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The Impact of Female Education on Teenage Fertility: Evidence from Turkey

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Abstract

This paper explores the causal relationship between female education and teenage fertility by exploiting a change in the compulsory schooling law (CSL) in Turkey. Using variation in the exposure to the CSL across cohorts and variation across provinces by the intensity of additional classrooms constructed in the birth provinces as an instrumental variable, the results indicate that primary school completion reduces teenage fertility by 0.37 births and the incidence of teenage childbearing by around 25 percentage points. Exploring heterogeneous effects indicates that female education reduces teenage fertility more in provinces with lower population density and higher agricultural activity. Finally, the CSL postpones childbearing by delaying marriage, thereby reducing fertility.

JEL classification: I25, J13, O10

Keywords: Economic Development, Fertility, Female Education, Compulsory Schooling, Instrumental Variables, Turkey

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1 Introduction

Teenage childbearing adversely affects maternal and child well-being, including health, labor force participation, and earnings.[1] Consequentially, reducing teenage childbearing is a key factor in achieving the Millennium Development Goals (MDGs) of reducing poverty, improving maternal health, and empowering women. Development economists and institutions have emphasized the role of female education in fertility, health, and human capital formation, and investment in female education has been adopted as a development tool in many developing countries (Schultz, 1993). However, a thorough understanding of the causal relationship between female education and teenage fertility has lagged behind the enthusiasm for educational interventions as a tool to reduce teenage childbearing.

This paper uses exposure to a nationwide reform of compulsory education system in 1997 in Turkey, which extended the basic educational requirement from five to eight years (free of charge in public schools) as an instrumental variable. The main objective of the compulsory schooling law (CSL) was to increase the education level to universal standards to enter the European Union. In order to accommodate the increased number of primary school students, additional classes and schools were constructed, new teachers were recruited, and transportation was arranged for children living in rural areas, who are often far away from existing schools. The construction of more than 58,000 classrooms between the 1996/97 and the 1997/98 Academic Year varied across 80 provinces (on average, around 10 additional classrooms per 1,000 primary school aged children). The CSL led to a significant increase in the number of students in primary school between the 1996/97 and the 2000/01 Academic Years, by around 21% from 8.65 million to 10.48 million.[2] The CSL provides an ideal natural experiment, providing an instrument that varied the number of years of schooling, without significant curriculum changes, to identify the impact of schooling on

[1]See Angrist and Evans, 2000; Chevalier and Viitanen, 2003; among others.

[2]For educational statistics, see http://sgb.meb.gov.tr.

fertility.[3]

This paper demonstrates that the CSL had a significant immediate effect on female education, thereby providing a useful instrument for evaluating the impact of schooling on teenage fertility. Using variation in the exposure to the CSL across cohorts and variation across provinces by the intensity of additional classrooms constructed in the birth-provinces as an instrumental variable, I show that female schooling reduces teenage fertility by around 0.37 births. More specifically, a 10 percentage-point increase in the probability of completing primary school (eight or more than eight years of schooling) decreases fertility before 18 by around 44%. Moreover, primary school completion reduces the probability of teenage motherhood by around 25 percentage points. Further, the results are robust with respect to a rich set of controls. The effect is higher than the corresponding effect estimated by ordinary least squares (OLS), which suggests about a 11% reduction in teenage births. This difference may be a consequence of education impacting fertility greater for a subsample of women whose educational attainment has been affected by the CSL. Exploring heterogeneous effects indicates that female education reduces teenage fertility more in provinces with lower population density and higher agricultural activity. I also find that the effect of the educational policy operates through a delay in marriage, which in turn postpones childbearing.

The existing literature documents strong associations between education and child health and fertility, even after controlling for family and community background variables. (For a survey of the literature, see Strauss and Thomas, 1995.) However, the observed associations do not imply causality. Omitted variables (Berger and Leigh, 1989)–in particular ability (Griliches, 1977) and discount rates (Fuchs, 1982), which are highly correlated with both education and fertility decisions–may bias the relationship between education and fertility. Thus, studies treating education levels as exogenous fall short of answering the

[3] I discuss the features of the CSL in Section 2.

question of whether there is a causal relationship between education and fertility.

While there is a growing literature examining the causal effect of education on non-market outcomes, there are surprisingly few studies examining the effect of education on fertility in developing countries.[4] Part of the reason for this is difficulty in identifying natural experiments. Breierova and Duflo (2004) examine the effect of a primary school construction program in Indonesia (INPRES) on child mortality and fertility, using the number of schools constructed in the region of birth and exposure across age cohorts induced by the timing of the program as instrumental variables. Their results suggest that the average parental education is an important determinant of very early fertility (before the age of 15), whereas it is unimportant for early fertility (before the age of 25). Similarly, Osili and Long (2008) estimate the effect of female schooling on early fertility (before the age of 25) by exploiting regional and age differences in the exposure to an Universal Primary Education (UPE) program implemented for the non-Western regions of Nigeria. Using the state classroom construction funds per capita as a measure of program intensity, their results suggest that female education reduces the number of early births. Lavy and Zablotsky (2011) estimate the effect of women's education on fertility by exploiting locality and age differences in exposure to the end of the military rule which restricted the mobility of Arabs in Israel. Their results suggest that women's education reduces completed fertility. In a recent working paper, Kirdar et al. (2012) find that the compulsory schooling in Turkey reduces the probability of getting married and giving birth at young ages using a

[4]In the context of a developed country, a number of studies have investigated the causal relationship between female education and fertility using various approaches and find mixed results. Using compulsory schooling laws, Black et al. (2008) and Silles (2011) find that increased education reduce the incidence of teenage childbearing in the U.S. and Norway, and Great Britain and Northern Ireland, respectively. Using a German compulsory schooling reform, Cygan-Rehm and Maeder (2013) find that education reduces completed fertility. On the other hand, a few recent studies find insignificant effects of education on fertility using compulsory schooling laws in several European countries (see Monstad et al., 2008 and Geruso et al., 2011; among others). McCrary and Royer (2011) use age-at-school-entry policies in California and Texas, and find that education does not affect fertility. Fort et al. (2011) find a positive effect of education on fertility, using the schooling reforms in Europe.

hazard model. Moreover, Dinçer et al. (2013) find a significant effect of education on the number of total pregnancies and total births per ever-married woman using a change in the compulsory schooling law in Turkey as an instrument.[5]

This paper follows recent studies using instrumental variables (IV) and adds to the existing literature in several respects.[6] The primary contribution is to explore the impact of female education on teenage fertility in a society lacking female empowerment and facing very high teenage fertility rates prior to the CSL. According to the World Economic Forum Global Gender Gap Report, the Middle East and North Africa (MENA) have the lowest regional ranking in comprehensive gender equality, highlighting the importance of understanding the role of education in reducing gaps in health and economic opportunities. In particular, Turkey is ranked far worse than countries previously studied and has a unique set of social and cultural institutions that have historically disadvantaged women. Focusing on teenage fertilities is particularly important in the context of Turkey because while total fertility is close to the replacement fertility, teenage fertility was very high prior to the CSL. Following the CSL, teenage fertility declined by around 33 percent from the 1990s, suggesting that the policy might have significantly reduced teenage fertility.

