4)
Monthly household income	0.003***	0.003***	0.0266***	0.0240***
(in KRW 10,000)	[0.000]	[0.000]	[0.00661]	[0.00782]
At least one parent with	10.112***	10.037***	8.158***	7.671***
higher education	[2.032]	[1.925]	[1.433]	[1.447]
Male	-1.849	-2.832	-4.941***	-4.724***
	[1.176]	[1.800]	[1.109]	[1.392]
First born child	1.295	0.889	4.060***	5.140***
	[0.850]	[1.850]	[0.789]	[1.331]
Pupil teacher ratio			0.996**	1.094**
			[0.351]	[0.449]
Public school			1.715	3.039**
			[1.379]	[1.209]
Hours of self study			0.180**	0.151*
			[0.0745]	[0.0779]
Ranking in school				-0.0649**
(teacher assessed)				[0.0285]
Mother employed	-2.228	-2.675		
	[1.469]	[1.853]		
Father employed	1.833	2.561		
	[4.046]	[4.476]		
General high school	18.039***			
	[3.645]			
R-squared	0.298	0.291	0.182	0.188
N	2226	1828	2265	1777
Dataset	YP - full	YP - GHS	KEEP	KEEP

Notes: The table presents the results of regressing monthly spending on tutoring on individual, parental and school characteristics using YP and KEEP datasets. Column (1) uses the full YP dataset while column (2) uses the sample of general high school students. All regressions include year and province fixed effects and state-specific linear trends.
Standard errors clustered by province are given in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

teacher of the student's percentage rank relative to the rest of the school.[5] It appears that students who are ranked higher by their teachers and spend more hours in self study are also those who spend more on private tutoring. While these results cannot be interpreted causally, they suggest that those who would be most affected by the imposition of the curfew would be the high ability students.

2.5 Empirical strategy

In this section, I describe in detail my identification assumptions and estimation strategy. In particular, I argue that the curfew on operating hours of *Hagwon* is a valid instrument for spending on tutoring.

2.5.1 Estimating model

The equation to be estimated is

$$y_{ist} = \beta P_{ist} + \gamma X_{ist} + \alpha_s + \delta_t + \rho_s t + u_{ist} \tag{2.1}$$

where y_{ist} refers to the outcome of interest for student i who attended school in province s at time t. The four outcomes I consider are: 1) an indicator for attending any higher education institution or completing any higher education qualification; 2) attending a four year college or completing a four year degree; 3) being employed; and 4) wages (in natural logarithm). P_{ist} refers to the monthly expenditure by parents on private tutoring for student i in his/her final year of high school (in constant 2010 KRW), X_{ist} is a vector of parental and student characteristics, α_s is a region fixed effect, and δ_t is a time fixed effect. Since it is a concern that other state-specific trends might be

[5]It can be argued that this is not a bad control as it is an assessment of the student's performance from the previous year as opposed to being an outcome of the tutoring obtained this year.

correlated with the curfew, I also control for state-specific linear trends, $\rho_s t$, in all specifications. The term u_{ist} is a random error factor. I also consider a second specification where an interaction between expenditure on tutoring and parental education is included.

As mentioned previously, the monthly expenditure on tutoring is most likely related to school characteristics as well as unobserved parental and student characteristics such as importance placed on education, ambitions of the parents for child i, the student's ability and motivation, etc. As a result, estimates of β through probit or ordinary least squares (OLS) are likely to be biased and inconsistent.

In this paper, I use the curfew imposed on the operating hours of *Hagwon*, which was implemented in different provinces in different years, as a source of exogenous variation in spending on tutoring. In particular, I consider exposure to the curfew, measured as interactions between dummy variables indicating years of exposure to the curfew (determined by the age of the individual) and the closing time imposed by the curfew, as instruments for tutoring expenditure.[6] Since it is very likely that the imposition of curfews in different regions were based on state- and time- specific factors, identification is based on the assumption that, conditional on state and time fixed effects and the state-specific linear trends, the imposition of the curfew was exogenous.

2.5.2 Curfew as an IV

Using the curfew on the operating hours of *Hagwon* as an instrument for spending on tutoring requires that the curfew satisfy relevance and validity. In this section, I consider some issues that might arise from using the curfew as an IV.

The first issue concerns the first stage. While the curfew needs to have a

[6] A similar approach is used in Duflo (2001) who uses exposure to a school construction programme in Indonesia as an instrument for years of schooling.

significant effect on spending on tutoring, the effect should be negative to allow the comparison of tutoring expenditure before and after the curfew. To clarify, it is possible for students to switch to more expensive forms of tutoring such as one-on-one tutoring or reschedule classes for the weekend as a result of the curfew on *Hagwon* operating hours. This would result in expenditures remaining unchanged or even rising after the imposition of the curfew, which would be problematic if the quality of tutoring changed as a consequence of the curfew. It is not possible to completely rule out the possibility of substitutions away from *Hagwon* classes but the extent of this problem can be gauged from the first stage estimates and will be discussed further in Section 2.8.

While the first stage examines the effect of the instrument on the treatment (here, spending on tutoring), it is not possible to directly test the validity of the instrument or the existence of other channels by which the curfew may affect the educational outcomes. For instance, if universities altered their admissions policies to make special provision for states with a curfew or if families moved to avoid the constraints of the curfew, the validity of the curfew as an instrument would be violated. However, given that the curfews were enacted in states with the highest concentration of educational facilities and private tutoring (the seven provinces in which the curfew was imposed accounted for 68 percent of Korea's total population in 2012), it is unlikely that either of these explanations bear out. Colleges, if taking regional disparities into consideration, would be more likely to penalise a student living in a state with a curfew, while a household that moves for educational purposes would be far more likely to move into one of these states than out of it. Furthermore, while there is no evidence to suggest that colleges take province of origin into account when making admissions decisions, inter-provincial mobility for households with high school students is very low in Korea. Published statistics on internal migration in Korea indicate that only 3.6 percent of 15-19 year olds changed their state of residence in 2016, with just 1 percent moving from a state with a curfew to one without (KOSIS 2017b). In the Youth Panel sample, only 29 students (1 percent of the sample) moved out of states with a curfew over the survey

period and, of them, only 9 moved after the imposition of the curfew.

Finally, it is important to think about the treatment effect captured by the estimation. Given that the curfew is for either 10pm or 11pm, the curfew will only be binding for those students who attend tutoring classes until late at night and spend heavily on tutoring. The results obtained, therefore, will be a local effect for those heavy spenders, particularly if there is reason to believe that the returns to tutoring expenditure are not constant. Based on the descriptive analysis of the determinants of private spending, it is the students whose parents are more educated and wealthy that spend more money on tutoring. The results from the KEEP data are also suggestive of students with higher ability (as assessed by their teachers) and motivation (as measured by hours of self-study) spending more on tutoring. As such, it seems plausible that the effects I estimate are specific to this type of student.

2.6 Effect of the curfew

In this section I investigate the effect of the curfew on *Hagwon* operating hours on spending on tutoring. Aside from being the first stage of the IV estimation, the effect of the curfew is interesting in its own right, highlighting the enormous investment of time and money devoted to tutoring in Korea.

Table 2.4 presents the results of the first stage. The first stage is estimated separately for the full sample and the general high school sample. In models where the regressor of interest (here the exposure to the curfew) is essentially the interaction of a state and time fixed effect, it is possible that there are other state-specific trends that might be correlated with the variable. The state-specific linear trends are an attempt to control for these other trends, though ideally the results should not change much with their inclusion. In the regression results presented below, I show results with and without the inclusion of these trends. All regressions also include dummies for being male,

being the first born child, parents' employment status, and at least one parent having higher education.[7] Standard errors are clustered at the state-year level - the level of the instrument.

The results indicate that the curfew imposed at 10pm had a significant negative impact on spending in both the full and general high school samples, while the 11pm curfew does not seem to have had any effect. Despite the lack of an effect of the 11pm curfew (which affected 7 percent of the sample), the joint significance of the curfew exposure dummies is strong, indicating a good first stage. The inclusion of state-specific trends affects the estimated effects of the 11pm curfew for the full sample, though the coefficients that change sign are insignificant in both specifications. Overall, however, it appears that the inclusion of the trends serves to strengthen the negative effects of the 10pm curfew rather than change them completely. Therefore, in what follows, I continue to use the specification which includes these state-specific linear trends.

The negative effect of the 10pm curfew indicates that the direct effect of the curfew which curtailed spending on tutoring overrode the substitution towards other types of tutoring as discussed in the previous section, though it still cannot be ruled out completely. The results also show that the effect of the curfew increases with the years of exposure to the curfew (the base category consists of students who did not face any curfew). That is, a student's spending on tutoring in her final year of high school depends not only on whether she lives in a province with a curfew but also on how long she has been exposed to the curfew. For instance, a student who has been schooling in a province with a curfew since her first year of high school spent much less in her final year than a student who was faced with that same curfew only in her final year. A possible explanation for this is that students (and parents) have adjusted gradually to spending less on tutoring, with younger cohorts spending less than

[7]Household income is not included as a control for two reasons: it restricts the sample size considerably and is most likely to be mis-measured. However, the parental employment and education indicators should capture most of this effect.

Table 2.4: Effect of the curfew on spending on tutoring

Monthly spending on tutoring (in KRW 10,000)	Full sample (1)	(2)	GHS sample (3)	(4)
curfew=11pm, years=1	1.675	-1.618	-1.043	-3.728
	[2.417]	[1.496]	[2.508]	[2.376]
curfew=11pm, years=2	5.094*	0.413	-0.845	-4.407
	[2.963]	[3.993]	[2.500]	[5.448]
curfew=11pm, years=3	3.2	-0.983	-3.777	-6.954
	[3.450]	[6.764]	[3.355]	[8.720]
curfew=11pm, years=4	21.457***	17.218		
	[5.607]	[11.095]		
curfew=10pm, years=1	-5.123	-3.308	-6.606	-8.036**
	[5.119]	[4.902]	[4.302]	[3.778]
curfew=10pm, years=2	-11.427**	-14.996***	-16.366***	-23.119***
	[5.240]	[5.151]	[4.479]	[3.905]
curfew=10pm, years=3	-14.570**	-23.182***	-18.641***	-30.365***
	[5.601]	[5.482]	[4.956]	[4.364]
curfew=10pm, years=4	-5.602	-18.875***	-12.416**	-28.730***
	[5.713]	[5.693]	[5.200]	[4.688]
curfew=10pm, years=5	-20.755**	-40.473***	-26.186***	-51.180***
	[9.334]	[8.213]	[8.363]	[7.569]
At least one parent with higher education	13.580***	13.715***	14.137***	14.322***
	[2.273]	[2.308]	[2.424]	[2.469]
Male	-1.498	-1.351	-2.377	-2.096
	[1.340]	[1.335]	[1.564]	[1.534]
First born	0.876	0.658	0.746	0.414
	[1.857]	[1.869]	[2.167]	[2.200]
Mother employed	-1.095	-1.226	-0.979	-1.147
	[1.390]	[1.389]	[1.675]	[1.663]
Father employed	8.351***	8.367***	10.594***	10.532***
	[2.481]	[2.518]	[3.398]	[3.510]
Attended general high school	17.514***	17.284***		
	[2.463]	[2.506]		
F-stat	40.14***	369.89***	15.64***	86.99***
State-specific linear trend	No	Yes	No	Yes
N	2710	2710	2231	2231

Notes: The table presents first-stage estimates for the full sample as well as the GHS sample. All regressions include time and state fixed effects and state-specific linear trends.
The F-statistics test the hypothesis that the coefficients on the curfew exposure dummies are jointly zero.
Standard errors clustered at state*year level given in brackets. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

the older cohorts.

By contrast, the 11pm curfew does not seem to have affected tutoring expenditure. This could either be because the 11pm curfew did not constrain spending or because individuals living in these provinces rescheduled classes or switched to alternative forms of tutoring. While the former explanation would weaken the first stage, the latter potentially complicates the interpretation of the effect of tutoring expenditure before and after the curfew. In Section 2.8 I verify this using PEES data to examine the impact of the curfew on the spending on different types of tutoring.

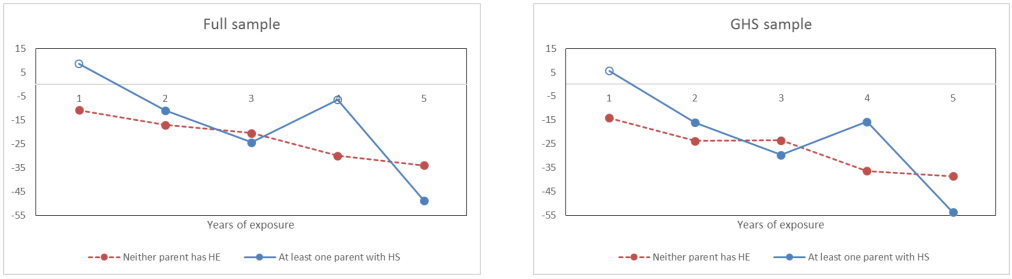
The first stage for the specification where an interaction term between spending on tutoring and parental education (captured by a dummy variable indicating that at least one of the parents has completed some higher education) is included is similar but the inclusion of the interaction term highlights slight differences in the response to the curfew by students from different backgrounds. Figure 2.2 plots the estimated effect of the curfew for each parental education group against the years of exposure to the curfew. Note that for the less educated parents this effect is just the coefficient on the corresponding curfew dummy whereas for the more educated parents the effect is the sum of the coefficients on the curfew dummy and interaction term.[8]

As in the model with no interaction between spending and parental education, only the 10pm curfew caused a significant reduction in spending on tutoring, with the size of the effect increasing in the years of exposure to the curfew. (The points in the graph represented by a marker with no fill are statistically insignificant.) Children of more educated parents who faced the 10pm curfew only in their final year of high school do not show a significant decrease in spending in response to the curfew, and by and large, it seems that more educated parents reduced their spending by smaller magnitudes than the less educated parents. Given that more educated parents also spend much more on tutoring, this suggests some potential substitutions (either in class times or

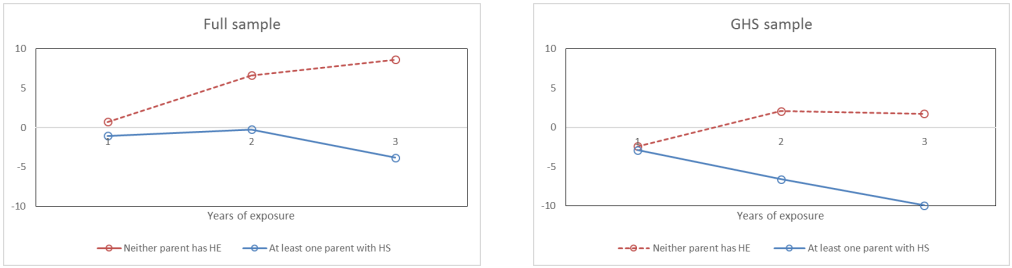
[8]The full regression table is available in Appendix A2.

Figure 2.2: Effect of the curfew by years of exposure and parental education

Panel A: 10pm curfew



Panel B: 11pm curfew



Notes: The graphs plot the effect of the curfew by years of exposure to the curfew for the two parental education groups and for the two curfews. The effect for the lower education group is given by the regression coefficient of the curfew dummy while the effect for the higher education group is the sum of the coefficient of the curfew dummy and the coefficient on the interaction between the curfew dummy and education dummy. The two top figures show the effects of the 10pm curfew, while the two bottom figures show the effects of the 11pm curfew. Markers with no fill represent effects that are not significantly different from zero at 10% significance.

tutoring type), an issue addressed in the section on robustness checks.

To summarise, I find that the imposition of the 10pm curfew resulted in a significant reduction in monthly spending on tutoring, while the 11pm curfew does not seem to have significantly affected tutoring expenditure.[9] As such, the first stage is driven by the effect of the 10pm curfew and the estimated effects of tutoring expenditure on educational outcomes will be the effects on those students whose spending was affected by the imposition of the curfew. The next section, which presents the results of the IV estimates, attempts to identify these effects.

[9]This is contrary to the findings of Choi and Choi (2015) and Choi and Cho (2016) who use data from the Private Education Expenditure Surveys and do not find significant effects of the curfew. However, both these papers focus on the 2009-2012 period and use different specifications for estimating the effects of the curfew. Furthermore, as evinced by the first stage results reported in this paper, while the impact of the curfew strengthens with the duration of exposure to it, the aforementioned papers are unable to use this variation.

2.7 Results

In this section, I present and discuss the estimated effects of spending on private tutoring on educational outcomes. The first part of the analysis is based solely on the Youth Panel sample and provides estimates of the effect on entering any higher education institution or entering a four year college.[10] I supplement these results using Regional Labour Force Survey data to estimate the effect of tutoring expenditure on longer term outcomes such as completing any higher educational qualification or completing a four year degree, and being employed.

Despite the dependent variables used in the estimations being binary outcomes, I use the 2SLS estimator. As explained in Angrist and Pischke (2009), while non-linear models may fit the conditional expectation function better, linear IV methods like 2SLS capture the local average treatment effect regardless of whether the dependent variable is binary, continuous or non-negative.[11]

2.7.1 Effect of tutoring expenditure on college entrance

The results of the analysis based on the YP sample are presented in Tables 2.5 and 2.6. Table 2.5 presents the results of the specification which is linear in spending on tutoring while Table 2.6 presents the results of the specification where spending is also interacted with parental education. OLS results are presented alongside the 2SLS results and the estimation is carried out for the full sample as well as the general high school sample.

The results from the linear specification presented in Table 2.5 do not show a significant relationship between private tutoring expenditures and entering

[10] Around 30% of the sample attend technical or vocational colleges which typically offer two year programmes.

[11] While Stata's *ivprobit* command seems like an easy alternative, it would provide inconsistent estimates given that the spending on tutoring is a non-negative variable and control function estimators (of which *ivprobit* is one) are only consistent when the endogenous variable is continuous (Dong and Lewbel 2015).

college. Indeed, even the OLS results do not show any association between entering any college and spending on tutoring though the effect on entering a four year university is significant and positive.

The results in Table 2.6 are more interesting. Once the effect of spending on private tutoring is allowed to differ by parental education, I find that private tutoring expenditure increases the probability of attending some higher education institution at 10 percent significance for children of less educated parents in the GHS sample. The estimated effect of tutoring expenditure on college entrance for children of more educated parents is significantly lower and is not significantly different from zero. The results in Column (6) indicate that an extra KRW 10,000 spent on a child of less educated parents increases the probability of her entering some college by 1 percentage point. An increase in spending by KRW 10,000 corresponds to an increase of roughly 4 percent from the average level of spending, which means that this estimated effect is sizeable. However, the estimated effects on entering a four year college are much smaller and are not significantly different from zero in either sample or for either parental education group.

Table 2.5: Effect of tutoring expenditure on college entrance

	Full sample				GHS sample			
	Any college		Four year college		Any college		Four year college	
	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Monthly private spending	-0.0001	-0.002	0.001*	0.002	-0.0002	-0.001	0.001**	0.0003
on tutoring (in KRW10,000)	[0.0002]	[0.002]	[0.0003]	[0.003]	[0.0002]	[0.003]	[0.0003]	[0.003]
At least one parent with	-0.022	0.002	0.053***	0.029	-0.019	-0.007	0.055***	0.061
higher education	[0.017]	[0.037]	[0.019]	[0.048]	[0.019]	[0.043]	[0.019]	[0.054]
Male	-0.002	-0.005	0.045**	0.047**	-0.018	-0.02	0.045**	0.044*
	[0.016]	[0.016]	[0.019]	[0.020]	[0.017]	[0.018]	[0.022]	[0.023]
First born	0.002	0.004	0.036*	0.035*	0.004	0.004	0.039*	0.039**
	[0.015]	[0.016]	[0.019]	[0.019]	[0.020]	[0.021]	[0.019]	[0.019]
Mother employed	0.016	0.014	-0.043*	-0.041	0.011	0.01	-0.033	-0.034
	[0.018]	[0.018]	[0.025]	[0.026]	[0.019]	[0.019]	[0.023]	[0.025]
Father employed	0.072	0.086**	0.122***	0.108**	0.026	0.035	0.138**	0.142**
	[0.044]	[0.044]	[0.044]	[0.045]	[0.049]	[0.049]	[0.059]	[0.060]
Attended general high school	0.117***	0.148***	0.319***	0.289***				
	[0.032]	[0.052]	[0.028]	[0.062]				

Notes: The table presents the estimated effects of tutoring expenditure on college entrance using 2SLS and OLS. The full sample includes 2,710 students while the GHS sample includes 2,231 students. Columns (1), (2), (5) and (6) use attending any college as dependent variable while columns (3), (4), (7) and (8) use attending a four year college as dependent variable. All regressions include time and state fixed effects and linear state-specific trends.
Standard errors clustered at state*year level given in brackets. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 2.6: Effect of tutoring expenditure on college entrance

	Full sample				GHS sample			
	Any college		Four year college		Any college		Four year college	
	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Monthly private spending	-0.0001	0.005	0.001***	0.004	-0.0003	0.010*	0.001***	0.004
on tutoring (in KRW10,000)	[0.0003]	[0.003]	[0.0003]	[0.004]	[0.0003]	[0.005]	[0.0003]	[0.005]
Spending*at least one parent	0.0001	-0.001	-0.001**	-0.001	0.0002	-0.004*	-0.001**	-0.001
with higher education	[0.0004]	[0.002]	[0.0004]	[0.002]	[0.0004]	[0.002]	[0.0004]	[0.002]
At least one parent with	-0.024	-0.046	0.078***	0.063	-0.026	0.013	0.081***	0.071
higher education	[0.020]	[0.053]	[0.024]	[0.049]	[0.021]	[0.049]	[0.023]	[0.050]
Male	-0.002	0.004	0.045**	0.049**	-0.018	-0.001	0.046**	0.050**
	[0.016]	[0.018]	[0.019]	[0.021]	[0.017]	[0.021]	[0.022]	[0.025]
First born	0.002	0.001	0.037**	0.036*	0.003	0.007	0.040**	0.040**
	[0.015]	[0.016]	[0.018]	[0.019]	[0.020]	[0.023]	[0.019]	[0.020]
Mother employed	0.016	0.021	-0.044*	-0.042*	0.011	0.017	-0.034	-0.032
	[0.018]	[0.018]	[0.024]	[0.024]	[0.020]	[0.023]	[0.023]	[0.024]
Father employed	0.072	0.036	0.120***	0.101**	0.027	-0.057	0.136**	0.114**
	[0.043]	[0.047]	[0.044]	[0.044]	[0.048]	[0.067]	[0.059]	[0.058]
Attended general high school	0.117***	0.038	0.313***	0.271***				
	[0.031]	[0.055]	[0.028]	[0.069]				

Notes: The table presents the estimated effects of tutoring expenditure on college entrance using 2SLS and OLS allowing the effect to differ by parental education. The full sample includes 2,710 students while the GHS sample includes 2,231 students. Columns (1), (2), (5) and (6) use attending any college as dependent variable while columns (3), (4), (7) and (8) use attending a four year college as dependent variable. All regressions include time and state fixed effects and linear state-specific trends.
Standard errors clustered at state*year level given in brackets. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The results from Table 2.6 reflect concavity in the relationship between college entrance and tutoring expenditure since parents who are more educated spend much more on tutoring for their children than parents who are less educated. This implies that the spending on tutoring shows decreasing marginal effects on college entrance. Furthermore, the fact that the linear specification is not able to pick up any effect of tutoring on college attendance suggests that students are, on average, closer to the flatter end of the tutoring-college attendance curve. This can be explained by the fact that the LATE being captured here is the effect of tutoring on those whose spending was high enough to be constrained by the curfew.

Comparison between the OLS and 2SLS estimates do not reveal a systematic direction of bias, though the OLS estimates are generally much smaller in magnitude (in absolute terms) than the 2SLS estimates, suggestive of measurement error. Given that spending on tutoring in the final year of high school is used as a measure of tutoring, measurement error arises from both self-reporting of expenditure and from using final year spending as a measure of average spending over the total high school period. (This is discussed further in Section 2.8). As such, it is not surprising that the OLS estimates are attenuated towards zero.

2.7.2 Effects of tutoring on longer-term outcomes

The estimation of the effect of tutoring on longer term educational and labour market outcomes is an unexplored area given the lack of sufficiently long panels collecting the required information. By 2016, the most recent year for which the Regional Labour Force Survey (LFS) is available in Korea, the youngest cohort in the YP sample was aged 23, so it is reasonable to assume that most of the cohorts considered in the analysis had completed their first degree and entered the labour market. Therefore, I match educational and labour market outcomes from the LFS data with spending on tutoring from the YP data

to estimate the effect of tutoring expenditure on these longer term outcomes using two-sample 2SLS (TS2SLS). Put simply, the TS2SLS estimator uses first stage estimates from the YP data to predict tutoring expenditures at the province-year of birth level in the LFS sample. In the second stage, the outcome variables in the LFS data are regressed on predicted expenditure and the other exogenous controls to obtain the effect of tutoring expenditure on the outcome. Standard errors are adjusted as prescribed by Pacini and Windmeijer (2016) to account for the fact that the first-stage estimation was based on a different sample.

The LFS sample consists of 18,908 individuals born between 1989 and 1993. Of this sample, 3196 were still engaged in full-time, undergraduate education, 9958 were employed, 1976 were unemployed and the rest were economically inactive. I consider several different outcomes for this analysis: completion of a four year degree programme or any higher educational qualification, employment and wages. When estimating the effect of tutoring on the probability of completing a higher educational qualification, I exclude full-time undergraduate students from the sample and when estimating the effect of tutoring on the probability of being employed, I exclude all economically inactive individuals (which includes the full-time students). However, it should be noted that the effects estimated without excluding full-time students or the economically inactive population are hardly different. Given that the LFS does not include any family background characteristics, the only controls included are sex, province and year of birth fixed effects and province-specific, linear trends. Furthermore, I am only able to estimate the linear specification of the model as given in Equation 2.1. The results of the two-sample 2SLS estimation are presented in Table 2.7.

These results show a significant, positive effect of spending on tutoring on the probability of completing a four year degree.[12] Here, an increase in tutoring

[12]While I exclude individuals engaged in full-time undergraduate studies when estimating the effects on degree completion, estimating the effects using the entire sample does not significantly change the results.

Table 2.7: Results of two-sample 2SLS estimation

Dependent variable	Spending	N
Completed four year degree	0.0039***	15712
	[0.0008]	
Completed any degree	0.0019*	15712
	[0.0011]	
Employed (=0 if unemployed)	0.0018***	11934
	[0.0004]	
Employed (=0 if unemployed)	0.0019***	18908
or economically inactive	[0.0007]	
Log wages	-0.0004	9958
	[0.0012]	

Notes: The table presents the two-sample 2SLS estimates for four regressions; each row corresponds to a different dependent variable. The coefficient on spending on tutoring (in 10,000 KRW) for each regression is given in the second column. The last column indicates how many observations were used in the second stage regression. All estimates are based on a first-stage regression estimated using YP data on a sample of 2,617 individuals. All regressions include a dummy for being male, year of birth and state fixed effects, and linear state-specific trends. Standard errors, clustered at state*year of birth level, are given in brackets.
Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

expenditure by KRW 10,000 increases the probability of completing a four year degree by 0.4 percentage points. The estimated effect of completing any higher educational qualification is smaller and is less precise, though it is still different from zero at 10 percent significance.