Second, previous studies have investigated the impact of female education on fertility at markedly different points in the demographic transition; however, the role of policies is highly dependent on the stage of demographic transition. The case of Turkey provides an

[5]While working independently and without knowledge of each other's work, Dinçer et al. (2013) circulated a working paper around the same time a working paper for this paper was circulated. The primary contribution of this paper is to assess the impact of education on teenage fertility, which is a primary concern to improve maternal health and promote women empowerment. The empirical approaches are also dissimilar as Dinçer et al. (2013) use the number of teachers in 12 regions and 20 sub-regions as the intensity of the CSL, while I use the number of additional classrooms in 80 provinces.

[6]Recent studies have used similar strategies to uncover the causal effect of schooling on different outcomes of nonmarket returns: for adult health, see van Kippersluis, 2011; Kenkel et al., 2006; de Walque, 2007; Webbink et al., 2010; Grimard and Parent, 2007; Lleras-Muney, 2005; Silles, 2009; Clark and Royer, 2010; Kemptner et al., 2011; Albouy and Lequien, 2009; for child health, see Currie and Moretti, 2003; Lindeboom et al., 2009; McCrary and Royer, 2011; for political participation, see Borgonovi et al., 2010; for fertility, see footnote 4.

interesting case study because the policy intervention occurred at a later transition stage when the pace of fertility decline had slowed (starting from the early 1990s), which makes further reductions in fertility more difficult to achieve. Thus, this paper contributes to the literature by providing causal evidence that educational interventions can accelerate the demographic transitions at later stages.

Third, this study explores heterogeneous effects across various dimensions, including pre-change levels of initial fertility and education, population density, urbanization, agricultural activity, and income in the province of birth as well as parental education. This understanding is crucial for understanding the effect of educational reforms on fertility as these dimensions vary significantly within developing countries. Finally, this study discusses several channels through which education affects fertility.

The remainder of this paper is organized as follows: Section 2 provides background on fertility, development, and the educational policy in Turkey; Section 3 describes the data; Section 4 describes nd the identification strategy and presents the empirical strategy and the results; and Section 5 concludes.

2 Background

In this section, I discuss the conceptual framework, present the trends in fertility prior to the change in the CSL, discuss the background on education system in Turkey, and describe the CSL and the trends in education. The CSL increased compulsory schooling from five to eight years (free of charge in public schools) in 1997, with the objective of increasing education level to universal standards. However, it also had an effect on teenage fertility.

2.1 Conceptual Framework

Economic theory provides several mechanisms through which education may influence fertility choices. One explanation is that education increases the returns to labor market participation, thereby increasing the opportunity cost of time-intensive activities (Becker, 1981; Schultz, 1981). As a result, women might substitute time-intensive activities, such as childbearing and child rearing, in order to devote more time to labor market participation. Also, education may affect fertility preferences–for instance, more educated women may prefer fewer but healthier (higher quality) children (Becker and Lewis, 1973). Improvements in child health resulting from female education may also reduce child mortality, thereby lowering fertility since fewer births are required to achieve the same family size (Lam and Duryea, 1999; Schultz, 1993). Education may reduce fertility through increased knowledge about contraceptives and the effective use of contraceptive methods (Rosenzweig and Schultz, 1985, 1989). In addition, education may increase women's autonomy and bargaining power in the household, increasing women's participation in fertility decision-making (Mason, 1986). Lastly, staying in school longer might postpone childbearing if having children impedes upon attending school.

Economic theory points to a number of mechanisms in which education influences fertility; however, according to the demography literature, the relevance of these mechanisms is highly dependent on a country's stage of demographic transition. Changes in fertility behavior, including the adoption of birth control methods and preferences for smaller family size, caused by the spread of new ideas and information through mass media, family planning programs, etc., account for changes in the decline of the fertility rate in the early phase of the transition. However, as a country approaches the later stages of the transition, fertility becomes more closely tied to the level of socioeconomic development (Bongaarts, 2002). Further fertility declines, therefore, depend on improvements in socioeconomic conditions, particularly female education and child survival (Caldwell, 1980; Sen, 1999; Bongaarts, 2001). Therefore, increases in female education in demographic transitions may be linked to fertility declines at later stages.

2.2 Trends in fertility and development in Turkey before the CSL

Similar to many developing countries, Turkey has experienced a rapid fertility decline since the early 1960s. Turkey's fertility decline started with a family planning program introduced in 1965, which legalized the sale and use of contraceptives. In 1980, Turkey implemented export-oriented policies, which increased the demand for labor in the service and industrial sectors. As a result, migration from villages to cities increased, leading to rapid urbanization and industrialization, which reduced fertility. Moreover, the Population Planning Law in 1983 legalized induced abortions upon request for up to ten weeks gestation and allowed trained nurses and midwives to administer IUDs, which increased the prevalence of modern contraceptives.

The traditional marriage pattern of Turkey is characterized by the universality of marriage: almost all women engage in either civil or religious marriages by the end of their reproductive ages and childbearing out of wedlock is uncommon in Turkey.[7] Hence, age at first birth depends on marriage age, which in turn affects the overall fertility. Since the time interval between marriage and first birth has been stable with an average around 1.6 years in Turkey, a delay in age at first marriage may result in an overall fertility decline by postponing first births.[8]

The total fertility rate (TFR) exceeded 6 children per woman in the early-1960s, dropped

[7] 2008 Turkey Demographic and Health Survey: http://www.hips.hacettepe.edu.tr.

[8] The singulate mean age at marriage (the average number of years lived as never-married before they get married for the first time among those who marry before age 50) for both sexes did not change (22 for females and 25 for males) over a period of 13 years from 1985 to 1998 (Figure 1). Thus, a delay in age at first marriage can play a crucial role in reducing fertility.

to 5 in the late-1970s, and dropped further to around 3 in the late-1980s.[9] In the 1990s, however, fertility remained at around 2.6 births per woman (Figure 1). While TFR was close to replacement fertility rate during the 1990s, adolescent fertility rate (births per 1,000 women ages 15-19) remained at around 60 (very high compared to many countries) during the 1990s. Following the CSL, total fertility rate declined to around 2.4 births in 2003, which correspond to around 7% decline from the 1990s. On the other hand, adolescent fertility rate declined to around 40 in 2003, which correspond to around 33% decline from the 1990s.[10]

Even though there is not a consensus on the effects of socioeconomic factors on fertility, it is useful to look at changes in socioeconomic indicators in order to understand fertility trends, especially in the later stages of the transition.[11] The Gross Domestic Product (GDP) per capita almost doubled from 1980 to 1990; however, economic recessions were frequent during the 1990s (4 major crises took place in 1991, 1994, 1999, and 2001). Following the export-oriented reforms in the 1980s, the share of the population in urban areas rose from 44% in 1980 to 59% in 1990, but did not significantly increase during the 1990s (reaching 65% in early 2000). The labor force in the agricultural sector decreased from 60% in the 1980s to 47% in 1990 and to 45% in 1995. From 1990 to 1995, life expectancy at birth increased from 65 to 68 and from 61 to 64 years for females and males, respectively. Despite improvements in infant and children under five mortality rates in the 1980s, both exceeded 55 per thousand live births during the first half of the 1990s, which is very high compared to developed countries. Adult literacy rates (the proportion of the adult population aged 15+ which is literate) leveled off around 70 for females and 90 for males during the 1990s prior to the CSL. Hence, the CSL took place when many development indicators either

[9] TFR is defined as the average number of children that would be born to a woman by the end of her childbearing period if she were to experience the exact current age-specific fertility rates.

[10] Turkey Demographic and Health Survey Main Reports: http://www.hips.hacettepe.edu.tr.

[11] For statistics related to socioeconomic indicators, http://www.turkstat.gov.tr.

leveled off or showed very little progress.

2.3 Education and Compulsory Schooling Law in Turkey

2.3.1 Turkey's Education System

Since 1923, the centralized Ministry of National Education (MONE) directs all educational related policy decisions, prepares the common curriculum of educational institutions, and monitors implementation in cooperation with provincial offices.[12] Formal education in Turkey consists of pre-school, primary, secondary and higher education. Prior to the law change in 1997, five years of primary education was compulsory for all citizens. In 1997, compulsory primary education was increased from five to eight years. Following primary school, students may choose to attend one of the following secondary educational programs: general, vocational or technical high schools. The basic 8-year primary education level (public and private) gross enrollment rate is 107.58% in 32,797 schools with 503,328 teachers (Ministry of National Education, 2011).[13] As of 2010, there are more than 4.5 million students in secondary schools with a 93.34% gross enrollment rate.

2.3.2 Compulsory Schooling Law and Trends in Education

In 1997, the Turkish government took a "big bang" approach to education reform, increasing compulsory schooling from five to eight years.[14] The main objective of the 8-Year Basic Education Program was to increase the education level to universal standards to enter the European Union. In order to encourage compliance with the law, a new Primary School Diploma is awarded for only those completing the 8th grade.

[12] the Unification of Education Law no 430 issued on 03.03.1924.

[13] MONE calculates the gross enrollment rate by dividing the total number of students in a specific level of education by the population in the theoretical age group.

[14] Compulsory education was extended to 8 years with the Basic Education Law No 4306 dated 18.08.1997 as of the 1997/1998 Academic Year.

Education is provided free of charge in public schools. The 8-Year Basic Education Program included construction of schools and classes and recruiting new primary school teachers in order to accommodate a greater number of students. The Program aimed at providing opportunities for all children to stay in school at least to the eighth grade. Thus, low-income students were provided free textbooks, school meals, and student uniforms. Moreover, transportation expenses to children living at least 2.5 km away from nearby village schools were covered under the Bussed Primary Education Scheme launched in the 1989/1990 Academic Year in order to improve access for children in rural areas, especially for those in poor families. In addition, regional boarding primary schools (YIBO) were established to provide primary education services to settlements having no schools.[15]

58,726 additional classrooms were constructed within the first year of the change in the law (between the 1997/98 and the 1996/97 Academic Year), which corresponds to around a 30% increase in the number of classrooms from the 1996/97 Academic Year and an average of around 10 additional classrooms per 1,000 primary school aged children.

While the Program aimed to extend educational opportunities to a greater share of the population, the qualitative components of the education system in general and the design of the curriculum in particular stayed the same. In an in-depth case study prepared for the World Bank on the implementation of the 1997 Basic Education Law, Dulger (2004) attests that the Primary Education Program maintained the 1968 national curriculum with minor changes and that, due to time constraints in implementation, the MONE primarily focused on capacity issues to accommodate new students. Moreover, a 2007 OECD educational report emphasizes that the 1997 educational program in Turkey lacked implementation of a new curricula in order to improve the quality of the education system.[16]

The CSL had an impressive effect on enrollment rates of both sexes, especially on

[15]According to MONE, there were 687,056 children bussed to the primary schools, and 539 YIBO with 247,563 students in the 2010/2011 Academic Year.

[16]Reviews of National Policies for Education: Basic Education in Turkey: http://www.oecd.org.

female enrollments in rural areas (female enrollment in rural areas in grade six increased significantly in the first year of the change in the law, roughly 162%).[17] Moreover, the gap in female education levels between urban and rural areas has narrowed dramatically.[18] The net primary enrollment rate increased from 84.74 in the 1997/1998 Academic Year to 93.54 in the 1999/2000 Academic Year (Ministry of National Education, 2011).[19] The increase in the net primary enrollment rate was greater for females than for males: 90.25 to 98.41 for males and 78.97 to 88.45 for females. The sex ratio in primary education rose from 85.63 to 88.54.[20] Presently, the net primary enrollment rate is 98.41 for both sexes, 98.59 for boys and 98.22 for girls, and the sex ratio is 100.42. Over ten million children in all types of education institutions, including YIBOs receive 8 years of basic education in about 33,000 schools with approximately 503,000 teachers.

Figure 2 shows the trend in the number of students in basic education by academic year. The figure demonstrates that the CSL in 1997 had a significant effect on student primary school participation. Enrollments increased by around 15% from 9.08 million in the 1997/98 Academic Year to 10.48 million in the 2000/01 Academic Year.

3 Data

The analyses are based on the 2008 Turkish Demographic and Health Survey (TDHS-2008). The TDHS survey is a demographic health survey conducted every five years by Hacettepe University Institute of Population Studies (HUIPS) since 1993. Of the 11,911

[17]http://www.unicef.org/turkey/gr/ge21ja.html.

[18]The difference in the median number of years of education is 0.3 for ever-married women ages 15-49 in 2008: http://www.hips.hacettepe.edu.tr.

[19]The net primary enrollment rate is calculated by dividing the number of students of a theoretical age group enrolled in a specific level of education by the population in that age group.

[20]Sex Ratio indicates the relative greatness of female gross enrollment ratio as compared to male gross enrollment ratio in a specific educational year and level of education. It is calculated by dividing the female gross enrollment ratio by the male gross enrollment ratio multiplied 100.

households surveyed in 2008, 10,525 were successfully interviewed, which yields an approximate response rate of 88%. Among 10,525 interviewed households, 8,003 women were ever-married of reproductive ages at 15-49. The response rate for the ever-married sample is approximately 92%.

The TDHS-2008 uses two types of questionnaires, the Household Questionnaire and the Individual Questionnaire. The latter targets ever-married women of reproductive ages (15-49), whereas the former targets all usual members of and visitors to the household. The nationally representative survey provides information on socioeconomic and demographic characteristics of a large number of women and contains a detailed fertility history of women surveyed with the Individual Questionnaire. The TDHS-2008 data is appropriate for the purpose of this paper since it contains data on the education, year and province of birth, fertility and marriage history of women. Appendix A presents summary statistics for women in the sample of analysis, which are between the ages of 18 and 30.[21] The data include 4,537 women, of which 2,184 have children.[22] The average level of completed schooling is 6.85. The average fertility (the number of ever-born children) is 0.97 for the entire sample, 0.09 for fertility before the age of 18, 0.04 for fertility before the age of 17, and 0.02 for fertility before the age of 16.