The two labour market outcomes considered in this analysis are being employed (as opposed to unemployed) and log wages. The results show that individuals who spent more on private tutoring are more likely to be employed, with the effect being significantly different from zero at 1 percent level. I do not find any significant effect of tutoring on wages. However, I do not attach too much weight to the results from the wage regression for two reasons: the reduced form of the employment equation indicates strong effects of the curfew on employment which would lead to selection bias in the estimation of the wage regression as inclusion in the wage regression sample (being employed) is significantly affected by the instrument. Second, only half of the LFS sample is employed in 2016 with roughly 16 percent of the sample still engaged in full time education, while most of the individuals who are working are only likely

to have been working for a few years.

In all, the results point toward positive effects of tutoring on educational outcomes, though the results vary substantially according to the outcome considered. The estimation of a model linear in tutoring expenditure reveals a significant, positive relationship between tutoring expenditure and completing a four year degree, with a smaller, less significant effect on completing any degree. This model does not show any effect of tutoring on college entrance. However, allowing the effect of tutoring expenditure to differ by parental education reveals a large, positive effect of spending on tutoring on entering any college for children of less educated parents, though the effect for more educated parents is not significantly different from zero. Even under this specification, I do not find any significant effect on entering a four year college.

Intuitively, it appears that the linear specification is a better fit for explaining completion of a four year degree, given that it is a more difficult outcome to achieve. On the other hand, entering some college is an easier outcome to reach and so, in the range of spending for which the effects are captured, the relationship between spending and college entrance is concave. An implication of the linear specification not being able to pick up any effect of tutoring on college attendance is that students are, on average, closer to the flatter end of the tutoring-college attendance curve. Given that the effects captured are for those whose spending was constrained by the curfew, this is hardly surprising.

The estimated effects of tutoring on labour market outcomes show that while tutoring expenditure increases the probability of being employed it does not affect wages. Since spending on tutoring is found to positively affect the probability of completing a four year degree, it seems reasonable that these graduates are more employable, giving rise to the positive relationship between tutoring expenditure and employment. As explained earlier, while the estimates using log wages potentially suffer from sample selection bias, the lack of an effect of wages could also be explained by an experience-education trade-off for young workers as described in Sicherman (1991).

2.8 Robustness checks

In this section, I carry out several robustness checks on the relevance and validity of my identification strategy. In particular, I check the robustness of my first stage results and examine the effect of the curfew on spending on different forms of tutoring as well as on hours of sleep and internet usage for high school students. In addition, I also consider the implications of using tutoring expenditure in the final year of high school as a measure of the stock of tutoring obtained over the entire high school period.

2.8.1 Effect of the curfew by type of tutoring

As discussed in Section 2.6, the lack of a significant effect on spending under the 11pm curfew and the smaller response of more educated parents under the 10pm curfew could potentially be explained by parents either rescheduling classes or switching to alternative types of tutoring. To explore this further, I use the PEES data to examine the impact of the curfew on spending on different types of tutoring.

I estimate equations similar to the first stage regressions, using expenditure on the different types of tutoring - Hagwon, one-to-one tutoring and small-group tutoring - as dependent variables. Given that the PEES data does not indicate which year of high school a student is in, I use just two dummies to indicate the curfew at 11pm and the curfew at 10pm. The same set of controls used in the YP sample is used here, with the exception of the indicator for being the eldest child which is not available in the PEES data. The results of the regressions are presented in Table 2.8. It should be kept in mind that the differences in curfew dummies used and the time periods covered (the PEES dataset spans from 2009 to 2015 while the YP dataset spans from 2007 to 2011) would lead to some disparities between the two sets of results though ideally they would not be too large.

The results in Panel A show the estimated effects of the curfew on spending on different types of tutoring. As in my first stage estimation, while there is a significant, negative impact of the 10pm curfew on total spending on tutoring, the effect of the 11pm curfew on spending is not significant. Moreover, the results from this linear specification indicate that while spending on *Hagwon* classes fell significantly as a result of the 10pm curfew, spending on other types of tutoring were not significantly affected. This confirms that, on average, the 10pm curfew constrained spending on tutoring with little or no substitution towards other types of tutoring. The results from the general high-school sample are qualitatively very similar to the results from the full sample, the only exception being that a significant positive effect on spending on one-to-one tutoring is recorded under the 11pm curfew in the full sample. In the general high school sample, however, the 11pm curfew has not changed spending on any type of tutoring, indicating that the 11pm curfew was not binding.

Table 2.8: Effect of curfew on tutoring by type

Spending (in KRW 10,0000)	Total spending		Hagwon		One-to-one		Small group	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A: Linear specification								
11pm curfew	0.354	-0.224	-0.93	-0.954	0.987*	0.815	0.222	-0.024
	[0.884]	[1.367]	[0.713]	[0.820]	[0.522]	[0.644]	[0.502]	[0.593]
10pm curfew	-1.344**	-1.988***	-0.896*	-1.360***	-0.439	-0.583	0.049	0.047
	[0.532]	[0.675]	[0.456]	[0.512]	[0.317]	[0.461]	[0.235]	[0.273]
B: Curfew interacted with parental education								
11pm curfew	-0.006	-0.729	-0.981	-0.914	0.588	0.256	0.293	0.001
	[0.992]	[1.412]	[0.698]	[0.838]	[0.511]	[0.613]	[0.480]	[0.559]
10pm curfew	-5.132***	-5.780***	-4.135***	-4.559***	-1.244***	-1.464**	0.259	0.312
	[1.020]	[1.182]	[0.766]	[0.823]	[0.465]	[0.623]	[0.261]	[0.310]
11pm curfew*at least one parent	1.053	1.261	0.324	0.078	0.948*	1.227**	-0.174	-0.066
with higher education	[1.175]	[1.245]	[0.650]	[0.682]	[0.538]	[0.588]	[0.266]	[0.300]
10pm curfew*at least one parent	7.414***	6.679***	6.348***	5.648***	1.567**	1.538**	-0.410**	-0.466**
with higher education	[1.658]	[1.629]	[1.044]	[0.979]	[0.652]	[0.669]	[0.177]	[0.186]
F-test for curfew effects on spending of more educated parents								
11pm curfew	None	None	None	None	Positive at 5%	Positive at 10%	None	None
10pm curfew	Positive at 5%	None	Positive at 1%	Positive at 10%	None	None	None	None
Sample	Full	GHS	Full	GHS	Full	GHS	Full	GHS

Notes: The table presents the results of the regressions of spending on different types of tutoring on the curfew. All expenditure is measured in constant 2015 KRW. Panel A provides results of a linear specification of spending on the curfew, while Panel B provides results from interacting the curfew dummies with the dummy indicating that at least one parent has higher education. All regressions also include a full set of controls, state and year fixed effects and state-specific linear trends. Columns (1), (3), (5) and (7) use a sample of 250,683 high school students while columns (2), (4), (6) and (8) use the sub-sample of 216,847 general high school students.
The F-tests check that the sum of the coefficients on the curfew dummy and the interaction of that dummy with parental education, that is the effect of the curfew for more educated parents, is equal to zero. Standard errors clustered at state*year level given in brackets. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The results in Panel B show the estimated effects of the curfew, allowing the effect to differ by level of parental education. Again, it appears that only the 10pm curfew had any significant impact on tutoring expenditure. Less educated parents spent significantly less on tutoring as a result of the 10pm curfew, spending less on both *Hagwon* and one-to-one tutoring, though the reduction in spending on *Hagwon* is much larger in magnitude. The effect of the curfew on more educated parents is quite different. Using F-tests to verify the overall effects of each curfew on the spending of more educated parents, it appears that while neither curfew reduced total spending on tutoring by more educated parents, the 10pm curfew actually caused total expenditure to rise in the full sample. However, it seems that this is driven by an increase in spending on *Hagwon*, pointing to the possibility that, rather than shifting towards different types of tutoring, more educated parents simply re-scheduled their children's classes in *Hagwon*. I also find a slight increase in one-to-one tutoring by more educated parents under the 11pm curfew. However, given that the magnitude of the increase is relatively small (just over KRW 10,000) compared to average spending on tutoring overall (roughly KRW 200,000), it is unlikely that the overall quality of tutoring changed very much.

The results from this exercise confirm that the 10pm curfew constrained tutoring expenditure, causing spending to decline, while the 11pm curfew did not and confirms that substitution into alternative forms of tutoring is unlikely to be a major concern. Rather, it appears that more educated parents rescheduled extra classes in *Hagwon*. While this might weaken the first stage, it would not affect the interpretation of tutoring expenditure before and after the imposition of the curfew.

2.8.2 Effects on time use

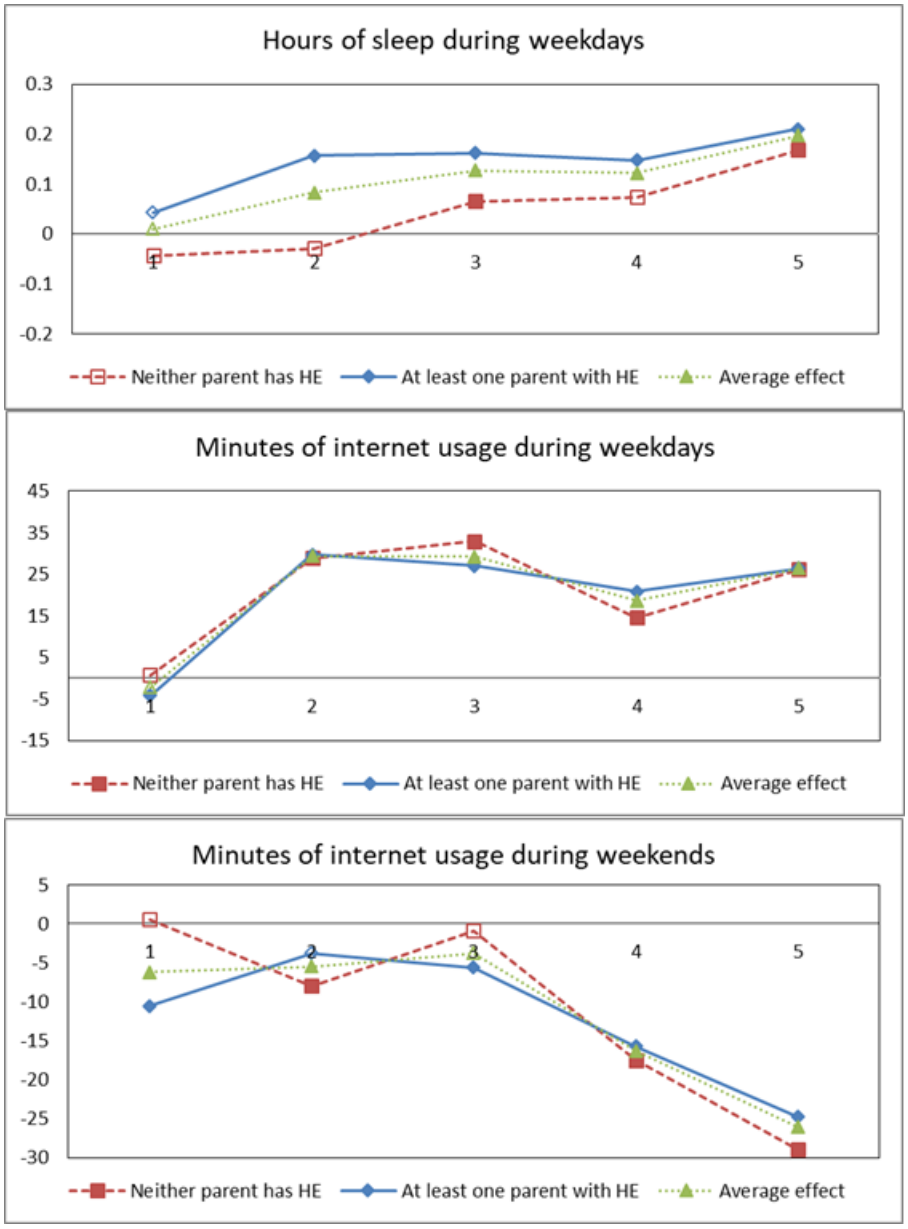
As the first stage estimates and the results of the previous section show, only the 10pm curfew constrained spending on tutoring. As such, the effects captured in the main analysis are the effects local to those whose spending was affected by this curfew. In this section, I further explore the effect of the 10pm curfew, focusing on sleeping hours and internet usage using the Korean Youth Risk Behaviour Survey. The only channel by which the curfew would affect time spent sleeping or browsing the internet is through changes to time spent at *Hagwon*. Therefore, if spending on tutoring decreased as result of the curfew, it would be reasonable to assume that either sleeping hours or internet usage or both would increase as a consequence of the curfew being imposed.

I regress my measures of time use (hours of sleep on weekdays and minutes of internet usage on weekdays and weekends) on the set of dummies indicating exposure to the 10pm curfew and the full set of controls for the sample of final-year high school students in the same five cohorts as the YP sample (in the final year of high school between 2007 and 2011). The regressions are carried out for high school and general high school samples separately and with and without interacting the curfew dummies with parental education. Note that the data on internet usage is available only after 2008 and that the dummies on parental employment status are replaced with measures of the socio-economic status of the household defined in the KYRBS.

Figure 2.3 plots the effects of the curfew on sleeping hours and minutes of internet usage on weekdays and weekends for the general high school sample. The effects for children of more and less educated parents are given by the blue (solid) and red (dashed) lines, respectively, while the green (dotted) line gives the average effect. (The full set of results from these regressions as well as the results for the full sample are available in Appendix A3 and A4.)

The figure shows that sleeping hours and internet usage during weekdays increased significantly, on average, as a result of the curfew being imposed, with

Figure 2.3: Effect of the curfew on time use



Notes: The graphs plot the effect of the 10pm curfew on weekday sleeping hours, weekday internet usage and weekend internet usage by year of exposure to the curfew using the GHS sample from the Korean Youth Risk Behaviour Surveys from 2007-2011. Data on internet usage is only available from 2008 onwards. The effect for children of less educated parents is given by the red, dashed line while the effect for the children of more educated parents (captured by the sum of the coefficient on the curfew dummy and the interaction term) is given by the blue, solid line. The green, dotted line gives the average effect obtained from the regression model which does not interact the curfew dummies with parental education. Markers with no fill represent effects that are not significantly different from zero at 10% significance.

the magnitude of the effect on sleep increasing with the years of exposure to the curfew. In terms of magnitude, the changes in sleeping hours are not very large, the largest coefficient corresponding to an increase in sleep of around 12 minutes. Note, however, that this is an effect averaged over all students, including those who get relatively little or no tutoring. The fact that a significant effect emerges at all indicates that there is a relatively large number of students obtaining tutoring until late at night. I also find a large increase in time spent on the internet during weekdays. These results are reassuring in that they are consistent with the finding of decreased spending as a result of the curfew with the size of the reduction increasing with years of exposure to the curfew. It also appears that internet usage during weekends decreased significantly after the imposition of the curfew, with the largest reduction of around 30 minutes. This points to the possibility that some of the tutoring foregone as a result of the curfew was re-scheduled for the weekend, especially among the younger cohorts who were exposed to the curfew for longer.

The effects on time use are not systematically different for the two parental education groups, except for the effects on hours of sleep. The figure indicates that children of more educated parents experienced larger increases in hours of sleep than the children of less educated parents. This is not surprising given that more educated parents spent more on tutoring and were likely to have been more affected by the imposition of the curfew.

The results of this exercise, which show increased sleeping time and internet usage after the imposition of the 10pm curfew, are consistent with my first stage results. Taken together, these results highlight the severity of the college entrance rat race with students putting in very long hours, even trading off sleep for additional tutoring.

2.8.3 Measurement error in tutoring expenditure

I now address a concern regarding measurement error in tutoring expenditure. While the IV approach provides a solution for classical measurement error, using spending on tutoring in the final year of high school as the measure of total tutoring expenditure over high school brings in a problem of measurement error different to the errors in self-reporting. The first stage results, which showed reductions in spending that increased with the years of exposure to the curfew, suggest that the curfew might have changed the distribution of tutoring over the three years of high school. If the measurement error caused by measuring total tutoring expenditure by expenditure incurred in the final year of high school is related to the instrument, the IV approach will not be able to eliminate the bias caused by measurement error.

To investigate this issue, I use the smaller sub-sample for which information on spending over all three years of high school is available to construct the measurement error (the difference between average spending over all three years and spending in the final year). I then regress the measurement error on the average spending over all three years and on the curfew exposure dummies that I use as instruments. The results of these regressions are presented in Table 2.9.

The regression results indicate that the measurement error is not correlated to the average spending over all three years of high school. However, given that the average spending variable is still subject to the errors in self-reporting, the results in Columns (1), (2) and (4) should be interpreted with caution. More important are the results in Column (3). While there are a few curfew dummies which are significantly related to the measurement error, the relationship does not seem to be systematic. For instance, having lived under the 10pm curfew for four years decreases the measurement error while having lived under the same curfew for five years increases it. Therefore, it is likely that the significant coefficients are more a result of sampling variation than a systematic

Table 2.9: Measurement error in tutoring expenditure

Measurement error	(1)	(2)	(3)	(4)
Average spending over	0.041	0.034		0.035
all years of HS	[0.065]	[0.059]		[0.059]
curfew=11pm, years=1			-1.03	-0.388
			[1.320]	[1.594]
curfew=11pm, years=2			2.485	2.933
			[1.906]	[1.983]
curfew=11pm, years=3			8.452***	8.852***
			[2.692]	[2.747]
curfew=11pm, years=4			2.081	2.677
			[4.334]	[4.440]
curfew=10pm, years=1			0.945	1.306
			[3.526]	[3.553]
curfew=10pm, years=2			0	0
curfew=10pm, years=3			1.759	1.48
			[1.320]	[1.317]
curfew=10pm, years=4			-2.411**	-2.864**
			[0.922]	[1.064]
curfew=10pm, years=5			9.322**	9.082**
			[3.519]	[3.463]
State and year FE	No	Yes	Yes	Yes

Notes: The table presents the results of the regressions of the constructed measurement error in tutoring expenditure on the average spending over all three years of high school and the curfew exposure dummies for a sample of 1,299 students for whom information on average spending over all three years is available. Average spending in measured in KRW 10,000. The first column does not include any time or state fixed effects. Standard errors clustered at state*year level given in brackets.
Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

relationship between the measurement error and the instruments.

2.8.4 Measurement error in the IV

A key concern arising from the TS2SLS analysis is that the LFS does not record the year or province in which the respondent completed high school, but only the province of residence at the time of the survey and year of birth. This means that the curfew variables will be defined on the basis of province of residence and year of birth in the LFS dataset. Inter-province migration and

early or late graduation would then result in the curfew variable being mis-measured. It is possible to think of scenarios in which this measurement error would be correlated with the outcomes (for instance, less academically inclined students may take longer to graduate high school and will also not attend college), which means that the measurement error would be non-classical. Now, when the mis-measurement of the instrument occurs in both samples, the first stage and reduced form are affected proportionately but the bias cancels out in the IV estimate even in the case of non-classical measurement error (Pischke and von Wachter 2008). However, when the measurement error only occurs in one of the samples, the resulting TS2SLS estimator will also be biased.

It is possible to re-define the curfew variable in the YP sample in terms of the year of birth of the respondent, rather than her year of high school graduation, so that this particular source of measurement error, at least, will cancel out in the TS2SLS estimation. The results presented in Table 2.7 are obtained after using this correction.[13] The measurement error caused by incorrectly inferring the province of schooling to be the province of residence cannot be dealt with as easily. However, using statistics on internal migration for young Koreans, it is possible to get an idea of the magnitude of the problem. In particular, we need to know the transition matrix for the probability of movement for a young person between the end of high school and her mid-twenties, between the three types of provinces on which the instrument is based - provinces with no curfew, the 11pm curfew and the 10pm curfew.

Using published statistics on internal migration from the Korean Statistical Information Service (KOSIS), I construct a transition matrix for the probability of movement between the three types of provinces for individuals aged 20-24 in 2016. This is presented in Table 2.10.[14]

The table indicates that the probability of staying within a particular type

[13]This also explains why the sample size for the first stage estimates is smaller than the sample used in the YP 2SLS analysis.

[14]The full transition matrix broken down for the 16 provinces is available in Appendix A5.

Table 2.10: Transition matrix for internal migration for 20-24 year olds

		Destination		
		No curfew	11pm curfew	10pm curfew
Origin	No curfew	**0.926**	0.017	0.057
	11pm curfew	0.029	**0.932**	0.039
	10pm curfew	0.023	0.009	**0.968**

Notes: The table presents the transition matrix for movement between different provinces, categorised by type of curfew implemented, for individuals aged 20-24 in 2016. The probabilities in the diagonal cells are calculated to include those who move between provinces within a particular category as well as those who do not move at all. Probabilities are calculated based on statistics on internal migration by five-year age group and statistics on the resident population by five-year age group obtained from KOSIS.

of province is high, more than 90 percent in all categories. Those living in a province with a 10pm curfew are least likely to move (probability less than 4 percent) while those living in a province with no curfew are most likely to move (probability of roughly 7 percent). Therefore, while there will be some measurement error in the curfew variable, it is unlikely to be very large. It is possible to transform the TS2SLS estimates using this transition matrix and the transition matrix for movements between all 16 provinces. The results after transformation are very similar to those reported in Table 2.7 (see Appendix A6 for more details).

2.9 Theoretical framework

In this section, I provide a simple, theoretical model which can provide an economic intuition for the results presented in the previous section. While my identification strategy does not allow me to distinguish between signalling and human capital explanations for the effects of tutoring, the estimated effects of the curfew on spending on tutoring and sleeping hours, together with the very fact that a curfew had to be imposed to control spending on private tutoring, are highly suggestive of rat-race behaviour. As such, I develop a simple model of asymmetric information with two types of students where ability is the private information of the student and college admissions are based on test scores which are signals of ability. The use of signalling models

to describe rat-race conditions goes back to Akerlof (1976) who describes a workplace rat race in which all workers (other than the type with the lowest productivity) work faster than their optimal speed to signal their productivity to the employer. This concept of rat-race equilibria is also explicitly presented as the result of adverse selection by Landers, Rebitzer and Taylor (1996) in an application to the determination of work hours in law firms.

The model presented here is an adaptation of this asymmetric information framework to the choice of tutoring and college admissions. The lack of information on student ability faced by colleges gives rise to a cutoff test score with students scoring above the cutoff perceived as high ability and admitted to college. In the separating equilibrium, the cutoff mark is high enough to discourage low types from getting any tutoring while causing the high types to obtain more tutoring than would be optimal under perfect information.

After establishing the existence of a rat-race equilibrium, I examine several comparative statics to illustrate how the rat race may intensify further. This is similar to the analysis in Hopkins and Kornienko (2010), who illustrate the effects of changing the inequality of the distribution of rewards (corresponding to the payoffs from different educational outcomes in this paper) and endowments (corresponding to ability in this paper), on equilibrium outcomes in a tournament model with a continuum of types. While restricting the model to just two types and two rewards simplifies the comparative statics considerably, the broad qualitative conclusions about welfare effects are the same. The only noteworthy difference is the type of agent affected by changes in the inequality of these distributions: with a continuum of types, the changes affect lower and middle types whereas when there are only two types, the changes affect the high types' behaviour.

2.9.1 The model

Consider an environment in which there are two types of students - high ability and low ability. Other than for this difference in innate ability, students have the same endowment of wealth and attend identical schools. Students decide how much to spend on tutoring, which determines their test scores, with high ability students having a comparative advantage in the production of test scores over the low ability students. In addition to tutoring and innate ability, school quality also positively influences test scores.

The test score, T of type i is given by:

$$T_i = T_i(m_i, S; a_i), \quad i \in \{H, L\} \tag{2.2}$$

where $m_i \geq 0$ is the amount of tutoring chosen by type i while S is the quality of schooling and a_i is the innate ability of the student. I allow $T_i(0, S; a_i) > 0$ so that students achieve non-zero test scores even with no tutoring. $T_i(.)$ is strictly increasing and concave in m, S and a_i. I allow the function to differ between types but assume that $T_H(m; S) > T_L(m; S)$ for all m - that is, for a given level of tutoring, the high types always receive a higher test score.[15]

There are two outcomes - attending college or not.[16] Students derive utility from their educational outcome and from consumption (which is equal to the endowment after spending on tutoring). I assume that the test score is a pure signal in that students do not derive any utility directly from the test score though altering the framework so that the test score is a direct source of utility alongside being a signal of ability will not change the results qualitatively. All

[15]The key motivation behind allowing the function to differ between types is to allow school quality to affect test scores of the two types differently, which makes for more interesting comparative statics.

[16]Given that nearly all students in Korea attend some form of higher education the outcomes can also be interpreted as entering a two-year college versus entering a four year college.

students have the utility function

$$U(q, C) = q + C = q + y - m \tag{2.3}$$

where y is the wealth of the student and $q \in \{q_1, q_2\}$ corresponds to the payoffs from not attending and attending college, respectively.

Perfect information

In a setting of perfect information, all high types would be admitted to college, while low types would not and no one would spend on tutoring. In this perfect information equilibrium, therefore, low and high type payoffs will be given by:

$$U_L = q_1 + y$$
$$U_H = q_2 + y$$

Asymmetric information

When types are not observable, colleges are no longer able to distinguish high types from the low and instead use test scores to gauge the ability of a student.

First let us consider the possibility of the perfect information allocation with neither type spending on tutoring being maintained as an equilibrium. When neither type gets tutoring high types score higher than low types and it is possible for the perfect information allocation to be maintained as an equilibrium so long as the test score high types obtain with no tutoring, $T_H(0, S; a_H)$, is high enough to prevent low types from mimicking the high types:[17]

$$q_1 > q_2 - m_L(T_H(0)) \tag{2.4}$$

[17]This feature is usually seen in signalling models in which agents derive utility directly from the signal so that non-zero amounts of the signal are chosen even in the perfect information setting. In this case, even though students do not derive utility from the test score, the possibility of getting non-zero scores with no tutoring gives rise to this phenomenon.

where $m_L(T_H(0)) = T_L^{-1}(T_H(0); a_L)$ is the amount of tutoring low types need to reach $T_H(0, S; a_H)$.[18] This might be the case if the difference between high and low ability is very large or if the difference between q_1 and q_2 is very small. For the remainder of this paper, however, I will focus on the more interesting case in which $T_H(0)$ is not high enough to maintain a no-tutoring equilibrium in the presence of information asymmetry.

When the perfect information allocation can no longer be maintained, there are two classes of equilibria to consider: pooling and separating. However, we can use the Intuitive Criterion to rule out all pooling equilibria as well as any Pareto-dominated separating equilibria. Therefore, I will focus on the Riley equilibrium of the game in which low types maintain their perfect information allocation while the high types spend the lowest amount of tutoring that would prevent low types from mimicking them. This is equivalent to saying that high types obtain the lowest test score $\hat{T}$ that does not encourage low types to deviate.

In general, a separating equilibrium will be characterised by a cutoff score T', which satisfies the following two conditions:

$$q_1 \geq q_2 - m_L(T') \tag{2.5}$$

$$q_2 - m_H(T') > q_1 \tag{2.6}$$

where $m_i(T') = T_i^{-1}(T'; a_i)$ is the level of tutoring required by type i to reach the test score T'. Condition 2.5 is the incentive compatibility constraint while condition 2.6 is the participation constraint.

The Riley equilibrium is the equilibrium in which $T' = \hat{T}$ which is the solution to:

$$q_1 = q_2 - m_L(\hat{T}) \tag{2.7}$$

[18] Since $T(.)$ is a strictly increasing function of m, the inverse is well defined.

Note that:

$$q_2 - m_H(\hat{T}) > q_2 - m_L(\hat{T}) = q_1$$

so that the high types strictly prefer this outcome to pretending to be of low type. The first inequality follows from the single crossing property where $T_H(m) > T_L(m)$ for all m, which implies that $m_L(T) > m_H(T)$ for all T, and the equality follows from the definition of $\hat{T}$.

To summarise, given a low enough $T_H(0)$, the equilibrium described in this section leads to the same outcomes as the perfect information equilibrium for the low types but the high types will be strictly worse off as they now have to spend $m_H(\hat{T}) > 0$ on tutoring in order to attend college. The higher spending by high types is supported in the empirical findings with more educated parents spending more on tutoring in the YP sample (though, of course, children of more educated parents are not guaranteed to be of type H) and students who spend more time on self-study and are considered to have greater academic ability by their teachers spending more on tutoring in the KEEP results.

2.9.2 Comparative statics

I now provide some comparative statics using Equation 2.7 which illustrate how the rat race for college admission might be aggravated, driving the spending of high types further up, causing the marginal effects of tutoring they experience to become smaller.[19]

Proposition 1. *1. An increase in the payoff to college education, q_2, or a decrease in the payoff associated with no college education, q_1, will result in an increase in $\hat{T}$ which leads to an increase in $m_H(\hat{T})$*

[19]If condition (2.4) were satisfied and the no-tutoring equilibrium is maintained even with imperfect information, the comparative statics examined here would be altered so that changes currently shown to be causing $m_H(\hat{T})$ to rise will instead be changes that lead to condition (2.4) being violated, giving rise to a new separating equilibrium in which high types do have to obtain non-zero tutoring.

2. *An increase in school quality S will result in an increase in $\hat{T}$ but the effect on $m_H(\hat{T})$ is ambiguous*

Proof. 1. Differentiating Equation 2.7 with respect to q_1 and q_2 respectively gives:

(a) $\frac{\partial \hat{T}}{\partial q_1} = -\frac{1}{\frac{\partial m_L(\hat{T})}{\partial \hat{T}}} < 0$

(b) $\frac{\partial \hat{T}}{\partial q_2} = \frac{1}{\frac{\partial m_L(\hat{T})}{\partial \hat{T}}} > 0$

since $\frac{\partial m_L(\hat{T})}{\partial \hat{T}} > 0$.

$m_H(\hat{T})$ is increasing in $\hat{T}$ so an increase in q_2 or a reduction in q_1 will increase spending on tutoring by high types. Since $T_H = T_H(m_H, S; a_H)$ is concave, an increase in m_H results in a decrease in $\frac{\partial T_H}{\partial m_H}$.

2. Differentiating Equation 2.7 with respect to S gives:

$$\frac{\partial \hat{T}}{\partial S} = -\frac{\partial m_L(\hat{T})}{\partial S} \cdot \frac{1}{\frac{\partial m_L(\hat{T})}{\partial \hat{T}}} > 0$$

Since $m_H(\hat{T})$ is the solution to

$$\hat{T} = T_H(m_H(\hat{T}), S; a_H)$$

differentiating both sides of this equation with respect to S and rearranging terms gives:

$$\frac{\partial m_H(\hat{T})}{\partial S} = (\frac{\partial \hat{T}}{\partial S} - \frac{\partial T_H}{\partial S}) \frac{1}{\frac{\partial T_H}{\partial m_H}}$$

Since $\frac{\partial T_H}{\partial m_H} > 0$,

$$sign(\frac{\partial m_H(\hat{T}}{\partial S}) = sign(\frac{\partial \hat{T}}{\partial S} - \frac{\partial T_H}{\partial S})$$

□

The first set of effects is fairly intuitive. Higher utility from attending college or lower utility from not attending college (which can be interpreted as a high college premium) give the low types greater incentive to deviate from their equilibrium allocation. As such, the cutoff test score must be high enough to prevent this. Given that the payoffs from educational outcomes do not enter the function transforming tutoring into test scores, an increase in $\hat{T}$ results directly in an increase in the level of tutoring high types need to reach the new $\hat{T}$, moving the high types further upwards along the tutoring-test score curve. This result is consistent with that of Hopkins and Kornienko (2010), who show that increasing the inequality of rewards increases the incentive to put in extra effort.

The effect of changing school quality on the tutoring expenditure of high types is ambiguous. An improvement in the quality of schooling will raise test scores of all students for a given m and so $\hat{T}$ must rise to satisfy incentive compatibility (Equation 2.7). However, the response of the high types depends on whether the change in school quality has a larger effect on the cutoff score or on high type test scores. Note that the cutoff score is determined by low type behaviour. Therefore, the effect of changing school quality really depends on the relative importance of schooling in determining the test scores of the two types. For instance, if the improvement in school quality disproportionately helps low types, the corresponding rise in $\hat{T}$ will be larger than the improvements in high-type test scores. In this scenario, we end up in a worse situation, with the high types having to spend even more as a result of better school quality. Again, this result is analogous to that in Hopkins and Kornienko (2010) where a reduction in the inequality of initial endowments makes the low types more competitive.

Finally, even if an improvement to school quality raises the amount of tutoring consumed by high types, given that school quality is an argument of the function transforming tutoring into test scores, it is not guaranteed that the marginal effect of tutoring for high types falls. To see this, note that we are

interested in the sign of:

$$\frac{\partial}{\partial S}(\frac{\partial T_H}{\partial m}|_{m=m_H(\hat{T})}) = \frac{\partial^2 T_H(m_H, S)}{\partial m_H^2}.\frac{\partial m_H(S)}{\partial S} + \frac{\partial^2 T_H(m_H, S)}{\partial m_H \partial S} \tag{2.8}$$

It can be seen that the slope at $m_H(\hat{T})$ does not necessarily fall in response to an improvement in school quality even if $m_H(\hat{T})$ increases due to the last term in Equation 2.8. This term shows how the marginal product of tutoring changes in response to changes in school quality. It would be positive if schooling and tutoring were complements and negative if they were substitutes. However, if the response of m_H to a change in S is sufficiently large and positive or if the complementarity between school and tutoring is sufficiently low for high types, the marginal effect at the new m_H will fall even if tutoring and schooling are complements. On the other hand, if tutoring and schooling are substitutes, an increase in S will definitely cause the marginal effect of spending experienced by high types to fall when $\frac{\partial m_H(\hat{T})}{\partial S} > 0$.

2.9.3 Discussion

The model of the college admissions rat race presented in this section provides some economic intuition for the empirical evidence presented in this paper. The lack of information faced by colleges gives rise to an equilibrium in which the consumption of tutoring is inefficiently high, particularly among students of higher ability. While I do not directly estimate the relationship between student ability and spending on tutoring in this paper, the descriptive results from the KEEP dataset show positive associations between spending on tutoring and time spent on self-study and academic ability as assessed by teachers.

The results obtained in Section 2.7 provide estimates of the effect of tutoring expenditure on educational outcomes but cannot distinguish between human capital and signalling explanations for the results. However, the fact that colleges in Korea overwhelmingly rely on CSAT scores for making admissions

decisions together with the first stage estimates, which highlight large investments of time and money in tutoring, are highly suggestive of a rat race. Indeed, the rat race appears to be so severe that students attend classes late into the night with many students trading off sleep for more hours of tutoring.

As shown in the comparative statics section, a high college wage premium could explain this large investment in tutoring. Indeed, Machin and McNally (2007) find that having a tertiary education qualification was associated with a wage differential of 141 in Korea in 2003 (where the wage of those with a upper secondary or post upper secondary, non-tertiary qualification was normalised to a 100), up from 135 in 1998. This is in spite of the large increase in the supply of tertiary graduates observed over this period.

The comparative statics also suggest that improvements to school quality could intensify the rat race if said improvements benefited low ability types more than the high ability types. Many attempts to improve the quality of formal schooling have been made, alongside the provision of after-school classes by the schools themselves, to discourage the excessive reliance on tutoring in Korea. While these efforts certainly benefit students from low-income households, there is less evidence that they benefit students who are less academically inclined. However, if one were to assume that low ability students are less inclined to spend extra hours on study, it seems intuitive that improvements to the quality of compulsory schooling would have a higher marginal benefit for these students.

2.10 Conclusion

In this paper, I provide estimates of the causal effects of tutoring expenditure on long-term educational and labour market outcomes, using exogenous variation in private tutoring expenditure caused by the curfew on the operating hours of *Hagwon*. I find that while there is a positive effect of tutoring expen-

diture on completing a four year degree and on being employed, the effect on college entrance is subject to decreasing marginal effects. Furthermore, given that the specification linear in tutoring expenditure is unable to capture any effect for the average student, it seems that these students are at a flatter part of the tutoring-college entrance curve. This is explained by the fact that the LATE estimated in this paper is the effect on those spending large amounts of money on tutoring, even losing sleep in order to attend more classes.

I then place these empirical findings within an asymmetric information framework to explain how the use of test scores as a signal for ability leads to inefficiently high investments in tutoring by students of higher ability. Increases in the college premium and, under certain conditions, improvements to overall school quality could exacerbate the situation further by causing the high types to increase their spending even though the overall outcome, of high ability types attending college, remains unchanged. The model points to an inefficient, wasteful equilibrium that arises as a consequence of the rat race to attend college. The deviation of the individually optimal level of tutoring from the socially optimal level indicates that some state intervention would be required to restore the sector to efficient levels of tutoring. However, as demonstrated in the previous section, certain interventions might make the situation worse rather than better. While there are high enough payoffs to having a college degree together with high competition to get into college, it is unlikely that the rat race can be prevented.

Appendices

Appendix A

1 Summary statistics for supplementary datasets

Variable	Mean	Std. Dev.
A: KYRBS sample (N=46,489)		
Hours of sleep on weekdays	6.44	0.74
Internet usage in minutes (N=39,596)		
Weekdays	84.26	93.76
Weekends	134.89	128.91
Exposure to curfew	0.34	0.47
At least one parent with higher education	0.49	0.50
Male	0.51	0.50
Household Socio-Economic Status (scale of 1-5 where 1 is highest)	3.04	0.91
Attends general high school	0.79	0.41
B: PEES sample (N=250,683)		
Participates in academic tutoring	0.48	0.50
Monthly spending on academic tutoring (in KRW 10,000)		
Total	22.51	31.88
Spending on Hagwon	12.60	22.94
Spending on group tutoring	2.67	10.57
Spending on one-on-one tutoring	6.77	19.97
Exposed to curfew	0.55	0.50
At least one parent with higher education	0.55	0.50
Male	0.53	0.50
Mother employed	0.64	0.48
Father employed	0.91	0.28
Attends general high school	0.82	0.39
C: KEEP sample (N=2,265)		
Participates in tutoring	0.57	0.50
Monthly spending on tutoring	21.28	33.41
Monthly household income	355.74	239.19
At least one parent with higher education	0.35	0.48
Pupil teacher ratio in school	15.74	2.16
Attends public school	0.47	0.50
Teacher assessed ranking in school in previous year (N=1,777)	42.63	25.71
Hours of self-study a week	7.56	10.56
Male	0.53	0.50
First born child	0.54	0.50

Sources: KYRBS, PEES, KEEP

2 First stage estimates for model with interaction

Monthly spending on tutoring (in KRW 10,000)	Full sample (1)	GHS sample (2)
curfew=11pm, years=1	0.73	-2.427
	[1.474]	[2.721]
curfew=11pm, years=2	6.629	2.053
	[4.878]	[5.517]
curfew=11pm, years=3	8.636	1.72
	[6.852]	[8.035]
curfew=11pm, years=4	22.973**	
	[11.292]	
curfew=10pm, years=1	-10.782**	-14.200***
	[5.283]	[4.392]
curfew=10pm, years=2	-17.012***	-23.777***
	[5.889]	[4.477]
curfew=10pm, years=3	-20.397***	-23.554***
	[6.240]	[5.039]
curfew=10pm, years=4	-30.037***	-36.463***
	[6.432]	[5.299]
curfew=10pm, years=5	-34.057***	-38.629***
	[8.606]	[8.090]
curfew=11pm, years=1 * At least one parent	-1.797	-0.475
	[2.780]	[4.029]
curfew=11pm, years=2 * At least one parent	-6.864	-8.640*
	[5.810]	[4.885]
curfew=11pm, years=3 * At least one parent	-12.480***	-11.654***
	[4.099]	[2.796]
curfew=10pm, years=1 * At least one parent	19.321***	19.805***
	[5.149]	[4.715]
curfew=10pm, years=2 * At least one parent	6.076**	7.730***
	[2.452]	[2.600]
curfew=10pm, years=3 * At least one parent	-3.98	-6.152**
	[2.475]	[2.719]
curfew=10pm, years=4 * At least one parent	23.445***	20.765***
	[2.644]	[2.823]
curfew=10pm, years=5 * At least one parent	-14.731***	-15.163***
	[2.728]	[2.963]
At least one parent with higher education	11.546***	12.198***
	[2.415]	[2.609]
Male	-0.915	-1.603
	[1.340]	[1.558]
First born	0.572	0.448
	[1.843]	[2.175]
Mother employed	-1.2	-1.158
	[1.418]	[1.723]
Father employed	7.915***	10.203***
	[2.578]	[3.505]
Attended general high school	17.623***	
	[2.463]	
N	2710	2231

Notes: All regressions include time and state fixed effects and linear state-specific trends. Standard errors clustered at state*last year of high school level in brackets. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

3 Effect of the 10pm curfew on time use

	Full sample			GHS sample		
	Sleeping hours (weekdays)	Internet minutes (weekdays)	Internet minutes (weekends)	Sleeping hours (weekdays)	Internet minutes (weekdays)	Internet minutes (weekends)
curfew=10pm, years=1	-0.018	3.211	3.813	0.009	-2.265	-6.217**
	[0.035]	[2.807]	[3.308]	[0.025]	[1.941]	[3.035]
curfew=10pm, years=2	0.070*	19.799***	-15.833***	0.083***	29.389***	-5.487*
	[0.040]	[2.074]	[2.860]	[0.031]	[1.876]	[2.997]
curfew=10pm, years=3	0.082*	27.094***	-4.147	0.127***	29.305***	-3.744
	[0.048]	[2.118]	[2.818]	[0.037]	[1.818]	[2.990]
curfew=10pm, years=4	0.061	17.449***	-15.492***	0.122**	18.634***	-16.296***
	[0.058]	[2.962]	[4.363]	[0.048]	[2.412]	[4.056]
curfew=10pm, years=5	0.102	22.674***	-20.389***	0.197***	26.411***	-26.116***
	[0.074]	[3.875]	[6.152]	[0.063]	[3.081]	[5.358]
Male	0.145***	7.888***	27.707***	0.113***	6.055***	21.721***
	[0.010]	[1.628]	[2.261]	[0.010]	[1.752]	[1.850]
Attended general high school	-0.145***	-44.067***	-31.148***			
	[0.019]	[4.492]	[3.838]			
At least one parent	0.003	-5.821***	-13.106***	0.004	-6.136***	-15.111***
with higher education	[0.012]	[1.342]	[1.508]	[0.013]	[1.394]	[1.733]
2.E_SES	0.106***	7.114***	21.167***	0.114***	4.415*	18.698***
	[0.031]	[2.434]	[3.881]	[0.031]	[2.626]	[3.922]
3.E_SES	0.100***	11.209***	31.341***	0.114***	8.648***	29.071***
	[0.027]	[2.325]	[3.088]	[0.028]	[2.184]	[3.208]
4.E_SES	0.093***	20.285***	49.476***	0.100***	17.605***	49.331***
	[0.025]	[3.121]	[3.645]	[0.026]	[2.934]	[3.642]
5.E_SES	0.043	22.500***	50.722***	0.048	29.000***	61.930***
	[0.033]	[3.870]	[4.312]	[0.037]	[4.165]	[4.757]
N	46489	39596	39596	36276	31124	31124

Notes: All regressions use data from the Youth Panel and include time and state fixed effects and linear state-specific trends. The first three columns use all final year high school students and the last three columns use only final year high school students in general high schools. Data on internet usage are only available after 2008. Standard errors clustered at state*last year of high school level in brackets. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4 Effect of the 10pm curfew on time use with interaction

	Full sample			GHS sample		
	Sleeping hours (weekdays)	Internet minutes (weekdays)	Internet minutes (weekends)	Sleeping hours (weekdays)	Internet minutes (weekdays)	Internet minutes (weekends)
curfew=10pm, years=1	-0.06	2.794	7.364	-0.044	0.748	0.56
	[0.039]	[3.463]	[4.770]	[0.028]	[3.451]	[5.505]
curfew=10pm, years=2	0.006	21.860***	-15.503***	-0.029	28.904***	-7.986**
	[0.042]	[2.063]	[2.992]	[0.031]	[2.053]	[3.198]
curfew=10pm, years=3	0.038	28.709***	-3.165	0.065*	32.906***	-0.893
	[0.050]	[2.328]	[2.949]	[0.039]	[2.138]	[3.197]
curfew=10pm, years=4	0.003	13.452***	-16.872***	0.074	14.587***	-17.464***
	[0.060]	[2.993]	[4.356]	[0.049]	[2.542]	[4.064]
curfew=10pm, years=5	0.076	18.953***	-25.179***	0.167**	26.197***	-28.979***
	[0.075]	[3.892]	[6.174]	[0.064]	[3.225]	[5.456]
curfew=10pm, years=1	0.074***	0.753	-6.417	0.086***	-4.926	-11.084*
* At least one parent	[0.026]	[2.982]	[4.541]	[0.017]	[4.265]	[6.226]
curfew=10pm, years=2	0.116***	-3.837*	-0.649	0.186***	0.811	4.225**
* At least one parent	[0.012]	[2.018]	[1.598]	[0.011]	[1.725]	[1.716]
curfew=10pm, years=3	0.073***	-2.805	-1.761	0.097***	-5.883***	-4.688***
* At least one parent	[0.012]	[1.984]	[1.606]	[0.011]	[1.732]	[1.712]
curfew=10pm, years=4	0.094***	6.871***	2.331	0.074***	6.343***	1.769
* At least one parent	[0.012]	[1.969]	[1.606]	[0.012]	[1.732]	[1.729]
curfew=10pm, years=5	0.041***	5.919***	7.519***	0.043***	0.276	4.178**
* At least one parent	[0.012]	[1.921]	[1.612]	[0.011]	[1.759]	[1.706]
Male	-0.145***	-44.045***	-31.119***			
	[0.019]	[4.493]	[3.843]			
Attended general high school	0.145***	7.874***	27.695***	0.113***	6.046***	21.733***
	[0.010]	[1.633]	[2.259]	[0.010]	[1.755]	[1.845]
At least one parent	-0.016	-6.179***	-12.916***	-0.021*	-5.799***	-14.446***
with higher education	[0.012]	[1.740]	[1.732]	[0.012]	[1.639]	[1.740]
2.E_SES	0.106***	7.106***	21.207***	0.114***	4.454*	18.778***
	[0.031]	[2.433]	[3.882]	[0.031]	[2.629]	[3.922]
3.E_SES	0.101***	11.240***	31.356***	0.115***	8.659***	29.073***
	[0.027]	[2.337]	[3.095]	[0.028]	[2.195]	[3.207]
4.E_SES	0.094***	20.315***	49.505***	0.102***	17.613***	49.339***
	[0.026]	[3.137]	[3.648]	[0.026]	[2.949]	[3.643]
5.E_SES	0.044	22.491***	50.707***	0.048	28.986***	61.897***
	[0.033]	[3.879]	[4.313]	[0.038]	[4.155]	[4.747]
N	46489	39596	39596	36276	31124	31124

Notes: All regressions use data on final year high school students from the KYRBS 2007-2011 and include time and state fixed effects and linear state-specific trends.The first three columns use all final year high school students and the last three columns use only final year high school students in general high schools. Standard errors clustered at state*last year of high school level are given in brackets.
Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5 Transition matrix by province

		Destination																
		Seoul	Busan	Daegu	Incheon	Gwangju	Daejeon	Ulsan	Sejong	Gyeonggi	Gangwon	Chungbuk	Chungnam	Jeonbuk	Jeonnam	Gyeongbuk	Gyeongnam	Jeju
Origin	Seoul	**0.928**	0.003	0.002	0.005	0.002	0.002	0.001	0.001	0.037	0.004	0.002	0.003	0.002	0.002	0.002	0.003	0.001
	Busan	0.016	**0.929**	0.003	0.002	0.001	0.001	0.006	0.000	0.008	0.001	0.001	0.002	0.001	0.002	0.005	0.023	0.001
	Daegu	0.016	0.004	**0.931**	0.002	0.000	0.001	0.003	0.000	0.009	0.001	0.001	0.002	0.000	0.001	0.023	0.005	0.001
	Incheon	0.017	0.001	0.001	**0.937**	0.001	0.001	0.001	0.000	0.025	0.003	0.002	0.004	0.002	0.001	0.002	0.001	0.001
	Gwangju	0.024	0.002	0.001	0.003	**0.909**	0.002	0.000	0.001	0.014	0.002	0.001	0.002	0.006	0.031	0.001	0.001	0.001
	Daejeon	0.027	0.002	0.002	0.003	0.001	**0.898**	0.001	0.010	0.017	0.003	0.008	0.017	0.004	0.002	0.003	0.002	0.001
	Ulsan	0.021	0.020	0.006	0.002	0.001	0.002	**0.913**	0.000	0.008	0.002	0.001	0.002	0.001	0.001	0.010	0.010	0.001
	Sejong	0.032	0.003	0.001	0.005	0.001	0.035	0.001	**0.839**	0.023	0.002	0.019	0.025	0.004	0.002	0.003	0.002	0.001
	Gyeonggi	0.026	0.002	0.001	0.006	0.001	0.002	0.001	0.001	**0.943**	0.004	0.003	0.004	0.002	0.001	0.002	0.002	0.001
	Gangwon	0.040	0.004	0.003	0.009	0.001	0.003	0.001	0.001	0.039	**0.878**	0.006	0.004	0.002	0.001	0.005	0.003	0.001
	Chungbuk	0.027	0.002	0.002	0.005	0.001	0.012	0.001	0.004	0.025	0.005	**0.900**	0.007	0.002	0.001	0.004	0.002	0.001
	Chungnam	0.029	0.002	0.001	0.006	0.002	0.018	0.001	0.004	0.028	0.003	0.005	**0.888**	0.004	0.002	0.003	0.002	0.001
	Jeonbuk	0.027	0.002	0.001	0.004	0.007	0.006	0.001	0.001	0.020	0.002	0.002	0.006	**0.913**	0.005	0.002	0.002	0.001
	Jeonnam	0.028	0.005	0.001	0.005	0.035	0.003	0.001	0.000	0.021	0.002	0.002	0.004	0.007	**0.879**	0.002	0.004	0.001
	Gyeongbuk	0.023	0.010	0.026	0.003	0.001	0.004	0.005	0.000	0.016	0.003	0.004	0.003	0.001	0.001	**0.892**	0.006	0.001
	Gyeongnam-do	0.020	0.029	0.005	0.002	0.001	0.002	0.004	0.000	0.010	0.002	0.002	0.002	0.001	0.002	0.005	**0.912**	0.001
	Jeju	0.029	0.006	0.003	0.004	0.002	0.002	0.001	0.000	0.017	0.002	0.002	0.002	0.002	0.003	0.002	0.003	**0.921**

Notes: The table presents the transition matrix for movement between different provinces for individuals aged 20-24 in 2016. The probability in the diagonal cells are calculated to include those who move within the province as well as those who do not move at all. Probabilities calculated based on statistics on internal migration by five-year age group and statistics on resident population by five-year age group obtain from KOSIS (www.kosis.kr).

6 Correction for internal migration for TS2SLS results

First, consider TS2SLS estimation with no measurement error. Consider a scenario in which the outcome Y and endogenous treatment x are not observed together in the same dataset but an instrument Z is observed in both samples. Let Z_1 and Y_1 be observed in sample 1 which includes n_1 observations and Z_2 and X_2 be observed in sample 2 which includes n_2 observations. In this case, $\hat{\beta}_{TS2SLS}$ is calculated as:

$$\begin{aligned} \hat{\beta}_{TS2SLS} &= (\hat{X}_1'\hat{X}_1)^{-1}\hat{X}_1'Y_1 && (2.9) \\ &= (\hat{\pi}_{x_2}'Z_1'Z_1\hat{\pi}_{x_2})^{-1}\hat{\pi}_{x_2}'Z_1'Z_1Y_1 && (2.10) \\ &= (\hat{\pi}_{x_2}'Z_1'Z_1\hat{\pi}_{x_2})^{-1}\hat{\pi}_{x_2}'Z_1'Z_1\hat{\pi}_{y_1} && (2.11) \end{aligned}$$

where $\hat{\pi}_{x_2}$ is the first stage estimate from sample 2 and $\hat{\pi}_{y_1}$ is the reduced form estimate from sample 1.

A consequence of the instrument being mis-measured in Sample 1 is that the reduced form estimates (and second stage estimates) will be biased. In the context of this paper, inferring state of attending high school with the state of residence is the cause of measurement error. We now use the transition matrix for migration between provinces for individuals of the corresponding age group to correct these biased, reduced-form estimates.[20]

Say, for instance, that $\pi_{y_1,j}$ is the effect of living in state j on educational outcomes. However, what we want to know is $\pi^*_{y_1,i}$ which is the effect of finishing school in state i on educational outcomes. The two effects are related by:

$$\pi^*_{y_1,i} = \sum_j \pi_{y_1,j}.p_{ji} \tag{2.12}$$

where p_{ji} is the probability of the individual having finished school in state i given that he is currently living in state j. If P is a matrix whose i,j element is p_{ji}, the vector π_{y_1} is related to the true effects vector $\pi^*_{y_1}$ by $\pi^*_{y_1} = P\pi_{y_1}$.

[20]The procedure described here borrows from Card and Krueger (1992).

Therefore, if P and π_{y_1} are known, an estimate of $\pi^*_{y_1}$ can be retrieved. If all individuals continued to live in the state in which they finished school, $P = I$ and $\pi^*_{y_1} = \pi_{y_1}$.[21]

Once we have corrected the reduced form estimates, we can adjust $\hat{\beta}_{TS2SLS}$ accordingly as:

$$\hat{\beta}^*_{TS2SLS} = (\hat{\pi}'_{x_2} Z'_1 Z_1 \hat{\pi}_{x_2})^{-1} \hat{\pi}'_{x_2} Z'_1 Z_1 \hat{\pi}^*_{y_1} \tag{2.13}$$

As long as $\text{plim}_{n\to\infty} \hat{\pi}_{y_1} = \pi_{x_2}\beta$, $\hat{\beta}^*_{TS2SLS}$ will be consistent even if Z_1 is mis-measured. The transformed TS2SLS estimates are presented in the Table below.

The results change very little as a result of the correction (the largest change is of 0.05 percentage points) with the exception of the estimated effect on wages. However, as mentioned previously, the estimated effects on wages are likely to also suffer from sample selection bias. As such, given the similarity in estimates for the other outcomes, it can be concluded that the impact of the measurement error caused by internal migration is not very large.

TS2SLS coefficients corrected for internal migration

Dependent variable	Corrected	Uncorrected
Completed four year	0.0040	0.0039
Completed any higher edu	0.0022	0.0019
Employed	0.0012	0.0018
ln Wages	0.0008	-0.0004

Notes: The table presents the TS2SLS coefficients on spending on tutoring with and without correcting for the probability of internal migration.

[21]Note that in this case, the matrix P is composed of the transition matrix for movement between the three types of provinces categorised by the curfew (to correct the coefficients of the curfew dummies) as well as the transition matrix for movement between all 16 provinces (to correct the coefficients of the province fixed effects).