Other data sources are the National Education Statistics books by MONE, Turkey's Statistical Year Books and detailed education data by Turkish Statistics Institute (TurkStat). The sources contain detailed information on enrollment rates in formal and non-formal education for both sexes, number of teachers, number of schools and classes for different age groups in all provinces and for all academic years.[23]

[21]The basis of sample selection is discussed under the identification section.

[22]The TDHS-2008 contains information on whether a pregnancy has ever ended in a miscarriage, induced abortion, or a still birth; however, it does not provide the year of pregnancy termination, except for the latest pregnancy. Thus, I cannot determine whether or not the pregnancy was ended as a teenager. However, the results remain robust to the exclusion of such cases (618 women out of 4,537 for the sample of women ages 18-30).

[23]Turkey is divided into 5 main regions: West, South, Central, North, and East. However, a new regional

4 Empirical Methodology and Results

Exposure to the CSL is determined by year and province of birth. Children aged 12 or older in 1997, when the CSL took place, had already graduated from primary school since Turkish children attend primary school between the ages of 7 and 11, and therefore are "unexposed" to the policy.[24] On the other hand, children aged 11 or younger in 1997 would be affected by the CSL and therefore are "exposed" to the policy. Variation in the exposure to the CSL across provinces is determined by the intensity of additional classrooms constructed in the provinces of birth. Because I use the 2008 TDHS data set, exposed individuals are aged 18 to 22, while unexposed individuals are aged 23 and older.

4.1 Identification Strategy

Identification follows from the generalized regression framework:

$$E_{ijk} = a + \alpha_{1j} + \beta_{1k} + ProvinceTrend_{1jk} + (Intensity_j \times T_i)\gamma_1 + X'_{ijk}\theta_1 + \varepsilon_{ijk} \quad (1)$$

where E_{ijk} is the education of an individual i, born in province j, in year k, T_i is a dummy indicating whether individual i is "exposed" to the policy, a is a constant, α_{1j} is a province-of-birth fixed effect, β_{1k} is a year-of-birth fixed effect, and $ProvinceTrend_{1jk}$ is a province-specific time trend.[25] $Intensity_j$ is the number of additional classrooms per 1,000 primary school aged children between the 1996/97 and 1997/98 Academic Year in each province. X'_{ijk} is a vector of control variables, including controls for childhood environment (dummies

breakdown has been adopted from the European Union for statistical purposes as of 2002. Accordingly, there are 12 regions (NUTS I) with 81 provinces (Figure 3).

[24]It is possible that some of these females might have been exposed to the policy because of grade repetition. However, there was not a high prevalence of them, and, moreover, results are robust to excluding these females.

[25]For consistency with the literature, I use similar notation as Duflo (2001).

indicating whether individual i is Turkish, Kurdish, or others) and year-of-birth-specific (time-varying) province-level variable (enrollment rates interacted with year of birth dummies).[26] In all specifications, I correct the standard errors for clustering at the province level.[27]

The following equation estimates the impact of female education on teenage fertility

$$Y_{ijk} = a_2 + \alpha_{2j} + \beta_{2k} + ProvinceTrend_{2jk} + \pi E_{ijk} + X'_{ijk}\theta_2 + \nu_{ijk} \qquad (2)$$

where Y_{ijk} is the number of children born before age 18 of a woman i, born in province j, in year k.[28] As an alternative dependent variable, I also use a single dummy equal to 1 if the woman has at least one child before age 18.

OLS estimates of equation (2) may be biased if schooling is correlated with unobserved factors, such as family background and personal traits. For instance, women with high discount rates of time or low ability levels are less likely to have higher education levels and more likely to become teenage parents. In order to identify the causal effect of female education on teenage fertility, a two-stage least squares (2SLS) methodology is implemented. The interaction between the treatment dummy and the intensity measure is a valid instrument as exposure to the CSL should not directly affect fertility besides through changing educational attainment.

In order to address the concern for differential time trends in fertility and education across provinces, specifications control for province-specific time trends. Province-of-birth

[26] As an indicator of ethnicity, father's mother tongue categories are used. Specifications are robust to using mother's mother tongue categories.

[27] Alternative levels of clustering, including, clustering at the regional and sub-regional levels (12 and 20 clusters, respectively), clustering at the year of birth*province of birth levels, and two-way non-nested clustering (following Cameron et al., 2009; and Thompson, 2011), yield similar results. Results are availabe upon request.

[28] Because the youngest women in the sample are aged 18, teenage fertility is defined as the number of children born before age 18 to circumvent the problem of censored fertility. The effect of female education on the number of children born before the ages of 17 and 16 are also explored.

fixed effects control for differences across provinces such as socioeconomic development and social norms.[29] I also use year-of-birth fixed effects to account for common trends in fertility.

Recall the exclusion restriction requires that the intensity of the reform should not directly affect the outcomes of interest, besides via changing schooling. In other words, the excluded instruments should be uncorrelated with the error term in (2). One particular concern is that the intensity of the reform is not random as the government likely devoted greater resources to provinces with a greater number of students taking up enrollment as a consequence of the reform. In order to capture any time-varying factors correlated with pre-program enrollment rates, the estimations control for enrollment rates in the province of birth interacted with year of birth dummies.

4.2 Effect of the CSL on Education (First-Stage Estimation)

The results for different specifications are presented in Table 1. Education is measured as either the completed number of years of education or a dummy variable indicating whether a female completed eight or more years of schooling (primary school completion).[30] All specifications control for ethnicity, and year-of-birth and province-of-birth fixed effects. Column (2) controls for province-specific time trends, and column (3) adds enrollment rates in the province of birth interacted with year of birth dummies.

The estimated coefficients are all positive and statistically significant for both educational outcomes. The estimates of the increase in female schooling and primary school completion due to the CSL are 0.03 and 0.006, respectively. The results suggest that one additional classroom per 1,000 children increases female education by 0.03 years, and pri-

[29] There are 80 provinces included in the estimations based on the 1995 boundaries of Turkey. In all the estimations throughout the study, women born in Düzce are assumed to be born in Bolu since Düzce broke off Bolu and became a province in November 1999.

[30] Appendix B estimates the effect of the CSL on different levels of education.

mary school completion by 0.60 percentage points. The average number of additional classrooms per 1,000 children is 9.44, implying that the CSL increased female education by 0.19 years and primary school completion by 5.66 percentage points. This corresponds to around a 18% increase in primary school completion given that the average completion prior to the CSL is 32 percentage point (mean for unexposed cohort).

The F-statistics for the treatment dummy interacted with the intensity measure (excluded instrument) are reported in Table 1. The F-statistics for the dependent variable years of education are all less than 10, while the F-statistics for the dependent variable primary school completion are all greater than 10.[31] Because the excluded instruments are weakly correlated with years of education, I emphasize primary school completion as a measure of female education henceforth.