Chapter 3

Population Control Policies and Fertility Convergence

3.1 Introduction

In the middle of the twentieth century, almost all developing countries experienced a significant increase in life expectancy, which, together with high fertility rates, led to rapid population growth rates. The fear of a population explosion lent impetus to what effectively became a global population-control programme. The initiative, propelled in its beginnings by intellectual elites in the United States, Sweden, and some developing countries, most notably India, mobilised international private foundations as well as national governmental and nongovernmental organizations to advocate and enact policies aimed at reducing fertility. By 1976, following the preparation of the World Population Plan of Action at the World Population Conference in Bucharest in 1974, 40 countries, accounting for 58 percent of the world's population and virtually all of the larger developing countries, had explicit policies to reduce fertility rates. Between 1976 and 2013, the number of countries with direct government support for family planning rose to 160. In this essay, we will argue that concerted population control policies implemented in developing countries are

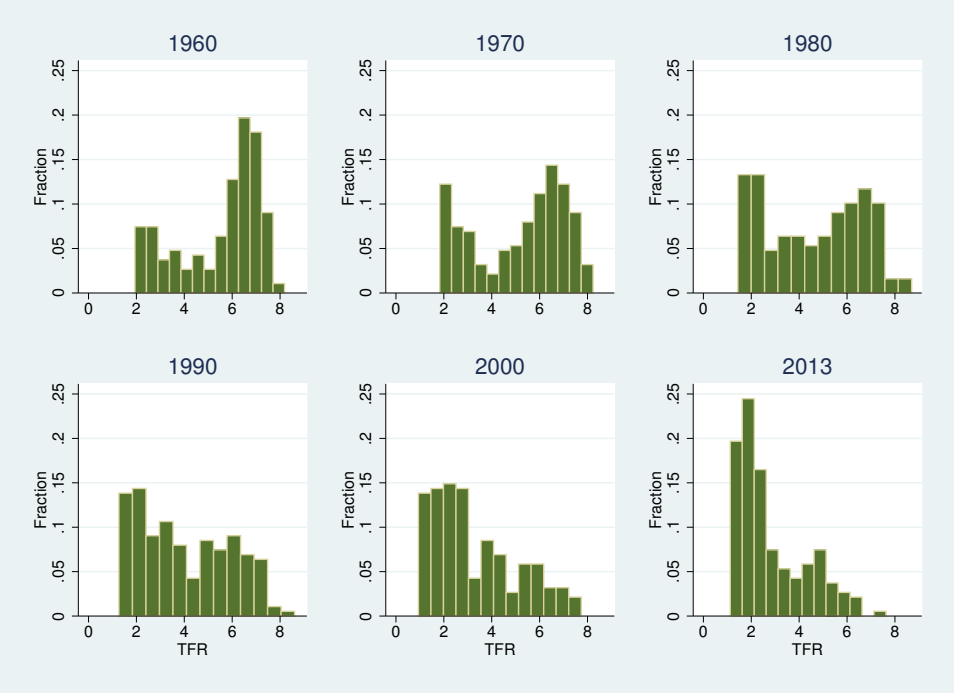
likely to have played a central role in the global decline in fertility rates in recent decades and can explain some patterns of that fertility decline that are not well accounted for by other socioeconomic factors.

To set the stage, we begin by reviewing some trends and patterns in the fertility decline in the last half-century across countries and regions. We argue that although socioeconomic factors do play an important role in the worldwide fertility decline, they are far from sufficient to account for the timing and speed of the decline over the past four decades. For example, the cross-country data in any given year show a negative correlation between per capita income and fertility rates. However, that relationship has shifted downward considerably over time: today the typical woman has, on average, two fewer children than the typical woman living in a country at a similar level of development in 1960.

We then discuss the evolution of global population-control policies in more detail. All population-control programmes involved two main elements: promoting an increase in information about and availability of contraceptive methods, and creating public campaigns aimed at establishing a new small-family norm. The evidence suggests that these public campaigns appeared to have been critical in complementing contraceptive provision. While estimating the causal effects of these programmes is challenging, we examine the relationship between different measures of family planning programme intensity and the declines in fertility over the past decades and find a strong association, after controlling for other potential explanatory variables such as GDP, schooling, urbanisation, and mortality rates.

In a final section, we discuss in more detail the role played by these other variables in the decline in fertility and highlight that the drop in fertility rates seems to be occurring and converging across countries with varying levels of urbanisation, education, infant mortality, and so on. We conclude that population control policies seem to be the factor that best accounts for this commonality.

Figure 3.1: Fertility histograms over time



Source: The data comes from the World Bank's World Development Indicators database.
Note: The figure shows fertility histograms at the beginning of each decade. In the final histogram, the year 2013 is used rather than 2010 to report the latest available information.

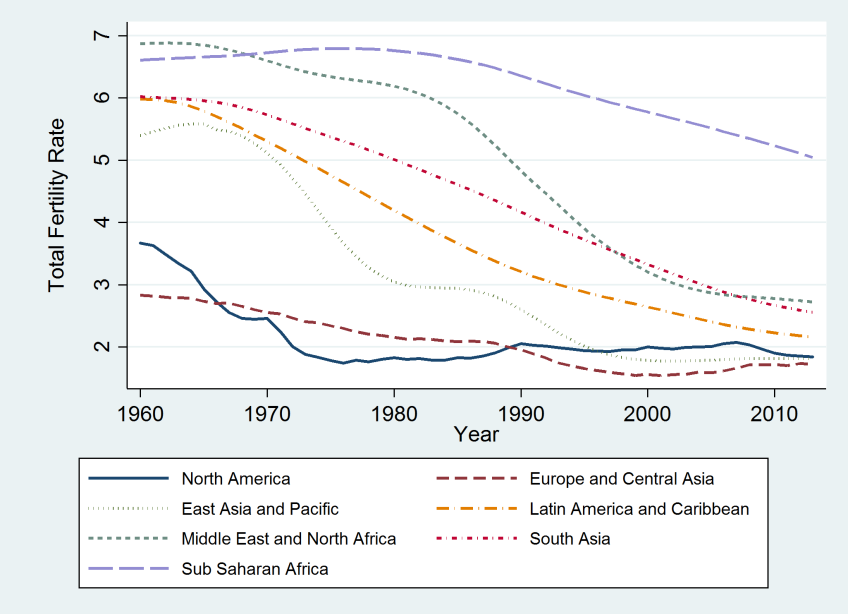
3.2 Fertility patterns across time and space

The world's total fertility rate declined from over 5.0 children per woman in 1960 to 2.5 children per woman in 2013.[1] This trend is not driven by just a few countries. Figure 3.1 plots fertility rate histograms for the start of decades since 1960; the bars show the fraction of countries for each fertility interval. (The figure shows 2013 rather than 2010 to report the most recent information.) In 1960, more half the countries in the world had a fertility rate between 6 and 8, and the median fertility rate was 6.2 children per woman. (When weighted by population, the world's median is 5.8.) In 2013, the largest mass of countries is concentrated around 2, with the median total fertility rate being 2.2.

These large declines in fertility took place in most regions of the world, as

[1]The total fertility rate is defined as the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates. In this paper, we will use "total fertility rate" interchangeably with "fertility" and "fertility rate."

Figure 3.2: Fertility trends across regions



Note: This figure plots the trends in fertility by region, as defined by the World Bank, between 1960 and 2013. The data comes from the World Development Indicators database.

shown in Figure 3.2. Between 1960 and 2013, fertility rates fell from 5.4 to 1.81 in East Asia and the Pacific, from 5.98 to 2.16 in Latin America and the Caribbean, from 6.87 to 2.83 in the Middle East and North Africa, and from 6.02 to 2.56 in South Asia. The fertility decline in sub-Saharan Africa has been slower, but still sizeable: since the 1980s, the total fertility rate in this region fell from 6.7 to 5. Within this region, South Africa has already reached a total fertility rate of 2.4 and Mauritius is now at a fertility rate of 1.44. While absolute declines in fertility were not as large in North America or Europe and Central Asia, the percentage declines in both regions have been significant — nearly 50 percent in North America and close to 40 percent in Europe and Central Asia. Interestingly, the fertility rate for North America bottomed out in the 1980s, and in Europe and Central Asia, it bottomed out in the 1990s.

A number of empirical studies have documented a negative relationship between fertility rates and income. While this relationship is indeed negative in the cross-section of countries, the relationship has changed over time, shifting

Figure 3.3: Fertility – income relation in 1960 and 2013

Source: Authors using data from the World Development Indicators database.
Note: For a sample of 88 countries, the figure shows the scatterplots and fitted line (that is, the lowess smoothed relationship or locally weighted smoothing function) between the total fertility rate and log of per capita GDP (in constant 2005 US$) in 1960 and 2013. The x-axis is log scale.

downward and becoming flatter over time. Figure 3.3 shows the relationship between the total fertility rate and real GDP per capita in 1960 and in 2013. The figure also shows fitted lines for these two years. The downward shift has been, on average, around 2 children per woman, meaning that today a woman has 2 fewer children than a woman living in a country at the same level of development in 1960, which is close in magnitude to the drop in overall world fertility of 2.5 children per woman. The cross-section relationship between fertility and income observed in 1960 would predict a total fertility rate of around 4 at the average per capita GDP for 2013 (recall the actual rate is 2.5).

As Figure 3.3 illustrates, the issue is not just to explain a decline in global fertility. It is also necessary to explain why the fall in fertility rates witnessed by developing countries in recent decades was so very rapid, compared with the rather slow and secular decline in fertility rates experienced by more mature economies. For example, the fertility decline began as early as the mid-1700s in some European countries and only reached replacement levels in the early twentieth century (Coale 1969). Furthermore, it is necessary to explain why

countries with markedly different levels of income, urbanisation, education, and other factors are all converging to very similar fertility rates. As we discuss in the next section, the worldwide spread of population-control programmes can help to explain these patterns in the fertility data.

3.3 The global family planning movement and its consequences

The following section provides a brief overview of the global family planning programme, discussing the historical context as well as outlining some of its characteristics. We then examine more systematically the link between fertility policy adoption and declines in fertility.[2]

3.3.1 Global evolution of family planning programmes

After World War II, there was growing concern with the unprecedented levels of population growth. A population-control movement developed, led by, among others, John D. Rockefeller III, whose main preoccupations were the growing imbalance between population and resource growth, and the potential for political instability given that most of the population growth was concentrated in the poorest countries of the world. In 1952, Rockefeller founded the Population Council, aimed at providing research and technical assistance for population programmes across the world. That same year, India started the first national population programme, and in parallel, the International Planned Parenthood Federation was established.[3] By the late 1950s, the "population question" was receiving the attention of the US government. A report by a

[2]This section draws heavily on Robinson and Ross (2007), who provide a compilation of case studies of family planning programmes in 22 countries across the world.

[3]The earlier birth-control movement led by Margaret Sanger in the United States (who set up the first birth-control clinic in the United States in 1916) and Elise Ottesen-Jensen in Sweden was another force leading to efforts for fertility reduction.

Presidential Committee studying the United States Military Assistance Programme (Draper 1959) devoted an entire chapter to the issue, ending with a recommendation that the government "assist those countries with which it is cooperating in economic aid programs, on request, in the formulation of their plans designed to deal with the problem of rapid population growth."[4] By this time, private foundations including the Rockefeller and Ford Foundations were providing seed funding for research and planning programmes, but it was in the mid-1960s that large-scale funding became available and the population planning movement really took off.

The first large-scale intervention was carried out by the Swedish government, which supported family planning efforts in Sri Lanka (then Ceylon), India, and Pakistan, starting in 1962 (Sinding 2007). Over time, several international organisations, like USAID and the World Bank, joined in providing funds and support for family planning programmes around the world. The invention of the modern intra-uterine device (IUD) and the oral contraceptive pill around the same time allowed for the possibility of easy-to-use and effective contraceptive methods becoming widely available for public use.

These early family planning efforts showed rapid effects in East Asian countries, including Hong Kong, South Korea, Singapore, and Thailand. Programme implementation and success would take longer in other developing countries, partly due to the difficulty of overcoming cultural inhibitions and religious opposition towards birth control, as well as operational problems including inadequate transport infrastructure and insufficient funding. The World Population Conference in 1974 appeared to be a turning point for the global family planning movement. Tables 3.1 and 3.2 show how countries around the world have been categorised by their fertility goals and the type of government support for family planning for selected years from 1976 to 2013, according to the UN World Population Policy database.

[4]For more references that trace the origins of the population control movement primarily to the West, see Appendix B.

Table 3.1: Number of countries with government goals for fertility policy

Year	Lower fertility	Maintain fertility	No intervention	Raise fertility	Total
1976	40	19	78	13	150
1986	54	16	75	19	164
1996	82	19	65	27	193
2005	78	31	47	38	194
2013	84	33	26	54	197

Source: The data is obtained from the UN World Population Policies database.
Note: The table shows the number of countries by type of policy adopted towards fertility. The data begins in 1976. Countries are categorised according to whether they had a policy to lower, maintain, or raise fertility or if they had no intervention to change fertility.

Table 3.2: Number of countries by government support for family planning

Year	Direct support	Indirect support	No support	Limit/Not permitted	Total
1976	95	17	28	10	150
1986	117	22	18	7	164
1996	143	18	26	2	193
2005	143	35	15	1	194
2013	160	20	16	1	197

Source: The data is obtained from the UN World Population Policies database.
Note: The table shows the number of countries by the type of support extended by the state for family planning services. The data begins in 1976. Countries are categorised by whether their governments directly supported, indirectly supported, or did not support family planning as well as if the government limited family planning services or did not permit family planning in the country.

In 1976, for example, the 40 countries that had explicit policies to limit fertility covered nearly one-third of East Asian countries, a quarter of Latin American and Caribbean countries, and nearly two-thirds of South Asian countries. By contrast, only one-fifth of countries in North Africa, the Middle East, and Sub-Saharan Africa had a fertility reduction policy in 1976. By 1996, 82 countries had a fertility reduction policy in place (by this time, some countries had reached their fertility reduction targets and changed to policies of maintaining fertility rates), including half of the countries in East Asia and Latin America, and more than two-thirds of the countries in Sub-Saharan Africa and South Asia. These countries represent 70 percent of the world's population. In 1976, 95 governments were providing direct support for family planning. (Support for family planning was not always associated with an explicitly stated goal

of reducing fertility.) The number of countries with state support for family planning has continued to rise steadily.

3.3.2 Features of family planning programmes

The early phases of family planning programmes in most developing countries typically sought to provide a range of contraception methods — some combination of oral contraceptives, IUD, condoms, sterilisation, and abortion — and information on their use. However, increases in the supply of contraceptives proved insufficient to lower fertility rates to desired levels, particularly in poorer or more traditional societies. This failure led to concerted efforts to change public attitudes and beliefs and establish a new small-family norm through active mass-media campaigns. We discuss these two phases in turn.

The implementation of the family planning programmes varied vastly across countries. Differences included the role of public and private provision; the price at which contraception was offered; subsidies to production or sales; the delivery system through which services were provided; the outlets for the mass-media campaigns; and the various supplementary policies that accompanied the core measures (Freedman and Berelson 1976).[5]

Most countries began their family planning programmes with a clinic-based approach that took advantage of the existing health infrastructure to provide modern contraceptive methods. Many countries also implemented programmes in hospitals to advise women on the use of contraception, often after women had given birth or undergone an abortion. However, this approach had limited success in countries where a large proportion of women gave birth outside of the formal health care system, like India and Iran. Thus, the policy was supplemented by the deployment of trained field workers who made house calls, particularly in rural areas. In some nations, such as Iran and Malaysia,

[5]For a more detailed summary of the key features of early family planning programmes around the world, highlighting the countries that implemented each approach, see Appendix C1.

family-planning programmes were linked to maternal and child health services at an early stage, which allowed for better integration of the programme into the country's health system. Towards the 1990s, with the re-branding of family planning as sexual and reproductive wellbeing, more countries have followed this approach.

Many of the family planning programmes established in the 1950s and 1960s, which focused on increasing the supply of contraception, failed to gain much traction. For instance, highly traditional societies and countries with a predominantly Catholic or Muslim population had difficulty gaining wide acceptance for their family planning programmes. It became clear that without changing the willingness to use contraceptives and, more importantly, reducing the desired number of children, merely improving access to birth control had limited impact. The importance of changing the desired number of children, in particular, was highlighted by leading demographers at the time such as Enke (1960) and Davis (1967), who argued that a desire to use contraceptives was perfectly compatible with high fertility. Countries thus began to present and to adapt their population-control policies to address these concerns.

For example, early in Indonesia's family planning programme, the government published a pamphlet titled "Views of Religions on Family Planning," which documented the general acceptance of family planning by four of Indonesia's five official religions — Islam, Hinduism, and Protestant and Catholic Christianity (Hull 2007). To overcome fears that husbands would resist male doctors or health professionals working with their wives, the family planning programme in Bangladesh relied heavily on female health workers visiting women in their homes to educate them about and supply them with contraceptive methods. This modality also ensured a greater diffusion of contraceptive knowledge and methods in rural Bangladesh (Schuler, Hashemi, and Jenkins 1995).

Mass communication was commonly used to shape attitudes toward family planning, often with the aim of changing public views by establishing a small-

family norm. During the 1970s, slogans proliferated in different media outlets (television, radio, and magazines), street posters, brochures, and billboards, all conveying a similar message regarding the benefits of small families. In India, the family planning programme's slogan, "Have only two or three children, that's enough," was widely publicised on billboards and the sides of buildings. Other slogans in India were "A small family is a happy family" and "Big family: problems all the way; small family: happiness all the way" (Khanna 2009). Bangladesh publicised the slogans "Boy or girl, two children are enough" and "One child is ideal, two children are enough" (Begum 1993). South Korea ran the slogan "Stop at two, regardless of sex" (Kim and Ross 2007); Hong Kong chose "Two is enough" (Fan 2007), and so on. China took population planning to the extreme in 1979, when it imposed a coercive one-child policy, but the Chinese fertility rate actually started falling significantly in the early 1970s, before the one-child policy was implemented (Zhang 2017). The strong population-control policy enacted in China in 1973 was characterised by mass-media messages such as "Later, longer, fewer" (Tien 1980) and "One is not too few, two, just right, and three, too many" (Liang and Lee 2006). In Singapore, bumper stickers, coasters, calendars, and key chains reinforcing the family planning message were distributed free of charge. In Bangladesh, television aired a drama highlighting the value of family planning (Piotrow and Kincaid 2001). The Indonesian programme became particularly noteworthy in its collaboration between the government and community groups in getting the messages of the programme across.

In Latin America, the Population Media Centre (a nonprofit organisation) collaborates with a social marketing organisation in Brazil to ensure the inclusion of social and health themes in soap operas airing on TV Globo, the most popular television network in Brazil. (TV Globo's programming is estimated to currently reach 98 percent of Brazil's population, and 65 percent of all of Spanish-speaking Latin America.) The Population Media Centre studied how programmes like "Paginas da Vida" ("Pages of Life") influenced Brazilians: about two-thirds of women interviewed said the *telenovela* "Paginas da Vida"

had helped them take steps to prevent unwanted pregnancy. Brazil's *telenovelas* have been popular across Latin America since the 1980s; they almost invariably depict the lives of characters from small families who were also very rich and glamorous (Population Media Centre 2016). In Brazil, the main force behind the anti-natalist movement was BEMFAM, an affiliate of the International Planned Parenthood Federation. The military regime of the 1970s and the Catholic Church hierarchy were opposed to birth control, though the local clergy and multiple nongovernmental organisations provided advice and information in favor of contraceptive use. In other Latin American countries, such as Colombia and Chile, family planning had strong support from the government.

Stronger inducements such as monetary or in-kind incentives and disincentives were also used in some countries as means of encouraging families to practice birth control. In Tunisia, for example, government family allowances were limited to the first four children; in Singapore, income tax relief was restricted to the first three children as was maternity leave, the allocation of public apartments, and preferred school places. Incentives for female or male sterilisation was a common feature of family planning programmes in India, Bangladesh, and Sri Lanka and resulted in a large number of sterilisations taking place during the 1970s. In Bangladesh, field health workers were paid for accompanying an individual to a sterilisation procedure, while in Sri Lanka and India both the sterilisation provider and patient were given compensation. In Kerala, India, individuals undergoing sterilisation were given payments in cash and food roughly equivalent to a month's income for a typical person. This type of incentivised compensation scheme, combined with increased regional sterilisation targets, led to a drastic increase in sterilisation procedures. Critics alleged that many acceptors were coerced by officials who stood to gain from higher numbers, both in monetary and political terms.

In addition to increased provision of information on and access to family planning methods, attempts were made to delay marriage and childbearing or to

increase birth spacing as a means of controlling fertility. For example, the legal age of marriage was increased to 18 years for women and 21 years for men in India, and to 17 years for women and 20 years for men in Tunisia. China raised the legal age for marriage in urban areas (to 25 years for women and 28 years for men) and rural areas (23 years for women and 25 years for men). China also imposed a minimum gap of three to four years between births and restricted the number of children to three per couple until it decided to implement the draconian one-child policy in 1979.

More recently, given the sizeable decline in birth rates that has already occurred, fertility control has been put on the back burner. In fact, the current HIV/AIDS epidemic has somewhat overshadowed fertility control, particularly in African countries (Robinson and Ross 2007), while family planning did not even warrant being a sub-goal in the Millennium Development Goals agreed to in 2000. Many countries are now below replacement-level fertility rates. Nonetheless, family planning programmes seem to have been incorporated into the broader framework of sexual and reproductive health services and become firmly entrenched in health care systems around the world.

The details of fertility programmes differed across countries. But from a broader view, the prevalence and growth of these programmes is remarkable. Fertility reduction programmes took place under both democratic and autocratic regimes, whether oriented to the political left or right (for example, Chile under both Allende and Pinochet), and in Buddhist, Christian, and Muslim countries alike. In some countries, like Brazil, family planning programmes were initiated and almost exclusively run by nonprofit, nongovernmental organisations, while in others, like Singapore or India, the government was fully involved.

A natural question is whether the type of less-coercive intervention carried out by most countries can be effective in helping to rapidly change norms and in overcoming other socioeconomic influences that affect fertility rates. In the context of China, Zhang (in this journal, 2017) observes that the one-child

policy can explain only a small change in fertility given that a robust family planning programme was already in operation since the early 1970s. He argues that strong family planning programmes, such as those observed in most East Asian countries during the 1960s and early 1970s, would be as effective in lowering fertility. In addition, recent experimental (or quasi-experimental) studies also suggest the effectiveness of public persuasion measures in reducing fertility. La Ferrara, Chong, and Duryea (2012) find that Brazilian regions covered by a television network showing soap operas that portray small families experienced a bigger reduction in fertility rates. In Uganda, Bandiera Buehren, Burgess, Goldstein, Gulesci, Rasul, and Sulaiman (2014) find that, adolescent girls who received information on sex, reproduction, and marriage reported wanting a smaller number of children. Evidence of family planning programmes in the United States appears more mixed, though recently, Bailey (2013) has shown that a targeted US family planning programme significantly reduced fertility. In the next section, we explore the question using cross-country data on spending and implementation effort of the programme and their relationship with fertility reduction.

3.3.3 Fertility policies and the decline in fertility rates

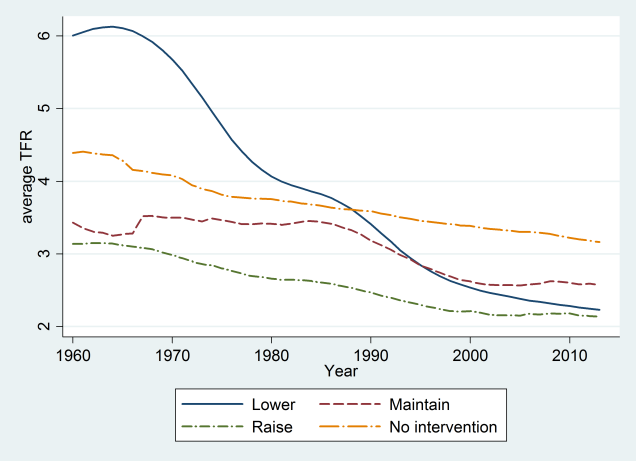
In seeking to assess the quantitative effect of the fertility programmes on the basis of cross-country data, there are clearly a number of covariates that could confound the estimation of a causal effect. The task is particularly difficult since different countries opted for a wide and varied range of fertility policies, with the specific choice of measures partly dictated by their feasibility in each country's institutional and cultural setting. Equally important, data availability is also limited. Thus, while estimating the causal effect of these programmes is beyond the scope of this essay, our analysis illustrates some descriptive relationships between fertility rates, population policy, and different measures of family planning programme intensity, conditioning on covariates of fertility traditionally used in the literature. Taken as a whole, this evidence

is strongly consistent with the hypothesis that population control programmes have played a major role in the fertility decline.

For the analysis that follows, infant mortality rates, the proportion of urban population, and per capita GDP are obtained from the World Bank's World Development Indicators, while data on the years of schooling of the population aged 25+ are taken from Barro and Lee (2013). Data on the existence of a fertility policy and government support for family planning come from the UN World Population Policies Database. We use three measures of family planning programme intensity: funds for family planning per capita; a family planning programme effort score; and the percentage of women exposed to family planning messages through mass media. Data on funds for family planning are taken from Nortman and Hofstatter (1978), Nortman (1982), and Ross, Mauldin, and Miller (1993), which, taken together, cover funding for family planning by source for 58 countries over various years starting in 1972 and going up to 1992. Family planning programme effort is measured using the Family Planning Programme Effort Index published in Ross and Stover (2001). This indicator, based on work by Lapham and Mauldin (1984), measures the strength of a given country's programme along four dimensions: policies, services, evaluation, and method access. The score has a potential range of 0–300 points, based on 1–10 points for each of 30 items, and has been calculated for 1972, 1982, 1989, 1994, and 1999, covering 95 countries. Finally, the Demographic and Health Surveys (DHS) from 57 countries in various years provide data on the percentage of women who have been exposed to family planning messages on the radio, television, or newspapers. These three measures altogether aim at capturing the intensity with which population programmes were implemented.

As a first exercise, we compare the country-level patterns in mean fertility rate by the fertility policy goals stated in 1976, which paints the striking picture shown in Figure 3.4. The data on fertility policy begins in 1976, but several countries had already adopted fertility reduction policies beforehand.

Figure 3.4: Evolution of fertility rates by policy in 1976



Source: The data on fertility policy is obtained from the UN World Population Policies Database and TFR is from the World Bank's World Development Indicators.
Note: The figure illustrates the evolution of weighted average total fertility rate, with countries grouped by the fertility policy observed in 1976. The policy could be to lower, maintain, or raise fertility; there also could be no intervention.

While fertility has fallen in all regions, even in the group of predominantly European countries that wanted to increase fertility, the countries that had identified the need to reduce fertility in 1976 recorded by far the highest average fertility rates before 1976, but the second-lowest average fertility rates by 2013. The countries where there was no intervention had the second-highest average fertility rates in 1976 and became the highest fertility group by 2013.

As our next exercise to study the relation between population programmes and fertility, we use data on funds for family planning. We look at the amount of funds (in real terms) available for family planning, from both government and non-government sources over the 1970s, 1980s, and 1990s for each country.