Furthermore, I estimate the following equation to rule out the possibility of pre-existing trends in education:

$$E_{ijk} = a + \alpha_{1j} + \beta_{1k} + ProvinceTrend_{1jk} + \sum_{l=7}^{18} (Intensity_j \times d_{il})\gamma_{1l} + X'_{ijk}\theta_1 + \varepsilon_{ijk} \quad (3)$$

where d_{il} is a dummy indicating whether individual i is age l in 1997 (a year-of-birth dummy). Females aged 19 in 1997 is the control group and hence this dummy is omitted from the regression. Recall, children aged 12 and older in 1997 were not exposed to the CSL, implying that the coefficients of the interactions should be zero for these cohorts. Exposure to the CSL implies the coefficients γ_{1l} should be significantly positive from l=11 to 7. Figure 4 plots the coefficients of interactions. Each point on the solid line represents γ_{1l} for each l. The pattern is consistent with the hypothesis that the change in compulsory schooling had no impact on the education of unexposed cohorts and had a positive effect

[31]Critical F-statistic of 10 is suggested by Staiger and Stock (1997). Cameron and Trivedi (2005) use this rule of thumb, but they also propose a less strict rule of thumb of critical F-statistic of 5.

on the education of the cohorts 11 and younger. The coefficients of the interactions are positive and significant for l=7 to 11, and close to 0 for l=12 to 18.

4.3 Effect of Female Schooling on Teenage Fertility

Table 2 presents both OLS and IV estimates of the effect of female schooling on teenage fertility. Panels A, B, and C of Table 2 report estimates for fertility before age 18, age 17, and age 16, respectively. Columns (1) and (2) include females aged 18-30. Panel D reports estimates for the probability of having at least one child before age 18 using a linear probability model (LPM).

The first row of Panel A displays the OLS estimates, indicating that primary school completion reduces the number of births before age 18 by 0.10 (significant at the 1% level). Thus, a 10 percentage-point increase in the probability of completing primary school reduces teenage fertility by 11% at the mean. The second row of Panel A presents the 2SLS results, indicating primary school completion reduces the number of births by 0.37. Thus, a 10 percentage-point increase in the probability of completing primary school reduces fertility by around 0.04, which corresponds to a reduction of 44% in teenage births at the mean.

Panels B and C report the OLS and 2SLS results for fertility before age 17 and 16, respectively. The OLS estimates suggest that primary school completion reduces the number of births before 17 and 16 by 0.05 and 0.02, while the 2SLS estimates suggest that primary school completion reduces the number of births before 17 and 16 by 0.24 and 0.22.

The OLS estimates in Panel D suggest that primary school completion reduces the probability of having a child before 18 by around 8 percentage points, while the IV estimates suggest education reduces teenage motherhood by more than 25 percentage points.

As a robustness checks, column (4) excludes females aged 11 in 1997 in order to adress the concern that they might have not benefited from the reform due to early enrollment. Column (4) demonstrates that the results are robust to excluding females aged 11 in 1997.

For all measures of teenage fertility, the IV estimates exceed the OLS estimates, suggesting that the OLS estimates may be biased downwards due to omitted variables that correlate with both higher levels of schooling and early child rearing, such as access to economic opportunities. Another possible explanation is that the IV estimates pertain to only a subsample of women whose educational attainment has been affected by the change in the compulsory schooling law. The effect of education on fertility may be higher for this subsample, thereby leading to larger IV estimates compared to OLS estimates. The possibility of heterogeneous effects of education on teenage fertility is explored in Section 4.4.

Table 3 demonstrates that the effect of the CSL on fertility persists for later fertility (number of births before the ages of 19, 20, 21, and 22–much beyond the ages above which the CSL binds). To assess fertility before various ages, treatment and control groups are defined to avoid censuring fertility. For example, for fertility before age 20, the treatment group is age 9-11 in 1997, whereas the control group is age 12-19 in 1997. As a robustness check, I use a tighter age window for the control group in Panel B. Panel A suggests that the CSL decreased fertility before age 20 and 21 by around 0.04 and 0.03, which corresponds to a reduction of 15% and 8% at the mean, respectively.[32]

4.4 Are there heterogeneous effects?

The effect of the CSL on education and the effect of education on fertility are likely to depend on multiple characteristics. Uncovering heterogeneous effects has important policy

[32]The effects of the CSL on fertility before age 20 and 21 are calculated by multiplying the average number of additional classrooms per 1,000 children with the coefficients in Table 3 (0.004*9.44=0.04 and 0.003*9.44=0.03, respectively). Reductions in terms of percents are calculated using the mean levels of fertility before age 20 and 21 (0.26 and 0.37, respectively).

implications both in understanding the expected outcomes and for designing optimal policy interventions. To examine whether there are heterogeneous effects, I split the sample into various subsamples by birth-province and use the specifications that include all controls.[33]

A. Pre-change levels of education and fertility in the province of birth

One hypothesis is that it is easier to increase education when the baseline level is lower and, similarly, to reduce fertility when the baseline level is higher (Barham, 2011). I explore heterogeneity of both the effect of female education on fertility and the effect of the CSL on education according to the baseline (pre-change) levels of fertility and education by dividing the sample into provinces (by birth) with average fertility or education of the unexposed cohort above (or below) the sample median.

Table 4 (first row) suggests that the effect of the CSL on female education is higher in provinces where the initial levels were lower than the sample median; however, the difference is not statistically significant. Second, the impact of female education on teenage fertility (second row) is higher (lower) in provinces with initial fertility above (below) the median. Specifically, primary school completion reduces teenage fertility by 0.47 births in provinces with initial fertility above the median, compared to 0.28 births in provinces below the median. The results therefore indicate that there are heterogeneous effects by pre-fertility levels in birth-provinces.

B. Pre-change characteristics of the province of birth

Another possible source of heterogeneity is population density because females in sparsely populated provinces are more likely to be affected by the CSL, either as a consequence

[33] I also test whether the effect of the CSL on education differs by parental education. The results provide evidence that the CSL was more successful at increasing education of women with lower levels of parental education; however, most of the estimates are not significant enough to be conclusive (results are available upon request).

of new school constructions or more transportation services. Other possible sources of heterogeneity are income (GDP per capita), urbanization rates (the percentage of population in cities), and agricultural activity (percentage of households engaged in agricultural production).[34]

The results are reported in Table 5. The effect of the CSL on education (first row) is slightly higher in provinces with urbanization rates, income levels, and population densities below the median. In provinces with population densities, incomes, and urbanization rates below the median, the CSL increased primary school completion by around 7, 7, and 9 percentage points, respectively, compared to 6 percentage points in provinces above the median. However, the differences are not statistically significant. The impact of female education on teenage fertility (row 2) is higher in provinces with lower urbanization rates and incomes, compared to insignificant effects in provinces above the median. Primary school completion reduces teenage fertility by 0.70 births in provinces with population densities below the median, compared to 0.45 births in provinces above the median (the difference is significant at the 5% level). Finally, primary school completion reduces teenage fertility by 0.41 births in provinces with agricultural activity above the median, compared to an insignificant effect in provinces below the median.