The patterns by region are as follows. Latin American countries appear to have the largest amount of funds for family planning per capita, with total funding exceeding US$2 per capita (in 2005 US dollars) in Costa Rica, El Salvador, and Puerto Rico. The region also has the highest proportion of non-state funding for family planning, more than double the state-funding in some countries. By contrast, in Asia, funding for family planning is predominantly state-led. As a percentage of GDP, total funds for family planning averaged at around 0.05

Table 3.3: Change in total fertility rates (TFRs) and funding for family planning programmes

Change in TFR	Absolute change		% change	
	(1)	(2)	(3)	(4)
Ln(average funds	-0.630***	-0.430**	-10.470***	-4.974**
per capita)	[0.120]	[0.181]	[1.487]	[2.030]
Change in years of		-0.130		0.0008
education of adults		[0.133]		[0.002]
Change in urban		-0.008		0.001
population as % of total		[0.009]		[0.003]
Change in ln(GDP per		-0.426*		-0.382**
capita)		[0.227]		[0.158]
Change in infant mortality		0.006*		0.668***
rate		[0.003]		[0.131]
N	56	37	56	37
R-squared	0.35	0.39	0.418	0.72

Source: Authors. Data on total fertility rate, urban population, per capita GDP, infant mortality rate, and US Consumer Price Index (used to convert the funds to real terms) are from the World Development Indicators. Data on years of schooling are from Barro and Lee (2013). Data on funds for family planning are from Nortman and Hofstatter (1978), Nortman (1982), and Ross, Mauldin, and Miller (1993).
Note: The table reports the results of regressions of the change in total fertility rate between 2013 and 1960 on the logged real value of average per capita funds for family planning for the 1970s, 1980s, and 1990s, controlling for the changes in years of schooling of the population aged 25+, urban population as a percentage of total population, log GDP per capita, and infant mortality rate between 2013 and 1960. Given the small number of observations for infant mortality rate and GDP per capita in 1960, we use the earliest available observation before 1965 to construct the change. All regressions include a constant. Per capita funds for family planning are converted to 2005 US$ before averaging. The values in parentheses are robust standard errors. *, **, and *** indicate significance at 10, 5, and 1 percent levels, respectively.

percent in the 1970s and 0.07 percent in the 1980s, but was as high as 0.47 percent in Bangladesh and 0.46 in Korea in the 1980s.[6]

Table 3.3 shows the results of a regression of the change in fertility on (logged) average family planning funds per capita over the 1970s, '80s, and '90s, with and without controlling for changes in the covariates of fertility traditionally used in the literature, such as GDP per capita, educational attainment, urbanisation, and infant mortality. (Each of these covariates will be discussed in more detail in the following section.) Columns 1 and 2 use absolute changes in all fertility (and the other covariates) between 1960 and 2013, and columns 3 and 4 use percentage changes in these variables over the same period.

[6]The full table with funds for family planning by country for the 1970s and 1980s is available in Appendix C2.

Despite the small number of observations available once the controls are included, the negative relationship between changes in total fertility rate and funds for family planning remains significant, indicating that the countries with more funding for family planning experienced greater reductions in fertility rates, even after controlling for the changes in income, urbanisation, infant mortality, and years of schooling of the adult population. (Controlling for years of schooling of adult women instead of adult population leads to similar results.) Quantitatively, the results indicate that a 1 percent increase in funding per capita is associated with a 5 percent reduction in the total fertility rate.

We do not include changes in female labour force participation rates in this regression because the cross-country data for this variable begins only in 1980. However, we replicate the exercise focusing on changes between 1980 and 2013 for all variables and find that the results hardly change, with no significant correlation between changes in female labour force participation and the fertility decline. We also carry out the exercise separately for government funding and private funding for family planning per capita, and find that government spending has a significant, positive correlation with the fertility decline whereas private spending does not appear to be significant (see Appendix C3 and C4 for the full set of results).

Our third exercise uses the family planning programme effort index published by Ross and Stover (2001) as an alternative measure of programme inputs. The regional averages of the index indicate that East Asia and South Asia have, in general, had the strongest family planning programmes over time. Latin America, North Africa, and the Middle East seem to have caught up on programme effort over the three decades, but the greatest gain appears to have been in Sub-Saharan Africa, which was the latest to adopt family planning programmes, in 1989–1999.[7] We use these data to examine the relationship between the observed change in fertility over the 1960–2013 period and the

[7]For more details on regional average program effort scores by year, see Appendix C5.

Table 3.4: Change in total fertility rates (TFRs) and family planning programme effort

Change in TFR	Absolute change		% change	
	(1)	(2)	(3)	(4)
Average family planning	-0.039***	-0.041***	-0.716***	-0.500***
programme effort score	[0.007]	[0.014]	[0.101]	[0.166]
Change in years of		-0.124		0.003
education of adults		[0.115]		[0.003]
Change in urban		-0.012		-0.0001
population as % of total		[0.008]		[0.005]
Change in ln(GDP		0.015		-0.108
per capita)		[0.198]		[0.192]
Change in infant mortality		0.002		0.549***
rate		[0.003]		[0.142]
N	107	55	107	55
R-squared	0.21	0.41	0.321	0.636

Source: Authors. Data on total fertility rate, urban population, per capita GDP, and infant mortality rate are from the World Development Indicators. Data on years of schooling are from Barro and Lee (2013). Data on family planning programme effort are from Ross and Stover (2001).
Note: The table reports the results of regressions of the change in TFR between 2013 and 1960 on the average family planning programme effort score over the 1970s, 1980s, and 1990s, controlling for the change in years of schooling of the population aged 25+, urban population as a percentage of total population, log GDP per capita, and infant mortality rate between 2013 and 1960. All regressions include a constant. Given the small number of observations for infant mortality rate and GDP per capita in 1960, we use the earliest available observation before 1965 to construct the change. All regressions include a constant. The values in parentheses are robust standard errors. *, **, and *** indicate significance at 10, 5, and 1 percent levels, respectively.

average programme effort score over the 1970s, '80s, and '90s, again controlling for the other covariates of fertility. Table 3.4 indicates a strong negative relationship, with larger fertility declines in countries with higher programme effort.

Next, we use the Demographic and Health Surveys (DHS) data on percentage of women exposed to family planning messages through mass media to carry out the same exercise as for family planning programme funds and programme effort score. Table 3.5 shows these results. The context of this analysis is slightly different from the two previous exercises because the data are based on DHS surveys which were carried out predominantly in sub-Saharan African countries (30 of the countries in the sample used in columns 1 and 3, and 15 of the countries in the sample used in columns 2 and 4) starting from the early 1990s. Therefore, these results capture more recent efforts in family planning

Table 3.5: Change in total fertility rates (TFRs) and exposure to family planning messages

Change in TFR	Absolute change		% change	
	(1)	(2)	(3)	(4)
% of women with exposure	-0.038***	-0.050***	-0.602***	-0.449**
to FP messages	[0.007]	[0.011]	[0.090]	[0.169]
Change in years of		0.054		0.001
education of adults		[0.154]		[0.002]
Change in urban		-0.035**		-0.016
population as % of total		[0.016]		[0.010]
Change in ln(GDP per		-0.529**		-0.379*
capita)		[0.244]		[0.197]
Change in infant mortality		0.002		0.551***
rate		[0.005]		[0.175]
N	57	30	57	30
R-squared	0.301	0.567	0.347	0.631

Source: Authors. Data on total fertility rate, urban population, per capita GDP, and infant mortality rate are from the World Development Indicators. Data on years of schooling are from Barro and Lee (2013). Data on exposure to family planning messages are from Demographic and Health Surveys from various years.
Note: The table reports the results of regressions of the change in total fertility rate between 2013 and 1960 on the percentage of women exposed to family planning messages through mass media for the earliest year (before 2005) for which information is available for that country, controlling for the change between 2013 and 1960 in years of schooling of the population aged 25+, urban population as a percentage of total population, log GDP per capita, and infant mortality rate. All regressions include a constant. Given the small number of observations for infant mortality rate and GDP per capita in 1960, we use the earliest available observation before 1965 to construct the change. The values in parentheses are robust standard errors. *, **, and *** indicate significance at 10, 5, and 1 percent levels, respectively.

as seen in sub-Saharan Africa.

The regression results show a significant, negative association between the fertility change and exposure to family planning messages after controlling for other covariates. It therefore seems likely that the delay in the implementation of the family planning programmes in sub-Saharan Africa explains the delayed decline in fertility in the region. Both in Table 3.4 and Table 3.5, the coefficients corresponding to the policy measure change little when adding the controls; this suggests that additional omitted variables are unlikely to make a difference.[8]

[8]As an additional robustness check, in the Appendix we exploit variation in the starting year of state-led family planning programmes in 31 countries to further explore the relationship between fertility decline and the establishment of these programmes. After controlling for changes in covariates as well as shocks that might have affected fertility in all countries in a given year, we find that the decline in fertility accelerated with their inception. Given the very small sample size, which comprises mainly the early adopters of family planning,

These exercises demonstrate a strong association between the establishment and intensity of family planning programmes with the decline in fertility rates, after adjusting for changes in per capita income, urbanisation, infant mortality, female labour force participation, and educational attainment. Most sub-Saharan African governments acknowledged rapid population growth as a policy concern much later than developing countries elsewhere. Even after the formulation of population control policies, commitment to family planning lagged behind that of other regions leading most international agencies working in family planning to invest their resources in the more promising areas of Asia and Latin America. The onset of the HIV/AIDS epidemic is also likely to have weakened the emphasis on fertility control due to limited resources being targeted towards addressing the epidemic as well as the emergence of a pro-natalist response to the high mortality rates caused by the epidemic (National Research Council Working Group on Factors Affecting Contraceptive Use 1993). While almost all African countries now provide direct or indirect support for family planning, their efforts have only recently caught up with the rest of the world. Perhaps not surprisingly in light of the strong correlations, the countries in sub-Saharan Africa tend to be the ones where fertility rates still remain above the world's average.

3.4 Considering other explanations for the decline in fertility

A number of other socioeconomic factors have been suggested as possible causes for the decline in fertility: urbanisation, greater investment in education per child, rising female labour force participation, and lower infant mortality (see Becker 1960, Becker and Barro 1988, Barro and Becker 1989, and Manuelli and Sheshadri 2009). The regressions presented in the previous

we do not place too much weight on these results, but consider it to be further suggestive evidence in favor of the importance of these programmes in accelerating the fertility decline. The results of this analysis are available in Appendix C6.

section indicate that, population-control policies are strongly associated with the fertility decline, whereas some of the traditional covariates display a much weaker association. Of course, these results are hardly conclusive, as disentangling cause and effect in this area is quite difficult, an issue compounded by the shortage of data and potential measurement error. In this section, we provide further arguments for why these factors, while important, are unlikely to overshadow the role of population-control policies in the fertility decline.

Urbanisation has been put forward as an explanation for the decline in fertility, as rural areas have historically had much higher fertility rates than urban ones. Arguably, in rural areas, children can be a significant input in agricultural production. Moreover, despite the fact that parents can earn higher average wages in urban areas, it can cost more to raise children there, as the costs of housing and (typically compulsory) education are higher.[9] The negative relationship between urbanisation and fertility is illustrated in Figure 3.5, which plots the proportion of population living in urban areas against the total fertility rate for all countries in 1960 and in 2013. Although countries with less urbanisation have higher fertility, it does not appear that the urbanisation process alone can account for the sharp decline in fertility rates observed over the past five decades. Rather, it appears that fertility rates fell rapidly in both urban and rural areas.

Given the strong possibility that the cross-country data on urbanisation is mis-measured, we explored this issue in more detail using the Demographic and Health Survey (DHS) data from 57 countries which, through their identification of rural and urban areas, provide separate rural and urban fertility rates. The decline in fertility can be decomposed into a within-area effect, corresponding to the decline in fertility within either rural or urban areas, and

[9]Becker (1960) argues that urbanisation could explain the decline in fertility. The idea is that farmers have a comparative advantage in producing children and food, though this advantage is smaller for higher "quality" of childbearing. Caldwell (1976)'s net wealth flow theory also supports the view that wealth flows from children to parents in primitive agricultural societies, whereas the direction of flows reverses as society modernises and costs of raising children go up.

Figure 3.5: Fertility and urbanisation

Source: Authors using data from the World Development Indicators database.
Note: For a sample of 190 countries, the figure shows the scatter plot and fitted line (smoothed lowess relationship, or locally weighted smoothing function) between fertility and urbanisation in 1960 and 2013. Urbanisation is measured as the proportion of the population living in urban areas.

a between-area effect (that is, the urbanisation effect), corresponding to the decline in fertility rates due to the increase in the share of the population living in (lower-fertility) urban areas rather than (higher-fertility) rural areas.[10] Perhaps surprisingly, the increased urbanisation (between-area effect) contributed to only about 14 percent of the fertility decline. Most of the decline in fertility is explained by the within-area effect. Moreover, the contribution of urbanisation to the decline in fertility does not vary significantly with a country's fertility or urbanisation rates. This result suggests that while urbanisation may be a small part of the decline in fertility rates, other forces have been at work driving down fertility in both rural and urban areas around the world.

The decline in fertility is often discussed as being part of a shift away from the quantity of children towards higher quality, as demonstrated by the increase in education levels around the world. There is clearly a strong negative re-

[10]It should be noted that, because these surveys were carried out in different years and at different intervals in different countries, the period over which the changes are computed is not the same for every country. Details of the data and calculations are available in Appendix D.

lationship between fertility and education, but it is difficult to establish the direction of causality between fertility and education given that they are both endogenous outcomes of a household's decision-making process. For example, quantity – quality trade-offs are analysed in Galor and Weil (2000) and Galor and Moav (2002), where technological growth, by raising the return to human capital, can generate a demographic transition (see also Doepke 2004). The link between fertility and education emerges not just because of a tradeoff between quantity and quality (or education) of the children, but also because educated parents choose to have fewer children, possibly because they attach more value to quality in that tradeoff or they have a comparative advantage in educating children (Moav 2005). Remarkably, fertility has fallen significantly even in countries and rural areas where educational attainment still remains low. For instance, Bangladesh, Morocco, Myanmar, and Nepal all recorded fertility rates below 2.7, with percentage declines of over 60 percent from their 1960 levels, despite their populations having less than five years of schooling on average in 2010. Table 3.6 presents the average fertility rate in 2010 and fertility change (between 2013 and 1960) for countries grouped by the level of education of the adult population in 2010. While fertility rates are clearly declining in the years of schooling of the population, all but the lowest education group display sizeable percentage declines in fertility. The countries with less than three years of schooling in 2010 are nearly all in sub-Saharan Africa, where the fertility remains very high.

The cross-country correlation between female labour force participation and fertility indicates only a weak relationship, given the high female labour force participation in European and North American countries as well as in sub-Saharan African countries. (Data on female labour force participation rates are obtained from ILOSTAT.) Furthermore, labour force participation rates did not change much over the past few decades, other than in Latin America and the Caribbean, where the female labour force participation rate rose from 34 percent in 1980 to 54 percent in 2013. For comparison, over the same period, female labour force participation fell slightly in East Asia and the Pacific (from

Table 3.6: Fertility change by education in 2010

Schooling 2010	Absolute decline in TFR	% decline in TFR	TFR in 2010
$years \leq 3$	1.35	19.12	5.87
$3 < years \leq 6$	3.23	52.26	3.15
$6 < years \leq 9$	4.09	67.23	2.04
$9 < years \leq 12$	1.67	43.50	1.73
$years > 12$	1.51	45.22	1.81

Source: Authors. Data on fertility are from the World Development Indicators database and "years of schooling" comes from Barro and Lee (2013).
Note: The table presents the average absolute and percentage change in total fertility rate between 2013 and 1960 as well as average total fertility rate in 2010 by years-of-schooling groups. Years of schooling is grouped into five categories: $years \leq 3$; $3 < years \leq 6$; $6 < years \leq 9$; $9 < years \leq 12$; and $years > 12$. "Years of schooling" is for the population aged 25+ in 2010 and covers 143 countries.

64 to 61 percent) and South Asia (from 35 to 30 percent), while it rose slightly in the Middle East and North Africa (from 18 to 22 percent) and Sub-Saharan Africa (from 57 to 64 percent).

Changes in infant mortality rates appear to be highly correlated with changes in fertility. There are two, not mutually exclusive, interpretations of this correlation. First, as infant mortality declines, fewer births are needed to ensure that a family's desired number of children survives to adulthood (for example, Kalemli-Ozcan 2002). The second interpretation, which we have emphasised in this paper, is that the decline in mortality rates and the consequent population acceleration in the 1950s and 1960s, triggered the population-control movement; this, in turn, with its emphasis on changing family-size norms and contraception provision, accelerated the fertility fall by reducing the desired number of children and the number of unwanted births.

With regard to the first interpretation (that as infant mortality declines, fewer births are needed), it is apparent that fertility rates did not react quickly to the decline in mortality rates in the mid-20th century; after all, it is precisely the relatively slow change in fertility compared to the relatively rapid growth in life expectancy that caused the remarkable acceleration in population growth in the 1950s and 1960s. As noted in the Report of the President's Committee to Study the US Military Assistance Programme (Draper 1959), "high fertility

rates are normally part of deeply rooted cultural patterns and natural changes occur only slowly." This was also the view shared by demographers at the time (Enke 1960; Davis 1967). Our regression analysis in the previous section has attempted to gauge the two channels — the direct effect of infant mortality declines, and population-control programmes — separately and both appeared relevant. Another way to tease out the role played by population-control programmes as separate from the direct effect of infant mortality, is to study trends in desired or ideal number of children and the share of unwanted pregnancies, which are two main targets of the population-control programmes. In principle, according to the first interpretation, lower mortality rates should only affect the number of births, not the ideal number of surviving children.[11] Population-control programmes, however, focused on influencing the desired number of children or family size.

The data from the Demographic and Health Surveys provide two measures aimed at capturing fertility preferences: one is the "ideal number of children" and the other is "wanted fertility rate." The ideal number of children is obtained as a response to the question: "If you could go back to the time you did not have any children and could choose exactly the number of children to have in your whole life, how many would that be?" The wanted fertility rate is constructed as the fertility rate that would be observed if all "unwanted" births were eliminated; that is, births that raise the number of surviving children over the stated desired number of children (Rutstein and Rojas 2006). We consider the ideal or "desired" number of children as a measure of preference for surviving children: the number of children the woman would choose to have in her whole life. In this context, fertility is directly affected by the desired number of children, but can deviate from it for reasons that are unrelated to preferences, such as infant mortality or the availability of means to control fertility. In particular, the wanted total fertility rate can exceed the desired number of

[11]Interestingly, the Barro and Becker (1989) framework predicts that, as mortality rates fall, the ideal (or, in the jargon, "optimal") number of surviving children actually increases, as the cost of raising children decreases. See Doepke (2005), who analyses different variants of the Barro–Becker model yielding this prediction.

Table 3.7: Changes in wanted and unwanted fertility (as a percentage of change in total fertility rate)

Change as a % of change in TFR	Overall	Urban	Rural
Wanted fertility	75.35	63.48	82.26
Ideal no. of children	*57.97*	*56.08*	*51.92*
Other	*17.38*	*7.41*	*30.35*
Unwanted fertility	24.65	36.52	17.74

Note and Source: The table shows the change in wanted fertility rate and unwanted fertility rate (defined as the difference between total and wanted fertility rates) as a percentage of the change in total fertility rate using data from the Demographic and Health Surveys in 52 countries. The change in wanted fertility is further decomposed into the contribution of the change in the ideal number of children and a residual. Note that different countries were surveyed in different years and at different intervals—the earliest available survey is from 1986 while the latest is from 2015.

children when women replace children who have died with additional births to reach the desired number of surviving children (Bongaarts 2011). Table 3.7 uses data from Demographic and Health Surveys in 52 countries to present the average change in wanted fertility rates as a percentage of the change in total fertility rate over the period analysed (different countries were surveyed in different years and at different time intervals, so the period over which the changes are computed differ across countries). The change in wanted fertility is further decomposed into the contribution of changes in the desired number of children and a second (residual) component that captures other reasons, which might include changes in infant mortality (under the heading "other"). The data indicates that the fall in wanted fertility accounts for a significant share of the fall in fertility, and that a large part of the fall in wanted fertility can be accounted for by the decline in the number of desired children. The pattern is observed in both rural and urban areas. The large role played by the change in the desired or ideal number of children is supportive of the role played by population programmes over and above the direct effect of lower mortality rates.

The last row of Table 3.7 reports the change in unwanted fertility also as a share of the change in total fertility rate. Unwanted fertility is defined as the

difference between total fertility rate and wanted fertility. Unwanted fertility has also fallen in both urban and rural areas, pointing to improved ability to control fertility given the wider availability of contraceptives. The decline in unwanted fertility is relatively less important as a share of the change in overall fertility. This, together with the large share accounted for by the decline in the ideal number of children, is consistent with the introduction of additional measures to promote a smaller family size as a result of the sluggish fertility response to wider contraception provision.

3.5 Conclusion

The rapid decline in fertility rates in the past five decades cannot be accounted for in a satisfactory way by economic growth, urbanisation, education levels, or other socioeconomic variables. The timing and speed of the fertility decline coincides with the growth of a neo-Malthusian global population-control movement that designed and advocated a number of policy measures aimed at lowering fertility rates across the world. The precise measures chosen by different countries varied in nature and scope, depending on the individual country's socioeconomic context. But common to almost all programmes was an enhanced provision of contraceptive methods and mass-media campaigns to establish a new small-family norm.

The global convergence in fertility to near replacement fertility rates will eventually ensure a constant world population, although the rise in life expectancy implies that it will take another few decades to reach a constant population level. Projections by the UN Population division suggest that populations in all regions except for Africa will stabilise by 2050. Including Africa, for which the projections are more uncertain, world population is expected to stabilise by 2100 at around 11.2 billion, with total fertility rates converging to 2 in all regions (United Nations Population Division 2015). Concerns over possible imbalances between resources and population will not disappear, but will be

mitigated as population growth flattens out. Insofar as the US experience can offer guidance, the diffusion of contraception and the decline of fertility and postponement of childbearing could increase female empowerment in developing countries through higher levels of investment in human capital (Goldin and Katz 2002). To the extent that lower fertility rates are associated with higher investment in human capital, the trends bode well for development and living standards in the world's poorest regions.

Appendices

Appendix B

In the paper we argue that the origins of the population control movement can be traced to the West. In what follows, we reproduce extracts from historical documents reflecting the preoccupation of intellectuals and policy makers in the West with the high fertility levels.

John D. Rockefeller, Jr., 1934, in a letter to his father:
"In concluding, may I add one further statement in regard to my interest in birth control. I have come pretty definitely to the conclusion that it is the field in which I will be interested, for the present at least, to concentrate my own giving, as I feel that it is so fundamental and underlying." [Rockefeller 1934]

Report of the President's Committee to Study the U.S. Military Assistance Programme, 1959:
"[T]hese high fertility rates are normally a part of deeply rooted cultural patterns, and natural changes occur only slowly. In many countries, national production is failing even to keep pace with population growth, and per capita gross national product and food supplies are therefore decreasing rather than increasing.

Government leaders in many of the less developed nations recognize that the only hope for their people lies in accelerating the normal adjustment to the rapidly declining mortality rate. Few countries have set up the necessary programs, although broad acceptance has been found in those areas where programs have been established.

The United States and the other more advanced countries can and should be prepared to respond to requests for information and technical assistance in connection with population growth. Such information will help to point up the seriousness of the problem, and to encourage action in countries where

population pressures exist. Such information is also useful in defining the areas in which initial efforts will be most effective. Recognizing an immediate problem created by the rapid growth, the United States should also increase its assistance to local programs relating to maternal and child welfare.

We Recommend: That, in order to meet more effectively the problems of economic development, the United States (1) assist those countries with which it is cooperating in economic aid programs, on request, in the formulation of their plans designed to deal with the problem of rapid population growth, (2) increase its assistance to local programs relating to maternal and child welfare in recognition of the immediate problem created by rapid population growth, and (3) strongly support studies and appropriate research as a part of its own Mutual Security Program, within the United Nations and elsewhere, leading to the availability of relevant information in a form most useful to individual countries in the formulation of practical programs to meet the serious challenge posed by rapidly expanding populations." [Draper 1959, p 96-97]

John D. Rockefeller Jr. at the National Conference on the Population Crisis 1960:

"In May 1960 at a National Conference on the Population Crisis co-sponsored by the Dallas Council on World Affairs and Newsweek magazine, John D. Rockefeller 3rd made a plea that was to be repeated many times in the decade ahead: The problems of population are so great, so important, so ramified and so immediate that only government, supported and inspired by private initiative, can attack them on the scale required. It is for the citizens to convince their political leaders of the need for imaginative and courageous action-action which may sometimes mean political and economic opposition." [Piotrow 1973, p 49]

Enke (1960) based on discussions with senior officials and Prime Minister of the Indian government:

"The willingness versus ability of adults to limit births has long been a matter of controversy. A cheap and available contraceptive pill will not be the answer

in Asia unless couples wish to avoid pregnancies... In the "extended" or three generation households of Asia, which still predominate in rural areas, children are not a liability to their parents during their infancy. And they are a real asset in later life to their procreators.

It is not enough for governments in these countries to support clinics that provide contraceptive information. It is not practical to tax extra children. Instead, governments must offer some strong and positive inducement to couples to limit births. Money might be such an incentive if paid in large enough amounts. Or other costly benefits, such as the education and support of parents' existing children, might be offered. [Enke 1960, p 343]

... In countries that are already overpopulated, and have crude population increases of 2 percent a year, there may not be time to wait for uncertain birth reductions following urbanization, emancipation of women, and a delayed recognition that falling death rates have reduced the number of infants a couple must have to obtain a given size family of grown children.

The knowledge and availability of contraceptives can be increased by government action. But the ability rather than the willingness to limit family size is affected thereby. Even a contraceptive pill is no panacea for the same reason. It may benefit "emerging" urban parents but not untutored rural peasants. And, even if the pill cost only 10 cents, the total resource cost over the fertile period of a woman's life would exceed $100. So money payments to men and women to constrain family size–in the ways described here–may be far more effective a limitation and much cheaper in resources. Schemes of this kind may do more for suffering humanity than successful medical research on contraceptives." [p 348]

Davis (1967) on the effectiveness of family planning programmes:
"By sanctifying the doctrine that each woman should have the number of children she wants, and by assuming that if she has only that number this will automatically curb population growth to the necessary degree, the leaders

of current policies escape the necessity of asking why women desire so many children and how this desire can be influenced ... Instead they claim that satisfactory motivation is shown by the popular desire (shown by opinion surveys in all countries) to have the means of family limitation, and that therefore the problem is one of inventing and distributing the best possible contraceptive devices. Overlooked is the fact that a desire for availability of contraceptives is compatible with high fertility ... We thus see that the inadequacy of current population policies with respect to motivation is inherent in their overwhelmingly family planning character. [Davis 1967, p 733-734]

... If excessive population growth is to be prevented, the obvious requirement is somehow to impose restraints on the family... Population-control policy can de-emphasize the family in two ways: (i) by keeping present controls over illegitimate childbirth yet making the most of factors that lead people to postpone or avoid marriage and (ii) by instituting conditions that motivate those who do marry to their families small. [p 737]

... In any deliberate effort to control the birth rate along these lines, a government has two powerful instruments – its command over economic planning and its authority (real or potential) over education. The first determines (as far as policy can) the economic conditions and circumstances affecting the lives of all citizens; the second provides the knowledge and attitudes necessary to implement the plans. The economic system largely determines who shall work, what can be bought, what rearing children will cost, how much individuals can spend. The schools define family roles and develop vocational and recreational interests; they could, if it were desired, redefine the sex roles, develop interests that transcend the home, and transmit realistic (as opposed to moralistic) knowledge concerning marriage, sexual behaviour, and population problems. When the problem is viewed in this light, it is clear that the ministries of economics and education, not the ministry of health, should be the source of population policy." [p 738]

John D. Rockefeller Jr. in a speech at the Population Tribune in Bucharest,

1974:

"It turns out that women who avail themselves of family planning are chiefly those who already have had many children. Over the 40-year span I have referred to, the population of the world has increased by 86 percent, from 2.1 billion to 3.9 billion. And the absolute number of people in poverty has continued to grow. Clearly, the programs that have been undertaken have proved inadequate when compared to the magnitude of the problems facing us. [Rockefeller 1978, p 511]

... [R]apid population growth is only one among many problems facing most countries, it is a multiplier and intensifier of other problems.... [R]educing population growth is not an alternative to development, but an essential part of it for most countries." [p 512]

National Security Study Memorandum 200 (The Kissinger Report), 1974:

"High birth rates appear to stem primarily from: a. inadequate information about and availability of means of fertility control; b. inadequate motivation for reduced numbers of children combined with motivation for many children resulting from still high infant and child mortality and need for support in old age; and c. the slowness of change in family preferences in response to changes in environment.