4.5 Channels through which education affects fertility

In this section I discuss possible channels through which education affects fertility. As mentioned, schooling may reduce fertility by delaying marriage, especially since childbearing out of wedlock is uncommon in Turkey. I estimate the effect of the CSL on the probability of being married and the probability of having no children before age 18.

[34] I use GDP per capita, population densities, and urbanization rates in 1990 (prior to CSL). However, I use agricultural activity in 2001 (the earliest data available at the province level is 2001) and assume that the percentage of households engaged in agricultural activity has not changed significantly over the four years since the change of the CSL in 1997.

Table 6 displays the results of whether the CSL had an effect on the probability that a woman remains single and does not have kids before age 18. Estimations of different specifications for both outcomes produce statistically significant coefficients with expected signs. The estimates suggest that the CSL decreased the probability of getting married before age 18 and raised the probability of having no kids before age 18 by 2 percentage points at the mean (0.002*9.44). Thus, the fall in fertility before age 18 may be partly explained by postponed childbearing due to delayed marriage.

Furthermore, education may influence contraceptive knowledge and use. Family planning programs, starting in 1965, increased the prevalence of contraception; however, the trend stalled at around 60% during the 1990s. In the 2000s, the trend resumed, increasing to 70%, and in particular modern contraceptive use increased by 10%.[35] While we cannot precisely account for the effect of education on contraceptive knowledge and use, it is plausible that greater education had an important role on the increased prevalence. This represents another channel through which education may reduce fertility.

Another possible mechanism is via the effect of schooling on labor market participation. Female labor force participation for women aged 15+ in Turkey declined from around 30% in the 1990s to around 25% in the 2000s.[36] In both decades, women with greater education (high school or more) had higher participation rates than women with less education. Because there are many confounding factors affecting the labor market from one year to another, it is difficult to draw conclusions on the effect of female education on labor force participation. This might be explored in future research as more years of data become available.

Finally, the tradeoff between "quality" and "quantity" of children may be another possible channel. Given that infant and children under five mortality stalled at very high rates

[35] See footnote 10.
[36] Ibid.

in the 1990s (both rates exceeded 55 per thousand live births), increased female education may affect child health, thereby reducing the number of children.[37] Parents with more education may also invest more in their children's schooling, which increases both the quality and the cost of children, thereby reducing the number of children desired. Future research might also explore this tradeoff as more data becomes available.

5 Conclusion

This paper explores the causal relationship between female education and teenage fertility using a change in the compulsory schooling law in Turkey. I find that the CSL increased primary school completion by approximately 6 percentage points for primary school age females in 1997.

Exploiting variation in schooling generated by the timing of the CSL and variation in the intensity of additional classrooms identifies the causal effect of female education on teenage fertility. The IV estimates suggest that primary school completion reduces teenage fertility by 0.37 births. Moreover, the decline in teenage fertility is particularly acute in provinces with lower population density and higher agricultural activity. Finally, I demonstrate that the effect of education can be partly explained by postponed childbearing due to delayed marriage. An interesting area for future research is to explore additional channels, such as labor market participation and investment in children.

These findings have several important implications for development policy. Improving female education is an important factor for reducing teenage fertility, which in turn is associated with improvements in health, labor market participation, and female empowerment.[38] Therefore, expanding educational opportunities in countries that currently disem-

[37] http://data.un.org.

[38] Furthermore, Caceres-Delpiano (2012) show that an increase in fertility has a cost for both children and other household members in developing countries, such as increases in the incidences of unstable family

power and disadvantage women, such as Turkey and MENA in general, is an important step in achieving the aims of the UN MDGs. This paper also underscores the importance of targeting subpopulations within the country where the impact of expanding educational opportunities have the greatest impact in reducing teenage fertility, such as areas with low income and high agricultural activity. Finally, this paper demonstrates that educational interventions are effective in reducing fertility at later stages of the demographic transition, at which point conventional policies for reducing fertility may no longer be effective.

References

Albouy, V. and Lequien, L. (2009). Does compulsory education lower mortality? *Journal of Health Economics*, 28(1):155–168.

Angrist, J. and Evans, W. (2000). Schooling and labor market consequences of the 1970 state abortion reforms. In *Research in Labor Economics 18*, pages 75–113. Emerald Group Publishing Limited.

Barham, T. (2011). A healthier start: The effect of conditional cash transfers on neonatal and infant mortality in rural Mexico. *Journal of Development Economics*, 94(1):74–85.

Becker, G. S. (1981). *Treatise On the Family*. Harvard University Press, Cambridge, MA.

Becker, G. S. and Lewis, H. G. (1973). On the interaction between the quantity and quality of children. *Journal of Political Economy*, 81:S279–S288.

Berger, M. and Leigh, J. (1989). Schooling, self selection, and health. *Journal of Human Resources*, 24:433–455.

arrangements and the odds of child mortality.

Black, S. E., Devereux, P. J., and Salvanes, K. G. (2008). Staying in the classroom and out of the maternity ward? The effect of compulsory schooling laws on teenage births. *Economic Journal*, 118:1025–1054.

Bongaarts, J. (2001). Fertility and reproductive preferences in post-transitional societies. *In Global Fertility Transition. Population and Development Review*, supplement to volume 27:260–281.

Bongaarts, J. (2002). The end of the fertility transition in the developing world. *In Completing the Fertility Transition. Department of Economic and Social Affairs, Population Division, New York : United Nations*, pages 288–307.

Borgonovi, F., d'Hombres, B., and Hoskins, B. (2010). Voter turnout, information acquisition and education: Evidence from 15 European countries. *The B.E. Journal of Economic Analysis & Policy*, Vol. 10:Iss. 1 (Contributions), Article 90.

Breierova, L. and Duflo, E. (2004). The impact of education on fertility and child mortality: Do fathers really matter less than mothers?, NBER Working Papers 10513, National Bureau of Economic Research, Inc.

Caceres-Delpiano, J. (2012). Is there a cost associated with an increase in family size beyond child investment? Evidence from developing countries. *The B.E. Journal of Economic Analysis & Policy*, Vol. 12:Iss. 1 (Advances), Article 17.

Caldwell, J. C. (1980). Mass education as a determinant of the timing of fertility decline. *Population and Development Review*, 6(2):pp. 225–255.

Cameron, A., Gelbach, J., and Miller, D. (2006). Robust inference with multi-way clustering, NBER Working Papers 327, National Bureau of Economic Research, Inc.

Cameron, C. A. and Trivedi, P. K. (2005). *Supplement to Microeconometrics: Methods and Applications*. Cambridge University Press, New York.

Chevalier, A. and Viitanen, T. K. (2003). The long-run labour market consequences of teenage motherhood in Britain. *Journal of Population Economics*, 16(2):323–343.