... We cannot wait for overall modernization and development to produce lower fertility rates naturally since this will undoubtedly take many decades in most developing countries, during which time rapid population growth will tend to slow development and widen even more the gap between rich and poor. [National Security Council 1974, p 6-7]

... The political consequences of current population factors in the LDCs - rapid growth, internal migration, high percentages of young people, slow improvement in living standards, urban concentrations, and pressures for foreign migration — are damaging to the internal stability and international relations of countries in whose advancement the U.S. is interested, thus creating polit-

ical or even national security problems for the U.S. In a broader sense, there is a major risk of severe damage to world economic, political, and ecological systems and, as these systems begin to fail, to our humanitarian values. [p 8]

. . . While specific goals in this area are difficult to state, our aim should be for the world to achieve a replacement level of fertility, (a two-child family on the average), by about the year 2000. [p 9]

. . . The World Population Plan of Action is not self-enforcing and will require vigorous efforts by interested countries, U.N. agencies and other international bodies to make it effective. U.S. leadership is essential. The strategy must include the following elements and actions:

a. Concentration on key countries. Assistance for population moderation should give primary emphasis to the largest and fastest growing developing countries where there is special U.S. political and strategic interest. Those countries are: India, Bangladesh, Pakistan, Nigeria, Mexico, Indonesia, Brazil, the Philippines, Thailand, Egypt, Turkey, Ethiopia and Columbia. Together, they account for 47 percent of the world's current population increase. (It should be recognized that at present AID bilateral assistance to some of these countries may not be acceptable.) Bilateral assistance, to the extent that funds are available, will be given to other countries, considering such factors as population growth, need for external assistance, long-term U.S. interests and willingness to engage in self-help. Multilateral programs must necessarily have a wider coverage and the bilateral programs of other national donors will be shaped to their particular interests. At the same time, the U.S. will look to the multilateral agencies, especially the U.N. Fund for Population Activities which already has projects in over 80 countries to increase population assistance on a broader basis with increased U.S. contributions. This is desirable in terms of U.S. interests and necessary in political terms in the United Nations. But progress nevertheless, must be made in the key

13 and our limited resources should give major emphasis to them.

b. Integration of population factors and population programs into country development planning. As called for the world Population Plan of Action, developing countries and those aiding them should specifically take population factors into account in national planning and include population programs in such plans.

c. Increased assistance for family planning services, information and technology. This is a vital aspect of any world population program. 1) Family planning information and materials based on present technology should be made fully available as rapidly as possible to the 85 % of the populations in key LDCs not now reached, essentially rural poor who have the highest fertility.

d. Fundamental and developmental research should be expanded, aimed at simple, low-cost, effective, safe, long-lasting and acceptable methods of fertility control. Support by all federal agencies for biomedical research in this field should be increased by $60 million annually.

e. Creating conditions conducive to fertility decline. For its own merits and consistent with the recommendations of the World Population Plan of Action, priority should be given in the general aid program to selective development policies in sectors offering the greatest promise of increased motivation for smaller family size. In many cases pilot programs and experimental research will be needed as guidance for later efforts on a larger scale. The preferential sectors include:...
   – Developing alternatives to children as a source of old age security;
   – Education of new generations on the desirability of smaller families. [p 10-11]

... The U.S. should encourage LDC leaders to take the lead in advancing family planning and population stabilization both within multilateral organizations and through bilateral contacts with other LDCs. This will require that the

President and the Secretary of State treat the subject of population growth control as a matter of paramount importance and address it specifically in their regular contacts with leaders of other governments, particularly LDCs." [p 12]

Appendix C

1 Features of early family planning programmes

Strategy	Method of implementation	Description
Increasing access to contraceptives	Ministry of Health clinics or hospital-based facilities	All countries with a state-led family planning programme as well as countries where the state allowed private institutions to use state infrastructure provided family planning services in clinics and hospitals. Main examples: Mexico, Brazil, Uruguay, Kenya.
	Post-partum family planning in major hospitals	Women counselled on birth spacing and contraceptive methods soon after delivery. Limited in scope as most deliveries did not take place in hospitals in most developing countries at the time Main examples: Iran, Sri Lanka, Colombia, Tunisia, Jamaica, Hong Kong, Thailand, Malaysia, India, Ghana.
	Pairing family planning with maternal and child health services	While this was usually done in order to make use of existing medical infrastructure, particularly in rural areas, it was also carried out in countries that wished to maintain a low profile for their programmes (e.g., Guatemala). Main examples: Iran, Chile, Colombia, Korea, Singapore, Thailand, Malaysia (rural areas), Philippines, Pakistan, Sri Lanka, Nepal, Brazil, Honduras, Botswana, Guatemala.

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Strategy	Method of implementation	Description
	Trained fieldworkers to reach remote, rural areas	Midwives and/or community workers were trained to deliver and in some cases prescribe or administer contraceptive methods. Main examples: Egypt, Morocco, Korea, Hong Kong, Taiwan, Singapore, Indonesia, Philippines, India, Pakistan and Bangladesh, Sri Lanka, Kenya, Costa Rica, Colombia, Mexico, Iran, Nepal.
	Mobile clinics and family planning camps	Mobile clinics generally visited rural clinics, schools and government offices on a regular basis. The team usually consisted of one person to provide education and information and another to provide the medical services. Main examples: Iran, Hong Kong, Singapore, Malaysia, Nepal, Honduras, Tunisia, Turkey, South Korea, India. In India and Nepal, large scale vasectomy camps were set up temporarily in primary health centers to perform sterilisations and insert IUDs
	Contraceptive provision through integrated rural development programmes	Rural development projects (including education, sanitation and agricultural projects) expanded to include a family planning component, usually in the form of programme officers advocating and providing contraception to target population alongside their usual activities. Main examples: Philippines, Ghana, Iran, Turkey, Egypt.

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Strategy	Method of implementation	Description
	Employment based family planning programmes[a]	Contraceptive distribution, educational and promotional activities undertaken by employers or labour unions usually working in collaboration with a Family Planning Association or the government. Main examples: Tata Iron and Steel Company in India, the military in South Korea and Ecuador, Philippine Appliance Corporation, Misr Spinning and Weaving Company in Egypt, Coffee Grower's Association in Colombia, as well as employers in Kenya, Thailand, China, Bangladesh, Malaysia and Sri Lanka, labour unions in Turkey (TURK-IS) and Indonesia (Textile and Garment Labour Union). Later (starting in the 1980s) Latin America and the Caribbean (where most workers and their families are offered health care through the national social security system) extended their social security systems to include family planning. Main examples in Latin America: Mexico, Peru and Brazil.
	Enabling private sector and NGO involvement	In most countries, family planning programmes were originally piloted by private family planning associations which were later supported (through provision of state sector facilities and technical support) or taken over by the state. These associations continue to play a role in service provision and public education in many countries.

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Strategy	Method of implementation	Description
		Main examples: Family Planning Associations in Chile (APROFA), Colombia (PROFAMILIA), Guatemala (APROFAM), Jamaica (JFPA), Costa Rica, Honduras, Mexico, Brazil and Uruguay continue to be leaders in family planning activities alongside state programmes. In Egypt, Iran, Tunisia, Morocco, Turkey, South Korea, Singapore, Hong Kong, Taiwan, Indonesia, India, Pakistan, Bangladesh, Sri Lanka, Nepal, Ghana, Kenya Zimbabwe, Botswana and Mauritius family planning associations laid the foundations for large scale national programmes.
	Subsidised contraceptive provision and incentives for contraceptive usage	This included state subsidisation of private sector sale of contraceptives (social marketing), provision of contraceptives at no cost, and provision of incentives for the use of contraceptives. Main examples: Social marketing programmes in Bangladesh, Pakistan, India, Iran, Philippines, Honduras, Colombia, Mexico, Zimbabwe, Ghana, Mauritius, Taiwan. Certain family planning methods were provided free of charge in Jamaica, Iran, Turkey, Malaysia, Sri Lanka, Morocco and China. Patients, providers and/or fieldworkers bringing in the patient for sterilisations and IUD insertions compensated for travel and time in Bangladesh, Nepal, India, Sri Lanka, South Korea.

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Strategy	Method of implementation	Description
Educating public on population issues and contraceptive use	Interpersonal communication with fieldworkers and community based education	In addition to clinic based counselling, many programmes employed fieldworkers to provide information about family planning at family planning clinics and child health centres, on a door to door basis and even at marriage and birth registries (Hong Kong). Main examples: Egypt, Chile, Korea, Hong Kong, Taiwan, Indonesia, Philippines, Pakistan, Bangladesh, Sri Lanka, Kenya, Iran, Singapore. In Singapore, lectures and seminars on family planning were organised for newlyweds, community leaders, teachers and school principals.
	Print media such as posters, leaflets etc.	Posters, leaflets, newspaper advertisements and magazine articles were used to disseminate information about the benefits of contraceptive use, technical information about specific contraceptive methods, nearest family planning clinics, as well as to create awareness about the benefits of having smaller families. Main examples: Turkey, Korea, Singapore, India, Kenya, Egypt, Iran, Mauritius, Hong Kong, Indonesia.
	Electronic mass media including radio, film and television (particularly important for reaching non-literate population)[b]	Information on contraceptive use and population related issues was provided through spot announcements, interviews, news broadcasts, lectures, drama, advertisements and even music. Most early programmes focused on radio, later branching out into TV.

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Strategy	Method of implementation	Description
		Main examples: use of radio for building awareness in Iran, South Korea, Taiwan, Singapore, Indonesia (radio serial drama - Grains of sand in the sea), India, Colombia (radio spots pointing out benefits of having only the number of children that could be cared for, ending with the name and address of a PROFAMILIA clinic), Pakistan, Bangladesh, Costa Rica (nation-wide 10 minute radio programme Dialogo), Mauritius, Egypt, Turkey. Later, television dramas and films were used in Hong Kong, Mexico, India, Bangladesh, Brazil etc. to promote family planning and establish a small family norm. TV spots carrying family planning messages were also used in Egypt, Nigeria, Mali, Liberia, Zimbabwe and Mauritius.
	Including population concepts and concerns in school curricula[c]	Population topics were incorporated into social studies, geography, home economics, science and mathematics courses at primary and secondary school levels. Some Asian (Philippines, South Korea, China) and Latin American countries also incorporated material on human reproduction and family planning. Main examples: Morocco, Turkey, Hong Kong, Taiwan, Philippines, Costa Rica, Bangladesh, Indonesia, South Korea, Malaysia, Singapore, China, Sri Lanka, Thailand, Sierra Leone, Tunisia, El Salvador, Iran, Mauritius.

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Strategy	Method of implementation	Description
Other policies to encourage having fewer children	Increasing the legal age of marriage	Legal age of marriage increased in order to delay childbearing.
	Incentives for having smaller families	Main examples: Tunisia, India, China. These include explicit policies to discourage couples from having too many children. Main examples: Limiting government family allowances to the first four children in Tunisia, number of children for which tax exemptions are claimed cut to four and restricting paid maternity leave to four children in Philippines, and restricting maternity leave to the first two children born, restricting income tax relief to the first three children, and giving priority for the allocation of public apartments for families with fewer children among other policies in Singapore.

Notes: The table summarises key features of early family planning programmes around the world. Information on programmes in Egypt (Robinson and El-Zanaty 2007), Iran (Moore 2007), Tunisia (Brown 2007b), Morocco (Brown 2007a), Turkey (Akin 2007), Chile (Sanhueza 2007), Colombia (Measham and Lopez-Escobar 2007), Guatemala (Santiso-Galvez and Bertrand 2007), Jamaica (King 2007), South Korea (Kim and Ross 2007), Hong Kong (Fan 2007), Singapore (Teng 2007), Thailand (Rosenfield and Min 2007), Indonesia (Hull 2007), Malaysia (Tey 2007), Philippines (Herrin 2007), India (Harkavy and Roy 2007), Bangladesh and Pakistan (Robinson 2007), Sri Lanka (Wright 2007), Nepal (Tuladhar 2007), Ghana (Caldwell and Sai 2007) and Kenya (Heisel 2007) is from the compilation of case studies by Robinson and Ross (2007). Further information on the Latin American countries including Chile, Colombia and Guatemala is obtained from Shaffer (1968), Bertrand, Ward and Santiso-Galvez (2015) and the Cavenaghi (2009). Information on China (pre one-child policy) is obtained from Attane (2002) and Wang (2012). Information on Taiwan is obtained from Sun (2001). Information on Mauritius is from Hogan, Kennedy, Obetsebi-Lamptey and Sawaya (1985) and the information on Botswana and Zimbabwe is taken from the report by the National Research Council Working Group on Factors Affecting Contraceptive Use (1993).

[a] Information on this section is obtained from Rinehart, Blackburn and Moore (1987) [b] Information on this section is obtained from Gilluly and Moore (1986) and Church and Geller (1989) [c] Information on this section is obtained from Sherris and Quillin (1982)

2 Funds for family planning by country

Country	Total per capita funds		Govt per capita funds		Non-govt per capita funds		Total funds (% of GDP)	
	1970s	1980s	1970s	1980s	1970s	1980s	1970s	1980s
Asia								
Afghanistan		2.56		0.00		2.56		
Bangladesh	41.02	186.56	16.39	36.24	24.63	150.32	0.07	0.47
Hong Kong, China	54.65	66.00	26.74	48.42	27.91	17.57	0.01	0.00
India	68.42	99.55	64.10	89.67	4.32	9.88	0.08	0.16
Indonesia	74.75	101.37	39.52	71.38	35.23	29.99	0.09	0.11
Korea, Rep.	108.63	147.06	85.32	132.12	23.32	14.94	0.04	0.46
Malaysia	165.63	105.86	102.10	95.60	63.53	10.26	0.04	0.03
Mongolia		6.60				6.60		0.00
Nepal	28.06	35.94	15.67	27.93	12.40	8.02	0.07	0.12
Pakistan	76.01	41.58	32.21	18.07	43.79	23.51	0.13	0.07
Philippines	145.58	62.43	79.85	37.85	65.73	24.58	0.11	0.05
Singapore	134.12	97.74	132.62	97.38	1.50	0.36	0.01	0.01
Sri Lanka	16.11	16.68		11.76		4.92	0.02	0.02
Taiwan	50.88	89.44	46.52	89.35	4.36	0.10		
Thailand	44.54	42.87	11.33	26.70	33.21	16.17	0.03	0.03
Vietnam				5.81				
Latin America and Caribbean								
Bolivia	13.20		0.96		12.25		0.01	
Brazil		8.70	2.28	0.00		8.70		
Colombia	59.18	47.40		23.70		23.70	0.02	0.02
Costa Rica	184.92	203.73	52.57	132.81	132.35	70.92	0.05	0.06
Dominican Rep.	91.42		43.28		48.15		0.04	
El Salvador	300.66	324.76	237.06	235.47	63.60	89.29	0.15	0.22
Honduras		125.80		0.00		125.80		0.08
Nicaragua				204.57				
Panama		59.59		14.29		45.30		0.01
Puerto Rico	897.43		390.17		507.26		0.09	

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Country	Total per capita funds		Govt per capita funds		Non-govt per capita funds		Total funds (% of GDP)	
	1970s	1980s	1970s	1980s	1970s	1980s	1970s	1980s
Trinidad and Tobago				26.51				
Venezuela			123.35	1.50				
North Africa and Middle East								
Egypt	16.33		1.81	11.96	14.51		0.01	
Iran	248.01		243.34	0.07	4.67		0.05	
Iraq		3.26		2.25		1.02		0.00
Jordan		61.82		21.45		40.37		0.02
Morocco		55.53		45.49		10.05		0.03
Tunisia	124.05	130.23	36.10	73.57	87.96	56.66	0.05	0.06
Turkey	23.03	23.58	21.81	20.51	1.22	3.06	0.01	0.01
Sub Saharan Africa								
Botswana		15.40		7.48		7.93		0.01
Burkina Faso		23.93		6.70		17.23		0.05
Central African Rep.		35.21		16.93		18.28		0.05
Congo, Rep.				0.37				
Ethiopia		6.66						0.02
Ghana	49.70		40.64		9.06		0.04	
Guinea		15.24		0.71		14.53		0.02
Kenya		43.36		12.25		31.11		0.07
Liberia		48.34						0.08
Madagascar		3.78		1.46		2.32		0.01
Mauritania		29.51		0.76		28.75		0.04
Mauritius	356.05	385.87	180.29	244.30	175.76	141.58	0.11	0.12
Nigeria		9.39						0.02
Rwanda		55.90		29.90		25.99		0.10
Somalia		2.00						0.01
Tanzania	7.52		0.35		7.17			
Uganda	5.63						0.01	
Zambia		23.26		3.53		19.73		0.03

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Country	Total per capita funds		Govt per capita funds		Non-govt per capita funds		Total funds (% of GDP)	
	1970s	1980s	1970s	1980s	1970s	1980s	1970s	1980s
Zimbabwe	51.70	142.60	45.47	100.50	6.23	42.10	0.02	0.10

Notes: The table reports the total funds for family planning per capita and per capita funds for family planning by source: government or non-government for the 1970s and 1980s. (We compute averages for the two decades as different countries have data for different years.) Averages for the 1970s and 1980s are computed in constant 2005 U.S.$ cents for comparability. The final two columns report the total funds for family planning as a percentage of GDP (both in nominal terms) averaged for the 1970s and 1980s. Data on funding for family planning are taken from Nortman and Hofstatter (1978), Nortman (1982), and Ross, Mauldin, and Miller (1993), while data on the price index (for conversion to real terms) and nominal GDP are from the WDI.

3 Change in fertility rates (1980-2013) and funding for family planning programmes

Change in TFR	Absolute change	% change
Ln(average funds per capita)	-0.257*	-5.487***
	[0.141]	[1.529]
Change in years of education of adults	-0.168	-0.020
	[0.130]	[0.015]
Change in urban population as % of total	-0.022	-0.015***
	[0.013]	[0.005]
Change in ln(GDP per capita)	0.331	-0.045
	[0.298]	[0.216]
Change in infant mortality rate	0.018***	0.363***
	[0.005]	[0.094]
Change in female LFPR	0.003	-0.029
	[0.008]	[0.021]
N	43	43
R-squared	0.402	0.574

Notes: The table reports the results of regressions of the change in TFR between 2013 and 1980 on the logged value of average per capita funds for family planning for the 1970s, 80s and 90s, controlling for the changes in years of schooling of the population aged 25+, urban population as a percentage of total population, log GDP per capita infant mortality rate and female labour force participation rate between 2013 and 1980. All regressions include a constant and use a sample of 43 countries. Total per capita funds for family planning are converted to 2005 US$ before averaging. Data on total fertility rate, urban population, per capita GDP, infant mortality rate and US Consumer Price Index (used to convert the funds to real terms) are from the World Development Indicators. Data on years of schooling is from Barro-Lee (2013). Data on female labour force participation rate is from ILOSTAT. Data on funds for family planning are from Nortman and Hofstatter (1978), Nortman (1982) and Ross, Mauldin and Miller (1993). The values in parentheses are robust standard errors. * Significant at 10% level ** Significant at 5% level ***Significant at 1% level

4 Change in fertility rates and funding for family planning programme by source

Change in TFR	(1)	(2)	(3)
Ln(average government funds per capita)	-0.250**		-0.241**
	[0.116]		[0.117]
Ln(average private funds per capita)		-0.125	-0.060
		[0.128]	[0.0947]
Change in years of education of adult women	-0.047	-0.199	-0.0688
	[0.121]	[0.138]	[0.123]
Change in urban population as % of total	-0.014*	-0.007	-0.013
	[0.007]	[0.010]	[0.008]
Change in ln(GDP per capita)	-0.377*	-0.369	-0.382*
	[0.216]	[0.246]	[0.223]
Change in infant mortality rate	0.004*	0.004	0.005*
	[0.003]	[0.003]	[0.003]
N	31	31	31
R-sq	0.445	0.34	0.449

Notes: The table reports the results of regressions of the change in TFR between 2013 and 1960 on the logged value of average per capita funds for family planning from the state and private sources for the 1970s, 80s and 90s, controlling for the changes in years of schooling of the population aged 25+, urban population as a percentage of total population, log GDP per capita and infant mortality rate between 2013 and 1960. All regressions include a constant and use a sample of 31 countries. Total per capita funds for family planning are converted to 2005 US$ before averaging. Data on total fertility rate, urban population, per capita GDP, infant mortality rate and US Consumer Price Index (used to convert the funds to real terms) are from the World Development Indicators. Data on years of schooling is from Barro-Lee (2013). Data on funds for family planning are from Nortman and Hofstatter (1978), Nortman (1982) and Ross, Mauldin and Miller (1993). The values in parentheses are robust standard errors. * Significant at 10% level ** Significant at 5% level ***Significant at 1% level

5 Programme effort score by region

Region	1972	1982	1989	1994	1999
Europe and Central Asia	20	27	46	42.2	53
East Asia and the Pacific	39.4	46.1	52.5	55.7	58.5
Latin America and the Caribbean	30.2	39	50.6	50.3	50
North Africa and the Middle East	11.4	17.9	40.5	41.8	58.3
South Asia	24.3	46.3	55.6	56.8	64.4
Sub Saharan Africa	5	15.5	36.7	43.9	51.1
Total	19.3	28.5	44.3	47.8	53.6
No. of countries	89	94	92	95	88

Notes: The table reports the average family planning programme effort score for each region. The regional averages are calculated using data from Ross and Stover (2001).

6 Effect of state-led family planning programme implementation on fertility decline

ΔTFR_t	(1)	(2)	(3)
State programme	-0.066**		
	[0.023]		
L1.State programme		-0.059**	
		[0.020]	
L2. State programme			-0.050*
			[0.018]
ΔGDP_t	0.009	0.005	0.003
	[0.078]	[0.077]	[0.080]
ΔIMR_t	0.001	0.002	0.002
	[0.005]	[0.005]	[0.005]
$\Delta Urban_t$	-0.022	-0.021	-0.021
	[0.016]	[0.016]	[0.016]
ΔEdu_t	0.006	0.006	0.005
	[0.011]	[0.011]	[0.011]
Total obs. (NT)	1574	1574	1553
R-squared	0.191	0.187	0.177

Notes: The table reports the results of fixed effects regressions of the year on year change in TFR on a dummy variable for establishment of state family planning programme (0 before establishment, 1 after), controlling for the year on year change in the log of per capita GDP, infant mortality rate, urban population as a % of total population and years of schooling of the population aged 25+. Columns (2) and (3) use 1 and 2 year lags of the programme dummy, respectively. All regressions are estimated using a sample of 31 countries and include country and year fixed effects. Data on total fertility rate, urban population, per capita GDP, and infant mortality rate are from the World Development Indicators. Data on years of schooling is from Barro-Lee (2013). Since years of schooling at available at 5-yearly intervals we replace missing values with data from the closest year for which data is published. Data on family planning programme implementation dates are compiled using information from Robinson and Ross (2007), Cavenaghi (2009), Shaffer (1968), Bertrand et al (2015), Attane (2002), Hogan et al (1985) and National Research Council Working Group on Factors Affecting Contraceptive Use (1993). The values in parentheses are robust standard errors. * Significant at 10% level ** Significant at 5% level ***Significant at 1% level

Appendix D

In formulas, the overall fertility rate equals the weighted average of urban and rural fertility rates:

$$F_t = \lambda_{r,t} F_{r,t} + \lambda_{u,t} F_{u,t}$$

Where $\lambda_{r,t}$ is the proportion of the country's population living in rural areas in period t, $\lambda_{u,t} = 1 - \lambda_{r,t}$, and $F_{r,t}$ and $F_{u,t}$ are the rural and urban fertility rates at time t, respectively.

With some algebra, the change in overall fertility between time 0 and time t can be exactly decomposed as:

$$\Delta F_t = F_t - F_0 = \underbrace{(\Delta\lambda_{r,t}\bar{F}_{r,t} + \Delta\lambda_{u,t}\bar{F}_{u,t})}_{\text{Between (urbanisation) effect}} + \underbrace{(\bar{\lambda}_{r,t}\Delta F_{r,t} + \bar{\lambda}_{u,t}\Delta F_{u,t})}_{\text{Within effect}}$$

where 0 and t correspond to the start and end of the period, respectively; and the terms denoted with a bar are the time averages: $\bar{x}_j = (x_{j,t} + x_{j,0})/2$, for $j = r, u; x = \lambda, F$

The results of the decomposition exercise are presented in the table below.

Fertility rate decomposition by region

Country	Change in fertility	Between effect	Within effect	First year	Last year
Angola	0.5	108.82%	-8.82%	2006	2011
Bangladesh	-1.1	6.82%	93.18%	1993	2014
Benin	-1.1	8.65%	91.35%	1996	2011
Bolivia	-1.5	8.03%	91.97%	1989	2008
Brazil	-0.9	18.32%	81.68%	1986	1996
Burkina Faso	-1	17.41%	82.59%	1993	2014
Burundi	-0.8	14.63%	85.37%	1987	2012
Cambodia	-1.1	7.58%	92.42%	2000	2014

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Country	Change in fertility	Between effect	Within effect	First year	Last year
Cameroon	-0.7	21.78%	78.22%	1991	2011
Colombia	-1.1	21.19%	78.81%	1986	2010
Comoros	-0.3	21.37%	78.63%	1996	2012
Congo, Dem. Rep.	0.3	40.30%	59.70%	2007	2013
Congo, Rep.	0.3	-96.59%	196.59%	2005	2011
Cote d'Ivoire	-0.3	43.75%	56.25%	1994	2011
Dominican Republic	-1.2	-11.64%	111.64%	1986	2013
Egypt, Arab Rep.	-1	-31.42%	131.42%	1988	2014
Eritrea	-1.3	16.86%	83.14%	1995	2002
Ethiopia	-0.7	31.49%	68.51%	2000	2011
Gabon	-0.1	200.00%	-100.00%	2000	2012
Ghana	-2.2	13.64%	86.36%	1988	2014
Guatemala	-2.4	9.38%	90.62%	1987	2014
Guinea	-0.4	-1.36%	101.36%	1999	2012
Guyana	0.3	27.78%	72.22%	2005	2009
Haiti	-1.3	13.02%	86.98%	1994	2012
Honduras	-0.4	20.83%	79.17%	2005	2011
India	-0.7	4.52%	95.48%	1992	2005
Indonesia	-0.5	15.00%	85.00%	1987	2012
Jordan	-2.1	4.93%	95.07%	1990	2012
Kazakhstan	-0.5	8.71%	91.29%	1995	1999
Kenya	-3	22.70%	77.30%	1989	2015
Kyrgyz Republic	0.2	-56.87%	156.88%	1997	2012
Lesotho	-0.2	97.16%	2.84%	2004	2014
Liberia	-2	20.83%	79.17%	1986	2013
Madagascar	-1.7	-18.15%	118.15%	1992	2013
Malawi	-2.3	2.27%	97.73%	1992	2015
Mali	-0.8	-4.40%	104.40%	1987	2015
Morocco	-2.1	4.89%	95.11%	1987	2003
Mozambique	0.7	-38.10%	138.10%	1997	2011

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Country	Change in fertility	Between effect	Within effect	First year	Last year
Namibia	-1.8	25.03%	74.97%	1992	2013
Nepal	-2	4.76%	95.24%	1996	2011
Nicaragua	-0.4	0.00%	100.00%	1998	2001
Niger	0.6	-15.24%	115.24%	1992	2012
Nigeria	-1	11.28%	88.72%	1990	2015
Pakistan	-1.1	4.85%	95.15%	1990	2012
Peru	-1.5	9.17%	90.83%	1986	2012
Philippines	-1.1	1.71%	98.29%	1993	2013
Rwanda	-2	5.46%	94.54%	1992	2014
Senegal	-1.4	21.92%	78.08%	1986	2014
Sierra Leone	-0.2	14.32%	85.68%	2008	2013
Tanzania	-1	17.94%	82.06%	1991	2015
Togo	-1.6	10.31%	89.69%	1988	2013
Turkey	-0.3	33.33%	66.67%	1993	2003
Uganda	-1.7	17.44%	82.56%	1988	2014
Vietnam	-0.4	-3.89%	103.89%	1997	2002
Yemen, Rep.	-3.3	12.01%	87.99%	1991	2013
Zambia	-1.2	-2.32%	102.32%	1992	2013
Zimbabwe	-1.4	11.48%	88.52%	1988	2015

Notes: The table reports the overall decline in fertility, the percentage of the change due to the between-area effect (urbanisation effect) and within-area-effect, and the years over which the overall change is calculated. Data on total and urban and rural fertility rates are obtained from the Demographic and Health Surveys. Proportion of urban population is calculated as $\lambda_{u,t} = \frac{F_t - F_{r,t}}{F_{u,t} - F_{r,t}}$.