Clark, D. and Royer, H. (2010). The effect of education on adult health and mortality: Evidence from Britain, NBER Working Papers 16013, National Bureau of Economic Research, Inc.

Currie, J. and Moretti, E. (2003). Mother's education and the intergenerational transmission of human capital: Evidence from college openings. *The Quarterly Journal of Economics*, 118(4):1495–1532.

Cygan-Rehm, K. and Maeder, M. (2013). The effect of education on fertility: Evidence from a compulsory schooling reform. *Labour Economics*, 25:35–48.

de Walque, D. (2007). Does education affect smoking behaviors?: Evidence using the Vietnam draft as an instrument for college education. *Journal of Health Economics*, 26(5):877–895.

Dinçer, M. A., Kaushal, N., and Grossman, M. (2014). Women's education: Harbinger of another spring? Evidence from a natural experiment in Turkey. *World Development*, 64:243–258.

Duflo, E. (2001). Schooling and labor market consequences of school construction in Indonesia: Evidence from an unusual policy experiment. *American Economic Review*, 91(4):795–813.

Dulger, I. (2004). Turkey: Rapid coverage for compulsory education—the 1997 basic education program. Shanghai. World Bank Conference "Scaling Up Poverty Reduction: A Global Learning Process".

Fort, M., Schneeweis, N., and Winter-Ebmer, R. (2011). More schooling, more children: Compulsory schooling reforms and fertility in Europe, IZA Discussion Papers 6015, Otober 2011.

Fuchs, V. R. (1982). Time preference and health: An exploratory study. NBER Chapters, pages 93–120. National Bureau of Economic Research, Inc.

Geruso, M., Clark, D., and Royer, H. (2011). The impact of education on fertility: Quasi-experimental evidence from the UK, mimeo Princeton, Princeton University.

Griliches, Z. (1977). Estimating the returns to schooling: Some econometric problems. *Econometrica*, 45(1):1–22.

Grimard, F. and Parent, D. (2007). Education and smoking: Were Vietnam war draft avoiders also more likely to avoid smoking? *Journal of Health Economics*, 26(5):896–926.

Kemptner, D., Jürges, H., and Reinhold, S. (2011). Changes in compulsory schooling and the causal effect of education on health: Evidence from Germany. *Journal of Health Economics*, 30(2):340–354.

Kenkel, D., Lillard, D., and Mathios, A. (2006). The roles of high school completion and GED receipt in smoking and obesity. *Journal of Labor Economics*, 24(3):635–660.

Kirdar, M. G., Tayfur, M. D., and Koç, I. (2012). The effect of compulsory schooling laws on teenage marriage and births in Turkey, MPRA Papers 38735.

Lam, D. and Duryea, S. (1999). Effects of schooling on fertility, labor supply, and investments in children, with evidence from Brazil. *Journal of Human Resources*, 34(1):160–192.

Lavy, V. and Zablotsky, A. (2011). Mother's schooling, fertility, and children's education: Evidence from a natural experiment, NBER Working Papers 16856, March 2011, National Bureau of Economic Research, Inc.

Lindeboom, M., Llena-Nozal, A., and Van der Klaauw, B. (2009). Parental education and child health: Evidence from a schooling reform. *Journal of Health Economics*, 28(1):109–131.

Lleras-Muney, A. (2005). The relationship between education and adult mortality in the United States. *Review of Economic Studies*, 72:189–221.

Mason, K. O. (1986). The status of women: Conceptual and methodological debates in demographic studies. *Sociological Forum 1:284-300*.

McCrary, J. and Royer, H. (2011a). The effect of female education on fertility and infant health: Evidence from school entry policies using exact date of birth. *American Economic Review*, 101:158–195.

McCrary, J. and Royer, H. (2011b). The effect of female education on fertility and infant health: Evidence from school entry policies using exact date of birth. *American Economic Review*, 101(1):158–95.

Ministry of National Education (2011). National education statistics formal education 2010-2011. Technical report, Ankara, Turkey. [online] `http://sgb.meb.gov.tr`.

Monstad, K., Propper, C., and Salvanes, K. G. (2008). Education and fertility: Evidence from a natural experiment. *The Scandinavian Journal of Economics*, 110:827–852.

Osili, U. O. and Long, B. T. (2008). Does female schooling reduce fertility? Evidence from Nigeria. *Journal of Development Economics*, 87(1):57–75.

Rosenzweig, M. R. and Schultz, T. P. (1985). The demand for and supply of births: Fertility and its life cycle consequences. *American Economic Review*, 75(5):992–1015.

Rosenzweig, M. R. and Schultz, T. P. (1989). Schooling, information and nonmarket productivity: Contraceptive use and its effectiveness. *International Economic Review*, 30(2):457–77.

Schultz, T. P. (1981). Economics of population reading. Addison Wesley, MA.

Schultz, T. P. (1993). Returns to women's education. In King, E. M. and Hill, M. A., editors, *Women's education in developing countries: Barriers, benefits, and policies*. Baltimore, MD: Johns Hopkins University Press (for the World Bank).

Sen, A. (1999). *Development as Freedom*. New York: Knopf.

Silles, M. A. (2009). The causal effect of education on health: Evidence from the United Kingdom. *Economics of Education Review*, 28(1):122–128.

Silles, M. A. (2011). The effect of schooling on teenage childbearing: Evidence using changes in compulsory education laws. *Journal of Population Economics*, 24(2):761–777.

Staiger, D. and Stock, J. H. (1997). Instrumental variables regression with weak instruments. *Econometrica*, 65(3):557–586.

Strauss, J. and Thomas, D. (1995). Human resources: Empirical modeling of household and family decisions. volume 3 of *Handbook of Development Economics*, pages 1883–2023. Elsevier.

Thompson, S. (2011). Simple formulas for standard errors that cluster by both firm and time. *Journal of Financial Economics*, 99(1):1–10.

van Kippersluis, H., O'Donnell, O., and van Doorslaer, E. (2011). Long-run returns to education: Does schooling lead to an extended old age? *Journal of Human Resources*, 46(4):695–721.

Webbink, D., Martin, N. G., and Visscher, P. M. (2010). Does education reduce the probability of being overweight? *Journal of Health Economics*, 29(1):29–38.