Chapter 4

The Large Fall in Global Fertility: A Quantitative Model

4.1 Introduction

Most developing countries experienced remarkable declines in total fertility rates (TFR) over the past few decades. The world's average TFR declined steadily during this period, falling from 5 children per woman in 1960 to 2.4 in 2015. This decline in fertility is not skewed by the experience of a few countries. In 1960, more than half of the countries in the world experienced fertility rates greater than 6. By 2015, the median TFR was 2.2 children per woman. Interestingly, the rapid decline in fertility has taken place in countries at widely different levels of development.

In the previous chapter, we have argued that while socioeconomic factors play an important role in the worldwide fertility decline, the timing and speed of the decline over the past five decades suggests that the population control policies implemented in many developing countries over this period might have played a significant role in accelerating the process. The design of population-control programmes consisted of two main parts. The first was the diffusion of contra-

ceptive supply and information. The second was the implementation of public campaigns aimed at reversing pro-natalist attitudes and establishing a new small-family norm. We argued that the second strategy of employing public campaigns to reduce desired levels of fertility was critical in complementing contraceptive provision.

To analyse the rapid decline in fertility, we study a model of endogenous fertility and human capital accumulation, augmented to include a role for endogenously evolving social norms on family size. In the model, individuals derive utility from both the quantity and "quality" of children and dislike deviating from the social norm on the number of children, where the norm is a weighted average of the fertility of the previous generation and the replacement level of fertility, which is close to two.[1]

Calibrating the model's structural parameters and initial conditions to match key moments in the data for developing countries in 1960, we use the model to simulate the transition to the steady-state levels of fertility and human capital. While the baseline model with no role for norms is able to endogenously generate a slight decline in fertility, we find that incorporating social norms into the model generates a much larger decline.

We then simulate the effect of population-control policies on family-size norms using information on funding for family-planning programmes. In particular, we allow the weight placed on the fertility of the previous generation - family size is greatly influenced by the family of origin - to decline with the intensity of these programmes, given that the majority of these programmes advocated having two children. We also consider several alternative mechanisms that might explain the fertility decline, including the fall in infant and child mortality and improvements in contraceptive technologies (the second component of the population-control policies). The model allows us to gauge quantitatively the role played by these different channels - human capital accumulation,

[1]We follow the literature's jargon, where "quality" relates to the level of human capital of the individual.

declining infant mortality, improved control over fertility, and reductions in the social norm on family size - in generating the fertility decline.

We find that the baseline model without norms generates a small decline in fertility. The inclusion of endogenously evolving social norms on fertility can generate a decline in fertility which is twice as large as the decline generated by the baseline mode, but still not enough to replicate the large declines in the data. We find that policies aimed at altering family-size norms significantly accelerate and strengthen the decline in fertility that would have otherwise gradually taken place as economies move to higher levels of human capital, lower levels of infant mortality, and higher supplies of contraceptive technologies.

The rest of the paper is organized as follows. Section 4.2 describes the model and Section 4.3 explains the calibration strategy. Section 4.4 presents the main results of the paper and Section 4.5 studies various extensions. Section 4.6 presents concluding remarks.

4.2 The Model

This Section studies a simple quantitative model of endogenous human capital and fertility choice. The goal is to gauge the impact of human capital accumulation and population-control policies on the rapid fall in fertility experienced by most developing countries in recent decades. The model builds on the Barro-Becker framework of fertility choice, incorporating human capital investment (see Barro and Becker 1989; Galor and Weil, 2000; Galor and Moav, 2002; Moav, 2005). We sequentially extend the analysis along many dimensions. First and foremost, we augment the model by introducing social norms on family size, which were a key target of population-control policies in developing countries.

Our modelling of adherence to social norms borrows from the literature on

social distance and conformity (Jones 1984, Akerlof 1997) in that individuals derive disutility from a function of the distance between their realised fertility and the social norm.[2]

We define the social norm on fertility as a weighted average of the fertility rate of the previous generation and the replacement level of fertility. The first term draws from the sociology literature that discusses the importance of reference groups in forming fertility norms (e.g. Clay and Zuiches 1980). Norms on family size are highly influenced by the family of origin.[3] We choose the replacement level as the second term in the average based on the observation that most economies appear to be converging to a similar focal point for fertility, currently just about two children per woman. This endogenously evolving norm naturally leads to a decline in fertility that is larger than that generated in a model without social norms. In this baseline model, we assume households perfectly control fertility. We model the impact of the family planning programmes and their mass communication strategies as an increase in the weight placed on the replacement level of fertility, causing the social norm on family size to shift downwards, accelerating the decline even more.

In further extensions of the model we also consider the role played by the overall fall in mortality rates. In a setting in which there is child mortality and uncertainty about how many children survive to adulthood, we find that the decline in mortality alone is not sufficient to explain the fall in fertility observed over the past few decades.[4] The decline in mortality rates did seem

[2]We deviate from the existing work on the impact of social norms on fertility in how we model social norms. Munshi and Myaux (2005), Palivos (2001) and Bhattacharya and Chakraborty (2012) model norms as the outcome of strategic decisionmaking and interaction, We take a simpler specification that is more amenable to quantification and in line with the literature on external habits or reference dependence.

[3]The impact of parental fertility on their children's fertility is also explored in the demography literature, focusing on developed countries. For example, Thornton 1980, Murphy 1999 and Kolk 2014.

[4]This point was previously made by Doepke (2005). Becker and Barro (1988)'s model predicts that when mortality rates decrease, the total fertility rate falls, but the number of surviving children remains the same. In survey data, we observe a decline not only in fertility rates, but also in the desired number of children. Kalemli-Ozcan (2002) introduces a precautionary motive to have children; in that context, a decline in mortality reduces both the fertility rate and the number of (desired) surviving children.

to have played an important role in triggering population-control policies, but it is unlikely to have fueled the fast fall in fertility through individual or decentralised responses, without the policy intervention. A second extension considers the case in which households cannot directly control fertility rates (contraception technologies are either not available or imperfect) and the role played by increased access to contraception (the second main component of population-control policies).

We do not explicitly model the possibility that children provide their parents with transfers in their old age, but our modelling choices can be recast in those terms, as parents care about their children's future earning capacity.[5] In what follows, we describe the model in more detail, specifying technologies and preferences.

4.2.1 Model setup

We consider an overlapping generation economy in which individuals live for two periods: childhood and adulthood. In each period, the economy produces a single consumption good using the productive capacity of the working adults and a fixed factor as inputs, where the supply of the fixed factor is exogenous. The human capital stock is determined by the fertility and educational choices of individuals.

4.2.2 Technology

Production occurs according to a constant returns to scale production technology. Using the specification in Galor and Weil (2000), output at time t, Y_t is

$$Y_t = ((\bar{H} + H_t)L_t)^{\rho}(A_t X)^{1-\rho}, \qquad 0 < \rho < 1 \tag{4.1}$$

[5]There is a growing literature which addresses these inter-generational transfers explicitly (see for example Boldrin and Jones 2002, Coeurdacier, Guibaud and Jin 2014, Choukhmane, Coeurdacier and Jin 2014).

where $\bar{H} + H_t$ is the productive capacity of a worker, L_t is the working age population, X is the fixed factor and A_t is the technology at time t, with $A_t X$ referring to "effective resources". The term $\bar{H}$ is a physical labour endowment all individuals are born with and H_t is human capital produced with investments in schooling.

Output per worker at time t, y_t, is

$$y_t = ((\bar{H} + H_t))^{\rho} x_t^{1-\rho}, \tag{4.2}$$

where $x_t = A_t X / L_t$ is the effective resources per worker at time t.

As in Galor and Weil (2000), we assume that the return to the fixed factor is zero. This assumption helps to keep the model simple so that the only source of earnings for households is labour income, which is true for many households in developing countries. X can then be interpreted as some productive public good which does not yield private returns to the citizens. (Galor and Weil (2000)'s interpretation is that there are no property rights over this resource in the country). Alternatively, as in Cespedes and Velasco (2012), one can think of X as being owned by a small group of "elite" individuals, who spend all the returns from X abroad (and whose behaviour we do not consider in our model).

The return to productive labour, w_t, is then given by its average product:

$$w_t = \left(\frac{x_t}{(\bar{H} + H_t)} \right)^{1-\rho} \tag{4.3}$$

4.2.3 Households

Each household has a single decision maker, the working adult. Individuals within a generation are identical. Children consume a fraction of their parents' time. Working adults supply labour inelastically, decide on their consumption, the number of children, and their education in period t.

Parents are motivated by altruism towards their children but are conscious of the social norm on the number of children that a family should have. As such, while parents derive utility from their children (both the quantity and the quality), they derive disutility from deviating from the social norm. The utility function for a working age individual of generation t can be expressed as:

$$U_t = u(C_t;\ n_t;\ q_{t+1}) - \varphi g(n_t, \hat{n}_t), \tag{4.4}$$

where u is a standard utility function over three goods: C_t, denoting consumption at time t, n_t, which denotes the number of children, and q_{t+1}, which indicates the quality of children as measured by their future earning potential. Following Galor and Weil (2000) and Moav (2005), we assume $q_{t+1} = w_{t+1}(\bar{H} + H_{t+1})$, where w_{t+1} is the future wage per unit of productive labour of a child, and $\bar{H} + H_{t+1}$ is the productive capacity of a child. The factor $\varphi > 0$ governs the disutility from deviating from the social norm and $g(n_t, \hat{n}_t)$ is a function of the deviation of the chosen number of children, n_t, from the social norm on family size, $\hat{n}_t$, where $g_{11}(n_t, \hat{n}_t) > 0$ and $g_{12}(n_t, \hat{n}_t) < 0$. The first condition implies that movements further away from the norm involve heavier penalties while the second implies that the marginal cost of the additional child is decreasing in the social norm. We model the social norm on family size as a weighted average between the previous generation's fertility, n_{t-1} and the replacement level of fertility, n^*, so that $\hat{n}_t$ can be expressed as:

$$\hat{n}_t = \phi n^* + (1 - \phi) n_{t-1}, \qquad 0 \leq \phi \leq 1 \tag{4.5}$$

The individual's choice of desired number of children and optimal education investment for each child is subject to a standard budget constraint. While parental income is given by $w_t(\bar{H} + H_t)$, we assume that a fixed fraction of income, τ_0, is spent on each child regardless of education while a discretionary education cost for each child, $\tau_1 h_t$, which is increasing in the level of education, h_t, is chosen by the parents. The remaining income is spent on consumption.[6]

[6]It is also possible to interpret the constraint as a restriction on the total amount of time

The budget constraint at time t is therefore,

$$C_t = [1 - (\tau_0 + \tau_1 h_t)n_t]w_t(\bar{H} + H_t) \tag{4.6}$$

Following Becker, Murphy, and Tamura (1990) and Ehrlich and Kim (2005), we specify the human capital production function as:

$$H_{t+1} = z_t(\bar{H} + H_t)h_t, \tag{4.7}$$

where $\bar{H} + H_t$ is the productive capacity of the parent, h_t is the educational investment (or schooling) in each child and z_t is the human capital production technology. This specification of productive capacity prevents perfect intergenerational transmission of human capital, allowing for positive levels of human capital even for children whose parents have no schooling ($H_t = 0$).

4.2.4 Equilibrium

In a competitive equilibrium, agents and firms optimally solve their problems and all markets clear. Let $v = (\bar{H} + H_t, n_{t-1})$. A competitive equilibrium for this economy consists of a collection of policy functions for households $\{C_t(v), n_t(v), h_t(v)\}$, and prices w_t such that:

1. Policy functions $C_t(v)$, $n_t(v)$, and $h_t(v)$ maximise

$$u(C_t; n_t; q_{t+1}) - \varphi g(n_t, \hat{n}_t)$$

   subject to the budget constraint (4.6), human capital production function (4.7) and $(C_t, n_t, h_t) \geq 0$;

2. w_t satisfies (4.3); and

available to work and have and raise children. In that case, τ_0 would be the fraction of time that has to be spent on raising a child regardless of the education level.

3. Markets clear such that:

$$C_t = [1 - (\tau_0 + \tau_1 h_t)n_t]y_t$$

4.3 Calibration

In the policy experiments that we carry out, we examine the transition of the economy from a given initial condition to a steady state level of fertility and human capital investment. Our calibration strategy, therefore, involves choosing structural parameters and initial conditions so that the outcomes of the model in the first period match the appropriate moments for consumption, income, fertility, education and population in developing countries in 1960.[7] Since the economic agent in this model is an individual, the fertility rate in the model is one half of the total fertility rates in the data. Similarly, we interpret the units of investment in human capital per child, h_t, as years of education.[8] In addition, one period in the model corresponds to the length of a generation, around 25 years.

The data on household consumption, per capita GDP, working age population and fertility are obtained from the World Bank's World Development Indicators (WDI) dataset while the data on average years of education are taken from the Barro-Lee educational attainment datasets (Barro and Lee 2010, Barro and Lee 2015).

[7]We refer to all countries which were not classified as OECD countries prior to 1970 as developing countries in the starting period. 1960 is the first year for which cross-country data on fertility, income, education and consumption are available.

[8]The data available is the average years of education of the adult population (aged 25 and above). As such, the investment in education for children born in a given period is observed in the data as the average years of education of the adult population in the next period. I.e., if the length of a generation is 25 years, h_{1960} is given by the average years of education of the adult population in 1985.

4.3.1 Technology

We set the productive labour share of income, ρ, to 0.66. Estimates of total factor productivity in East Asian countries over the 1966-1990 period by Young (1995) indicate that on average, annual TFP growth over the period ranged from -0.003 in Singapore to 0.024 in Taiwan. As such, we will assume a constant annual TFP growth rate of 0.018 which is compounded to obtain the TFP growth rate between generations, g_A.[9] In addition, we assume that there is no growth in the technology used in human capital production, z_t.

4.3.2 Cost of childrearing

Household expenditure surveys report the fraction of household expenditure spent on education. In our model, this fraction is represented by $\tau_1 n_t h_t$. This ranges from 2.6 percent in India in 2007/08 to 5.5 percent in Singapore in 2012/13. However, the value for τ_1, calculated using corresponding values for n_t and h_t from the data, is much more uniform, around 0.3 percent.[10] We therefore set τ_1 to 0.003. We then use the household budget constraint to back out the value for τ_0, given the initial levels of income, consumption, fertility and education.

4.3.3 Preferences

We assume utility is additively log linear in consumption, the number of children, the quality of children and social norms:

$$U_t = \ln C_t + \alpha \ln n_t + \theta \ln[w_{t+1}(\bar{H} + H_{t+1})] - \varphi g(n_t, \hat{n}_t), \tag{4.8}$$

[9]Our specification of utility implies that the value of g_A affects the simulations only through the initial value for the human capital stock as wages do not have an effect on fertility or human capital investment decisions. Assuming $g_A = 0$ barely changes the results of the quantitative exercise.

[10]See Appendix E1 for the full set of countries and expenditure statistics.

where $\alpha > 0$ reflects preferences for children, $\theta > 0$ for child quality.

As noted in Akerlof (1997), the use of the absolute value of the difference between individual fertility and the social norm gives rise to multiple equilibria. We use a more tractable functional form given by:

$$g(n_t, \hat{n}_t) = (n_t - \hat{n}_t)^2,$$

where individuals derive disutility from deviating above as well as below the social norm and deviations in either direction are penalised symmetrically. In Section 4.5 we consider a different functional form which treats upward and downward deviations asymmetrically and find that the results are very similar.

Given these preferences, the first order condition for n_t is given by:

$$\frac{\alpha}{n_t} = \frac{(\tau_0 + \tau_1 h_t)}{1 - (\tau_0 + \tau_1 h_t) n_t} + 2\varphi(n_t - \hat{n}_t) \tag{4.9}$$

The FOC equates the marginal benefit of having children with the marginal cost. The first term on the right hand side is the marginal cost in terms of foregone consumption while the second term will be a cost if the additional child pushes the total number of children over the social norm.

The first order condition for h_t is

$$\frac{\theta z_t (\bar{H} + H_t)}{(\bar{H} + H_{t+1})} = \frac{\tau_1 n_t}{(1 - (\tau_0 + \tau_1 h_t) n_t)}, \tag{4.10}$$

where the right hand side is the marginal utility to the parent from giving her child an additional unit of education and the left hand side is the marginal cost in terms of foregone consumption.

Our specification of utility leaves us with three preference parameters (α, θ, and φ) to be calibrated. We also require initial values for H_t and z_t. We start by calibrating a baseline model in which individuals do not care about norms ($\varphi = 0$) and pin down α from the first order condition for n_t, using

the cross-country macro data for developing countries for 1960. We use the output growth in the economy to pin down $\frac{\bar{H}+H_{t+1}}{\bar{H}+H_t}$ (which we will refer to as g_H, hereafter). Then, for given values of z_t (which we choose to match the empirical estimates of the returns to schooling) and $\bar{H}$, we use the first order condition for h_t and the human capital production function to obtain values for θ and H_1, the level of human capital of parents in the initial period.[11]

4.3.4 Norms

We now use the first order condition for fertility from the full model (equation 4.9) to obtain a value for ϕ, for given values of φ and n_{t-1}. We do not have enough moments in the data to back out φ and, to the best of our knowledge, there are no empirical measures of this parameter. Therefore, we set $\varphi = 0.1$ (the estimates of φ for later periods indicate that this value is reasonable). While data on fertility rates in developing countries prior to 1960 is scarce, we set n_0 to 3.5 (meaning seven children per woman - recall that in the model n_t is fertility per household) based on estimates of fertility for several non-European countries in the early twentieth century provided by Therborn (2004). Finally, the replacement level of fertility, n^*, is set to 1, reflecting a replacement level fertility rate of 2. Table 4.1 summarises the results of the calibration exercise.

4.3.5 Estimating the change in ϕ

We model the role of population control policies in changing the social norms on family size by an increase in ϕ. In order to estimate the value of ϕ in

[11] Rearranging the human capital production function gives:

$$H_t = (\frac{1}{g_H - z_t h_t} - 1)\bar{H}$$

where $g_H = \frac{\bar{H}+H_{t+1}}{\bar{H}+H_t}$. In order to obtain $H_t > 0$, it is required that $\frac{g_H - 1}{h_t} < z_t \leq \frac{g_H}{h_t}$. Using values for g_H and h_t from the data, we can obtain an upper and lower bound for z_t.

The Mincerian return to schooling is given by $\frac{\rho z_t}{g_H}$ in our model. Setting z_t close to the lower bound implies a return to an additional year of education of around 0.1, which is in line with the empirical estimates of the returns to schooling.

Table 4.1: Calibration of structural parameters

	Value	Description/Source
Parameters		
ρ	0.66	Productive labour share of output
g_A	1.56	TFP growth (Young 1995)
τ_0	0.04	Targeted to match household consumption in 1960
τ_1	0.003	Targeted to match share of household expenditure on education
g_H	2.61	Targeted to match per capita output and population growth
α	0.18	Targeted to match fertility rate of 5.96 in 1960 in baseline model
θ	0.06	Targeted to match years of education of 3.67 in 1960
φ	0.1	Disutility from deviating from social norm on fertility
ϕ	0.21	Targeted to match fertility rate of 5.96 in extended model
n^*	1	Corresponds to a replacement rate of fertility of 2
Initial conditions		
$\bar{H}$	1	Labour endowment
n_0	3.5	Targeted to match fertility rates in developing countries in early 20th century
z	0.44	Targeted to match returns to schooling of 0.1
H_0	0.004	Obtained from human capital production function, given g_H

Notes: The table reports the calibrated parameter values and initial conditions and the sources from which they are obtained.

subsequent periods, we estimate, by ordinary least squares, the first order condition for fertility using data for 2010, holding all parameters other than ϕ and φ constant. In other words, only preferences on how much individuals care about conforming to social norms and the weight placed on the replacement rate of fertility are allowed to change. In addition, we model ϕ as a function of the intensity of family planning programmes. Specifically, we set $\phi = \phi_0 + \phi_1 P$, where P is family planning programme intensity, measured by the logarithm of per capita funds for family planning, with the data on family planning funds compiled from Nortman and Hofstatter (1978), Nortman (1982), and

Ross, Mauldin, and Miller (1993). This gives rise to the following estimable equation:

$$\frac{\alpha}{n_t} - \frac{(\tau_0 + \tau_1 h_t)}{1 - (\tau_0 + \tau_1 h_t) n_t} = 2\varphi(n_t - n_{t-1}) + 2\varphi\phi_0(n_{t-1} - n^*) + 2\varphi\phi_1 P(n_{t-1} - n^*) \tag{4.11}$$

We estimate this equation using data on fertility, consumption and GDP per capita for 2010 and the average value of per capita funds for family planning over the 1970-2000 period.[12] Ideally, P would be the total spending per capita on family planning programmes over this period. However, given that for many countries we have only have data for one or two years, we use average per capita funding over the period 1970-2000. Note that this exercise is an attempt to recover a reasonable numerical estimate for ϕ which can be used in the quantitative analysis, rather than to establish a causal link between the family planning programmes and fertility.

The estimation of Equation 4.11 provides us with values for φ, ϕ_0, and ϕ_1. We find that the coefficients of the first and third terms in the equation (corresponding to 2φ and $2\varphi\phi_1$) are significantly different from zero and that the obtained values for φ, ϕ_0, and ϕ_1 have the expected signs and magnitudes (see Table 4.2). The value of φ is 0.36, indicating that our initial calibration of 0.1 is not unreasonable, allowing for an increase in the importance placed on adhering to norms over time. We calculate ϕ at the sample average of P to obtain a value of 0.44, which shows that the weight on n^* has doubled over the past fifty years.

[12]The budget constraint gives $\frac{(\tau_0+\tau_1 h_t)}{1-(\tau_0+\tau_1 h_t)n_t} = \frac{w_t(\bar{H}+H_t)}{C_t} - 1 = \frac{y_t}{C_t} - 1$.

Table 4.2: Estimation of φ and ϕ

Parameter	Value
φ	0.36
	(0.001)
ϕ_0	0.07
	(0.410)
ϕ_1	0.1
	(0.057)
ϕ $(= \phi_0 + \phi_1 \bar{P})$	0.44
Observations	52
R^2	0.27

Notes: The table reports the results from estimating Equation 4.11. The estimation is carried out using data on fertility, consumption and GDP per capita for 2010, and the average annual per capita spending on family planning over the 1970-2000 period. ϕ is calculated as $\phi = \phi_0 + \phi_1 \bar{P}$, where $\bar{P}$ is the sample average of per capita spending on family planning. Values in parentheses are p-values of the regression coefficients from which the values for φ, ϕ_0, and ϕ_1 are backed out and are based on robust standard errors.

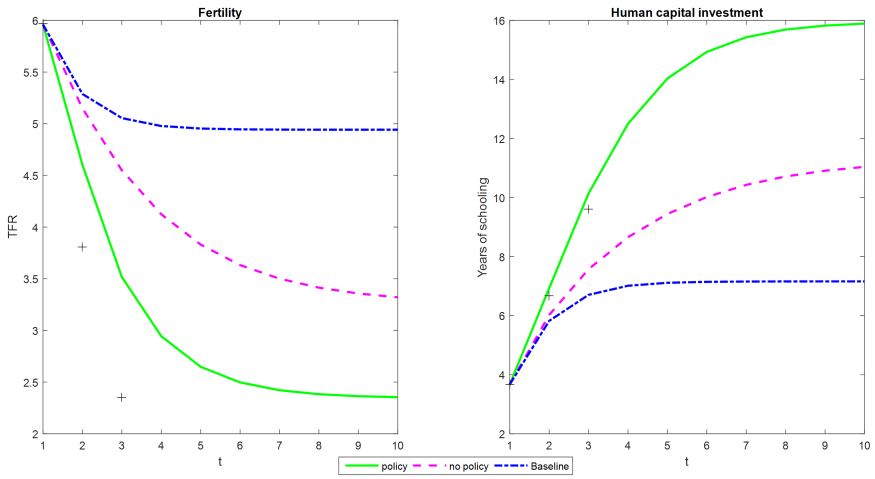
4.4 Results

The dynamics of fertility and human capital accumulation in the economy are governed by equations 4.5, 4.7, 4.9, and 4.10.[13] We now use the calibrated model to investigate how the two channels in our model, human capital accumulation and the presence of social norms on fertility, contribute to fertility decline. We begin from an initial level of human capital stock and fertility and examine the transition to a steady state.

We start by considering a baseline model in which individuals do not care about social norms ($\varphi = 0$) and the only mechanism by which fertility falls is the faster accumulation of human capital. We compare this model with our extended model of fertility and social norms. We consider two cases: the first in which ϕ and φ remain unchanged over time and the second in which ϕ and φ rise to the values estimated in the previous section (referred to as the model

[13]Note that since neither first order condition depends on w_t, the production side of the economy doesn't affect the dynamics of fertility and human capital.

Figure 4.1: Transition to steady state



Notes: The figure plots the path of fertility and investment in education for the different versions of the model. The dash and dot line corresponds to the baseline model where $\varphi = 0$. The dashed line represents the case where ϕ and φ remain unchanged over time, while the solid line represents changes in ϕ to 0.35 and 0.44 at $t = 2$ and $t = 3$, respectively and changes in φ to 0.25 and 0.36 at $t = 2$ and $t = 3$ respectively. The points marked by "+" refer to the values observed in the data where $t = 2$ is 1985 and $t = 3$ is 2010.

with policy changes). Since the estimated values are for 2010, we set ϕ and φ in 1985 to be in between the values of the initial calibration for 1960 and the estimated values for 2010. We do not impose any changes to the parameters after the third period.

Figure 4.1 shows the model's predicted path of TFR and investment in education (measured in years of education) under the different versions outlined above. The corresponding values in the data (only available for the first three periods for fertility and education) are marked by crosses.

The baseline model (given by the blue dash and dot line) in which individuals do not care about norms generates a very small decline in fertility. TFR falls to 5.3 in $t = 2$ and reaches a steady state of around 4.9 children per woman while investment in education rises to 5.8 years of schooling in $t = 2$ and reaches a steady state of roughly 7.2. The inclusion of social norms on fertility generates a larger decline in fertility, even when ϕ and φ remain unchanged. In this case, TFR falls from 6 children per woman to 3.6 within six generations and a steady state of 3.2 is reached after approximately ten periods. At the same time, human capital investment reaches a steady state of around 11 years

of schooling. The existence of endogenously evolving social norms on fertility is enough to generate a decline in fertility which is twice as large as the decline generated by the baseline model.

We now consider the effect of the population control policies (given by the green solid line), which we interpret as an increase in ϕ. As can be expected, the increase in ϕ (a larger weight placed on the replacement level of fertility) generates a much larger decline in fertility and increase in education, and a quicker convergence to the steady state. We allow ϕ to rise from 0.21 in $t = 1$ to 0.35 and then 0.44 in the two subsequent periods, which corresponds to a change in the norm on number of children from around 6 children in the initial period to around 3.4 by $t = 3$. Accordingly, the model predicts a decline in TFR to 3.4 at $t = 3$ and fertility reaches a steady state of 2.4 after 6 periods. At the same time, years of schooling rises from 4 to around 10 in just three generations. The increase in φ is less important, quantitatively, than the increase in ϕ. If we set the starting level of φ to 0.36, the resulting transition path is hardly different from that illustrated in Figure 4.1.

Comparing the results of the model with the data indicates that the inclusion of social norms with an increase in ϕ over time improves the predictions of fertility and years of schooling considerably. The model predicts years of schooling very well while predicting levels of fertility that are slightly higher than what is observed in the data. However, the predicted steady state level of fertility is close to two children per woman. Note that we do not allow ϕ and φ to change after $t = 3$. If we allowed ϕ to increase continuously over time, convergence to a low, steady-state level of fertility would be even faster. The changes in ϕ which would be required to exactly match the data would be an increase to 0.6 in $t = 2$ and then to 0.9 by $t = 3$. While we are estimating the change in ϕ captured by spending on family planning programmes, it is likely that when taking into account other factors such as increased access to mass media and modernisation, the actual increase in ϕ is larger than that estimated in this paper.

To summarise, this quantitative exercise points to the importance of changing social norms on family size for the decline in fertility observed in developing countries over the past few decades. We use data on family planning programme funds to capture the change in social norms brought about by these programmes which were widely adopted in developing countries during this period. The results suggest that the change in social norms brought about by these programmes accelerated the fertility decline considerably. While this confirms the results presented in Chapter 2, it is also consistent with empirical studies that find evidence of the effectiveness of public persuasion measures in reducing fertility (La Ferrara, Chong and Duryea 2012 and Bandiera et al. 2014).

4.5 Extensions and robustness checks

In this section we discuss a number of extensions of the model. First, we extend the model to allow a role for declining infant and child mortality in the fertility fall. Next, we incorporate imperfect control over fertility, allowing for a role for improvements in contraceptive technologies. Finally, we consider the effect of changing the specification of disutility from deviating from the norm, allowing upward and downward deviations to be treated asymmetrically.

4.5.1 Including mortality

The model presented in the previous section did not take into account the mortality decline observed in developing countries during this period. In this section, we extend our model to include uncertainty regarding the number of children that survive to adulthood. We then investigate the impact of an increase in survival rates on fertility and human capital investment. We follow Kalemli-Ozcan (2003) in how we incorporate mortality into the model.[14]

[14]In the original Barro-Becker (1989) framework, child mortality is modeled as an explicit cost of childrearing. Doepke (2005) studies three variations of this model: a baseline model

Parents choose a number of children, n_t, but only N_t of the infants survive to childhood and all children survive to adulthood. Parents spend on rearing and educating their surviving children and derive utility from the quantity and quality of these children.[15] In addition, parents care about how the number of their surviving children compares with the social norm on family size. The utility function for an adult of generation t can then be written as:

$$E_t U_t = E_t \ln C_t + \alpha \ln N_t + \theta \ln[w_{t+1}(\bar{H} + H_{t+1})] - \varphi(N_t - \hat{N}_t)^2 \qquad (4.12)$$

where $\hat{N}_t = \phi n^* + (1-\phi)N_{t-1}$ is the norm on family size.

Expected utility is maximised with respect to

$$C_t = [1 - (\tau_0 + \tau_1 h_t)N_t]w_t(\bar{H} + H_t) \qquad (4.13)$$

and the human capital production function (4.7).

As in Kalemli-Ozcan (2003), N_t is a random variable drawn from a binomial distribution, with $s_t \in [0,1]$ the survival probability of each infant. We use a second order approximation of the expected utility function around the mean value of N_t, $n_t s_t$. The approximated expected utility function is given by:

$$E_t U_t = E_t \left\{ \begin{array}{c} \ln[(1 - (\tau_0 + \tau_1 h_t)n_t s_t)w_t(\bar{H} + H_t)] + \\ \alpha \ln(n_t s_t) + \theta \ln[w_{t+1}(\bar{H} + H_{t+1})] \\ -\varphi(n_t s_t - \hat{N}_t)^2 - \frac{n_t s_t(1-s_t)}{2}[\left(\frac{(\tau_0+\tau_1 h_t)}{(\tau_0+\tau_1 h_t)n_t s_t)}\right)^2 + \frac{\alpha}{(n_t s_t)^2} + 2\varphi] \end{array} \right\} \qquad (4.14)$$

which incorporates the budget constraint (4.13). The last three terms represent the disutility arising from uncertainty in the number of infants that survive to

where fertility choice is continuous and there is no uncertainty over the number of surviving children, which is contrasted with an extension involving discrete fertility choice and stochastic mortality and another with sequential fertility choice. He finds that while the total fertility rate falls as child mortality declines in each model, the number of surviving children increases, and concludes that factors other than declining infant and child mortality were responsible for the fertility transition observed in industrialised countries.

[15] This is a slight deviation from Kalemli-Ozcan (2003) where education is provided before the uncertainty is realised.

adulthood.

The first order conditions for fertility and human capital investment become:

$$\frac{\alpha}{n_t}(1+\frac{(1-s_t)}{2n_t s_t}) = \begin{array}{c} 2\varphi s_t(n_t s_t - \hat{N}_t) + \varphi s_t(1-s_t) + \\ \frac{(\tau_0+\tau_1 h_t)s_t}{1-(\tau_0+\tau_1 h_t)n_t s_t}\left[1+\frac{1+(\tau_0+\tau_1 h_t)n_t s_t}{2(1-(\tau_0+\tau_1 h_t)n_t s_t)}\frac{(\tau_0+\tau_1 h_t)(1-s_t)}{(1-(\tau_0+\tau_1 h_t)n_t s_{t)}}\right] \end{array} \quad (4.15)$$

$$\frac{\theta z_t(\bar{H}+H_t)}{(\bar{H}+H_{t+1})} = \frac{\tau_1 n_t s_t}{(1-(\tau_0+\tau_1 h_t)n_t s_t)}\left[1+\frac{(\tau_0+\tau_1 h_t)(1-s_t)}{(1-(\tau_0+\tau_1 h_t)n_t s_t)^2}\right] \quad (4.16)$$

The key difference between this setup and that in Section 4.2 is that there is now an additional term in the marginal cost of both fertility and schooling which reflects the cost of uncertainty.

Calibration and results

The calibration exercise is carried out in the same way as before - we start from a model with mortality and no norms to back out all the parameters except ϕ and then use the extended model with norms and mortality to get an initial value for ϕ. We use the mortality rate for children below 5 years of age (measured as the number of deaths of children below 5 years of age per 1000 live births) for developing countries in 1960 (from the WDI database) as a measure of $1-s_t$. The re-calibration causes τ_0, α, θ, and ϕ to change. τ_0, α and θ change by very little (to 0.05, 0.17 and 0.05, respectively) whereas ϕ changes to 0.02, much lower than the $\phi = 0.21$ obtained for the model without mortality.

To identify the change in ϕ and φ over the past two periods, we carry out the same estimation exercise as before, again setting $\phi = \phi_0 + \phi_1 P$ but now using Equation 4.15. We see an increase in ϕ and φ, with a much larger relative increase in the value of ϕ than in the model without mortality. Table 4.3 shows the values of the parameters obtained from the estimation.

Table 4.3: Estimation of φ and ϕ with mortality

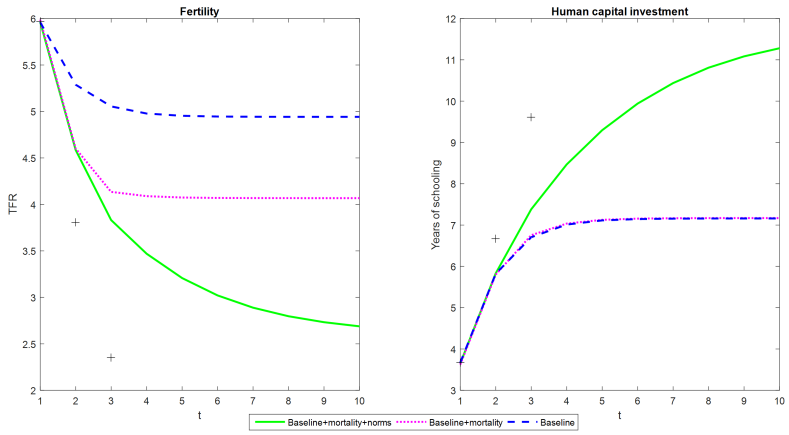
Parameter	Value
φ	0.29
	(0.006)
ϕ_0	-0.32
	(0.118)
ϕ_1	0.15
	(0.096)
ϕ $(= \phi_0 + \phi_1 \bar{P})$	0.21
Observations	50
R^2	0.37

Notes: The table reports the results from estimating Equation 4.15. The estimation is carried out using data on fertility, child mortality rates, consumption and GDP per capita for 2010, and the average annual per capita spending on family planning over the 1970-2000 period. ϕ is calculated as $\phi = \phi_0 + \phi_1 \bar{P}$, where $\bar{P}$ is the sample average of per capita spending on family planning. Values in parentheses are p-values of the regression coefficients from which the values for φ, ϕ_0, and ϕ_1 are backed out and are based on robust standard errors.

We then plot the transition paths of fertility and human capital to their steady states for three cases: the baseline model with no norms or mortality (given by the blue dashed line), the model with falling mortality rates and no norms (given by the pink dotted line), and the extended model of mortality and social norms (given by the green solid line). We allow s_t to rise over time from 0.78 in $t = 1$ to 0.91 and 0.96 in $t = 2$ and $t = 3$ as seen in the data. As before, since the estimation of ϕ and φ was for 2010, values of ϕ and φ for 1985 are set to be in between the values of the initial calibration for 1960 and the estimates for 2010, and do not change after the third period.

As figure 4.2 shows, the incorporation of mortality into the baseline model generates a larger decline in fertility than the baseline model which only includes human capital accumulation with TFR converging to around 3.9 children per woman rather than 4.9. However, the two models are not very different in their predictions of human capital investment. This is because the decline in the number of surviving children is very similar in these two models (see Figure 4.3). In the baseline model that incorporates the mortality decline, the number

Figure 4.2: Incorporating mortality

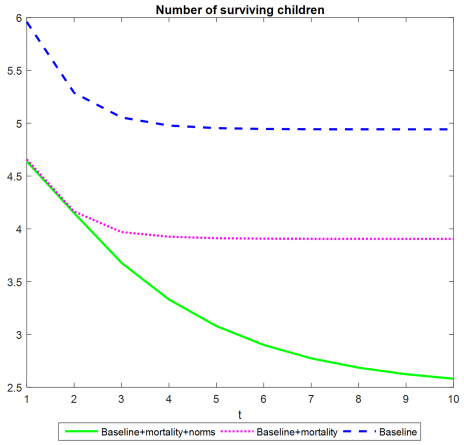


Notes: The figure plots the path of fertility and investment in education in the three versions of the model. The dashed line represents the baseline model with no mortality or social norms while the dotted line represents the baseline model augmented to include mortality where s_t rises to 0.91 at t=2, and to 0.96 at t=3, where it remains in all successive periods. The solid line represents the model with mortality and social norms. Here, s_t rises as described earlier while ϕ rises to 0.15 and 0.21 in the second and third periods, while φ rises to 0.2 and 0.28. The points marked "+" refer to the values observed in the data.

of surviving children drops from 4.7 to just 3.9 (compared to the decline from 5.9 to 4.9 in the baseline model without mortality). By contrast, including a social norm which falls over time generates a large decline in the number of surviving children - a drop from 4.6 to 2.6. Given that the investment in schooling is made for surviving children, a smaller decline in surviving children leads to a smaller increase in the years of schooling.

Our modelling of mortality, which is based on Kalemli-Ozcan (2003), allows the mortality decline to generate a decline in fertility through a hoarding effect, where the risk of child mortality results in a precautionary demand for children. The decline in fertility generated by the decline in social norms is slightly smaller than that in the model described in the previous section because uncertainty about the number of surviving children leads to higher fertility as an insurance against infant mortality. However, the presence of social norms that decline over time still leads to a significant acceleration in the fertility decline, indicating that the mortality transition cannot rule out the role of the population control policies in the fertility fall. Taken as a whole, we would argue that while the decline in mortality rates did play an important role in triggering

Figure 4.3: Number of surviving children



Notes: The figure plots the number of surviving children predicted by the three versions of the model. The dashed line represents the baseline model with no mortality or social norms while the dotted line represents the baseline model augmented to include mortality where s_t rises to 0.91 at t=2, and to 0.96 at t=3, where it remains in all successive periods. The solid line represents the model with mortality and social norms.

the introduction of population-control policies, its role in precipitating the fast fall in fertility through individual responses, without the policy intervention, is less clear.

4.5.2 Incorporating unwanted fertility

So far we have simulated the effect of population control policies on the fertility decline by focusing on their role in changing the norm on family size. We now extend the model such that individuals do not perfectly control fertility. In other words, we allow the lack of contraceptive technologies to cause a discrepancy between the desired and actual number of children.[16] This allows us to examine the impact of a reduction in unwanted fertility caused by the introduction of widespread modern contraceptives, which was the second main component of the population control policies.

We do not explicitly model the choice of contraceptive usage (see, for example, Cavalcanti, Kocharkov and Santos (2017)) but consider individuals' ability to

[16]The key difference between this and the mortality extension is that now individuals face the risk of overshooting their desired number of children whereas in the case of uncertainty about mortality, individuals faced the risk of ending up with less children than they wanted.

control fertility to be exogenously determined. So while the production side of the model is the same as before, we now assume that parents' inability to perfectly control their fertility leads to a distinction between the desired or chosen number of children, n_t^d, and the actual number of children, n_t^a. Specifically,

$$n_t^a = n_t^d + \varepsilon_t,$$

where ε_t is a stochastic error term causing the desired number of children, n_t^d, to differ from the actual number of children, n_t^a.

Individuals now have to maximize expected utility which, for an adult of generation t is given by:

$$E_t U_t = E_t[\ln C_t + \alpha \ln n_t^a + \theta \ln[w_{t+1}(\bar{H} + H_{t+1})] - \varphi(n_t^a - \hat{n}_t)^2], \qquad (4.17)$$

where E_t denotes expectations as of time t.

Individuals maximize expected utility with respect to the human capital production function (same as before) and the budget constraint, which is now changed slightly to

$$C_t = [1 - (\tau_0 + \tau_1 h_t) n_t^a] w_t(\bar{H} + H_t) \qquad (4.18)$$

The formulation of the expected utility function requires some distributional assumptions about unwanted fertility, ε_t. The data on wanted fertility rates in developing countries (obtained from Demographic and Health Surveys) indicates that ε_t is usually positive and has a positively skewed distribution. As such, we assume that ε_t follows a Poisson distribution with mean λ. Thus, a reduction in λ translates to a reduction in uncertainty as well as average unwanted fertility. We then carry out a second order approximation of the expected utility around the mean of unwanted fertility. Substituting in the budget constraint and human capital production function, the household problem

can be rewritten as:

$$\{n_t^d, h_t\} = \arg\max \left\{ \begin{array}{c} \ln[(1-(\tau_0+\tau_1 h_t)(n_t^d+\lambda))w_t(\bar{H}+H_t)] \\ +\theta \ln[W_{t+1}(\bar{H}+z_t(\bar{H}+H_t)h_t)] \\ +\alpha \ln[n_t^d+\lambda] - \varphi(n_t^d+\lambda-\hat{n}_t)^2 \\ -\frac{\lambda}{2}[\frac{(\tau_0+\tau_1 h_t)^2}{(1-(\tau_0+\tau_1 h_t)(n_t^d+\lambda))^2} + 2\varphi + \frac{\alpha}{(n_t^d+\lambda)^2}] \end{array} \right\} \quad (4.19)$$

subject to: $(n_t^d, h_t) \geq 0$.

The first order conditions for n_t^d and h_t are given by

$$\frac{\alpha}{n_t^d+\lambda} = \begin{array}{c} \frac{(\tau_0+\tau_1 h_t)}{(1-(\tau_0+\tau_1 h_t)(n_t^d+\lambda))} + 2\varphi(n_t^d+\lambda-\hat{n}_t) + \\ \lambda[\frac{(\tau_0+\tau_1 h_t)^3}{(1-(\tau_0+\tau_1 h_t)(n_t^d+\lambda))^3} - \frac{\alpha}{(n_t^d+\lambda)^3}] \end{array} \quad (4.20)$$

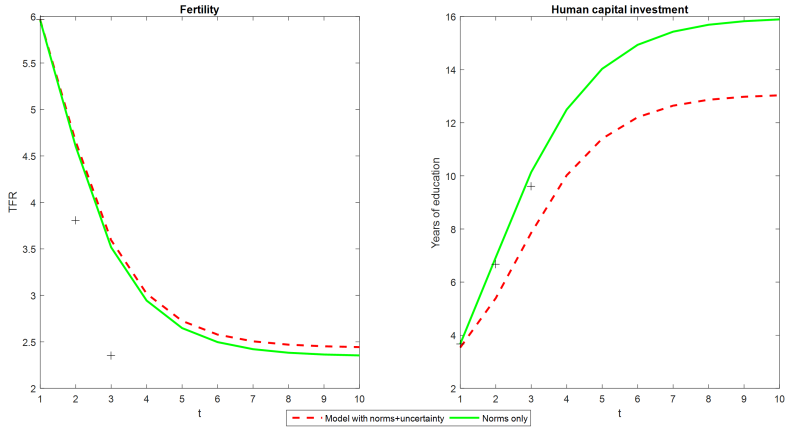
$$\frac{\theta z_t(\bar{H}+H_t)}{(\bar{H}+H_{t+1})} = \frac{\tau_1(n_t^d+\lambda)}{(1-(\tau_0+\tau_1 h_t)(n_t^d+\lambda))} + \lambda[\frac{\tau_1(\tau_0+\tau_1 h_t)}{(1-(\tau_0+\tau_1 h_t)(n_t^d+\lambda))^3}] \quad (4.21)$$

where the last term on the right hand side in Equation 4.21 reflects the cost of uncertainty. Since parents derive utility from all children (unwanted or not), the second line on the right hand side of Equation 4.20 reflects the cost of uncertainty adjusted for the gain in utility caused by having an extra child.

Calibration and results

The calibration strategy follows the same procedure as the main model, leaving parameters α, θ, τ_0, τ_1, g_H, ρ, n^*, and the initial conditions unchanged. However, ϕ needs to be recalibrated using Equation 4.20 for given values of φ and λ. λ is chosen using data on wanted fertility rates obtained from Demographic and Health Surveys which start in the late 1980s. Unwanted fertility (calculated as the difference between TFR and wanted fertility rate) is around 1 birth, on average, in the 1980s. Since this is well after the introduction of the oral contraceptive pill and the implementation of many family planning pro-

Figure 4.4: Incorporating unwanted fertility



Notes: The figure plots the path of fertility and investment in education in the two models. The dashed line represents the model with social norms and imperfect control over fertility while the solid line represents the model with only social norms. In both models ϕ rises to 0.35 and then 0.44 in the second and third periods. Similarly, φ rises to 0.25 and then 0.36. In the model with uncertainty, λ falls from 1 in the first period to 0.53 in the second, 0.28 in the third and then to 0.1, where it remains in all successive periods. The points marked by "+" refer to the values observed in the data.

grammes worldwide, we set initial λ to 1 (reflecting an average of 2 unwanted births). We then use Equation 4.20, to obtain the value of ϕ, with φ set to 0.1 as before. This gives us $\phi = 0.21$ which is the same as in the main model. As such, we allow ϕ and φ to rise to the same levels estimated in Section 4.3.5.

We then compare the transition paths of fertility and human capital for this extended model and the norms-only model using the same policy experiment of rising ϕ and φ, but also allowing λ to fall over time in the extended model. The fall in λ reflects the increased contraceptive prevalence over the past few decades. Using the data on wanted fertility we set λ to fall from 1 in the first period to 0.53 in the second, 0.35 in the third and then remain at 0.1 in all successive periods. Figure 4.4 plots the two transition paths.

As seen in Figure 4.4, predicted fertility in the two models is very similar, with the presence of unwanted fertility raising TFR slightly above the norms-only model. The main difference between the two models is in the predicted years of education. Uncertainty slows down the accumulation of human capital and keeps investment in education at a lower level than the norms-only model.

The comparison between the two models indicate that changing the norms on

fertility has a much larger effect on fertility decisions than merely increasing access to contraception. This is consistent with the fact that many of the family planning programmes supplemented their supply-side strategies of increasing access to contraception with large scale mass media campaigns to promote smaller family sizes. This point was made by demographers Enke (1960) and Davis (1967) at early stages of the global population control movement, and later by Becker (1992), who argued that family planning programmes focused on increasing contraceptive usage are effective only when the value of having children is lowered.

4.5.3 Functional form of disutility from deviation from the norm

We now consider the robustness of our results to an alternative specification for the disutility from deviating from the norm. In particular, we now use a functional form that treats upward and downward deviations from the norm asymmetrically with deviations below the norm being penalised more heavily than deviations above. This would be consistent with societal norms in developing countries where not having children is considered taboo. For this purpose, we set:

$$g(n_t, \hat{n}) = [\ln(n_t/\hat{n}_t)]^2$$

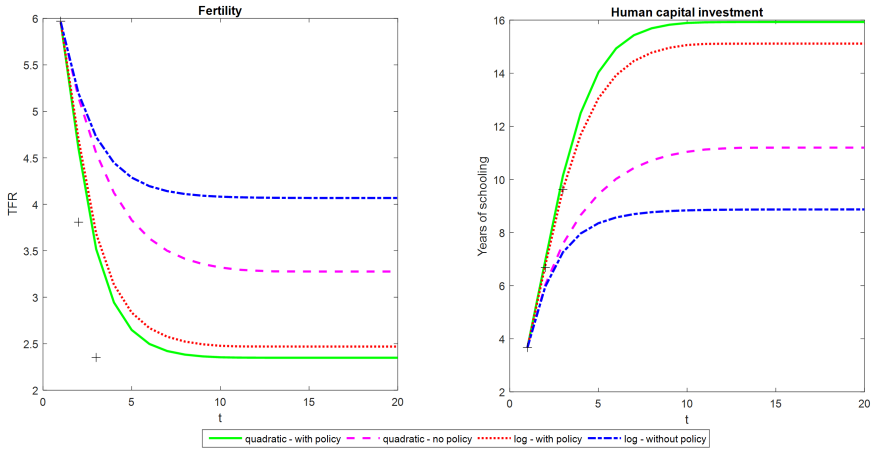
The first order condition for fertility changes to the following:

$$\frac{\alpha}{n_t} = \frac{(\tau_0 + \tau_1 h_t)}{(1 - (\tau_0 + \tau_1 h_t)n_t)} + 2\varphi \frac{1}{n_t} \ln(n_t/\hat{n}_t) \tag{4.22}$$

while the first order condition for human capital investment remains unchanged.

Under the same parameter values and initial conditions as in the previous section, we plot the transition paths of fertility and investment in human capital to their steady state values. We consider two experiments: one in which ϕ and φ increase and the other in which both parameters remain unchanged

Figure 4.5: Comparing functional forms



Notes: The figure plots the path of fertility and investment in education in the full model under two functional forms: quadratic disutility from norm deviation (main analysis) and log disutility from norm deviation. For each functional form we consider two experiments: one where ϕ and φ rise (to the levels estimated in Section 4.3.5 and the other where they remain unchanged. The solid and dashed lines correspond to quadratic disutility with and without policy changes, respectively. The dotted and dash-dot lines correspond to log disutility with and without policy changes. The points marked by "+" refer to the values observed in the data.

over time. We compare the results of this model with the results of the main model with quadratic disutility from deviating from the norm.

The results show that the two functional forms yield results that are qualitatively very similar. The decline in fertility is slightly smaller in the log disutility version (corresponding to the red dotted line), reflecting the increasing penalties for deviating below the norm. The results under the two functional forms show greater divergence when ϕ and φ remain unchanged. As described before, the model with quadratic disutility converges to a TFR close to 3.2 and approximately 11 years of schooling after around ten periods. However, the model with log disutility converges to a TFR of approximately 4.1 and just 8.8 years of schooling.

4.6 Conclusion

In this paper, we present a tractable model that allows us to quantitatively assess the role of different mechanisms driving the large declines in fertility experienced by developing countries over the past few decades. In particular, we examine the role of population-control policies aimed at affecting social norms and fostering contraceptive technologies. The model builds on the Barro-Becker framework of endogenous fertility choice, incorporating human capital accumulation and social norms over the number of children. Using data on several socio-economic variables as well as information on funding for family planning programmes to parametrise the model, we simulate the implementation of population-control policies. We also consider several extensions such as adding a role for the mortality decline and improvements in contraceptive technologies. The model suggests that, while a decline in fertility would have gradually taken place as economies move to higher levels of human capital and lower levels of infant and child mortality, policies aimed at altering the norms on family size significantly accelerate and strengthen the decline.

Appendices

Appendix E

1 Household spending on education

Country	$\tau_1 n_t h_t$	n_t	h_t	τ_1	Year	Source
India	0.026	1.4	5.94	0.003	2007/08	Tilak 2009
Singapore	0.055	0.6	11	0.008	2012/13	Singapore Dept. of Statistics 2014
Sub Saharan Africa	0.042	2.75	5.22	0.003	2001-08	Foko, Tiyab and Husson 2012
Sri Lanka	0.039	1.71	7.22	0.003	1980/81	Department of Census and Statistics
Sri Lanka	0.056	1.22	10.67	0.004	2012/13	of Sri Lanka 2015
Latin America and the Caribbean	0.019	1.1	8.71	0.002	2010	Regional Bureau of Education for Latin America and the Caribbean 2013
South Korea[a]	0.039	0.61	12.96	0.005	2012	OECD 2016a, OECD 2016c
Chile[a]	0.037	0.929	10.35	0.004	2012	OECD 2016a, OECD 2016c
Indonesia[a]	0.007	1.22	8.02	0.001	2012	OECD 2016a, OECD 2016c

Notes: The table reports the fraction of household expenditure spent on education and the backed out value for τ_1, which is the fraction of household expenditure spent per children per year of education using data for different countries and years. The sources for data on household expenditure on education in given in the last column while data for the corresponding years on fertility and years of schooling are obtained from the World Development Indicators and Barro-Lee datasets. Given that years of education are published at 5 yearly intervals, we choose the closest year for backing out τ_1.
[a] $\tau_1 n_t h_t$ calculated using private spending as a % of GDP and household expenditure as a % of GDP. Private spending on education excludes expenditure outside educational institutions such as textbooks purchased by families, private tutoring for students and student living costs so possibly underestimates household spending on education.

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