Figure 1: Total Fertility Rate (TFR) and Mean Age at First Marriage and Birth (MAFM and MAFB); Sources: TurkStat, Hacettepe University Institute of Population Studies (HUIPS)

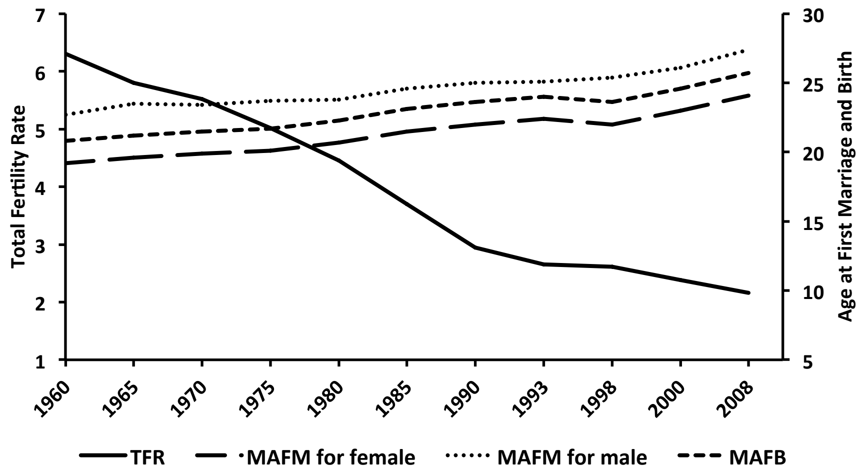


Figure 2: Number of Students in 8-year Primary Education by Academic Year; Enrollments in the 1992/93-1996/97 Academic Years prior to the change in the CSL are the sum of the number of students in the 5-year compulsory primary education and 3-year junior high school

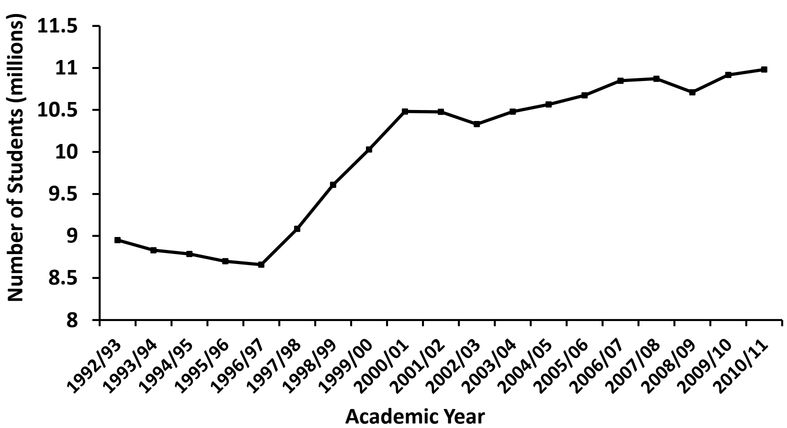
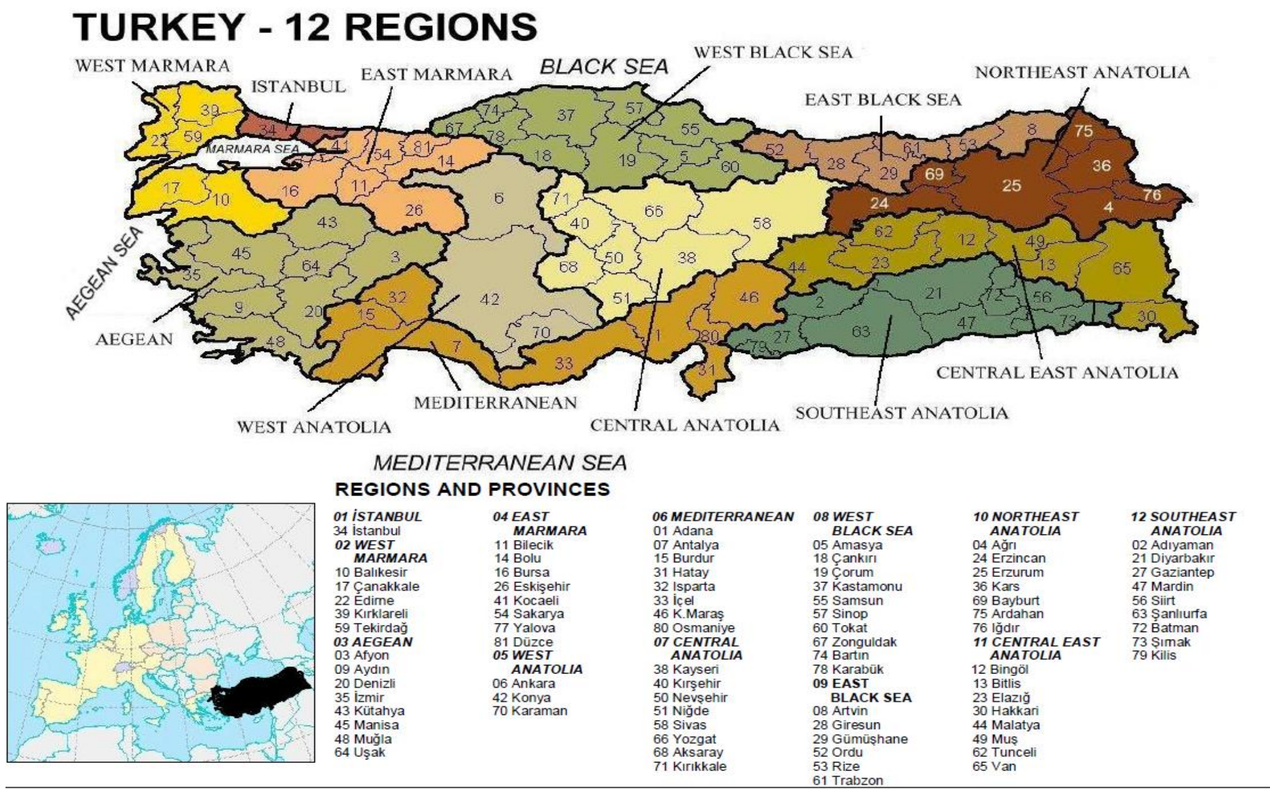
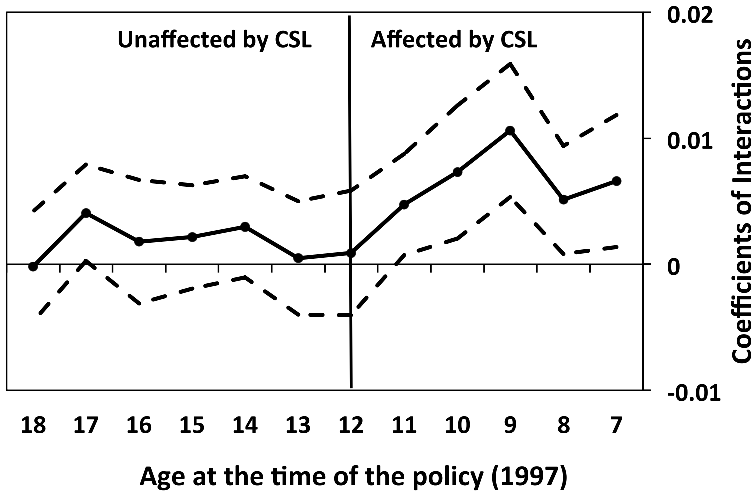


Figure 3: Administrative Regions and Provinces of Turkey



Source: Turkey Demographic and Health Survey 2008 Main Report, Hacettepe University Institute of Population Studies, http://www.hips.hacettepe.edu.tr/eng/index.html

Figure 4: Coefficients of the Interaction Between the Intensity Measure and a Dummy For Age in 1997



Notes: The sample includes all females between the ages of 18 and 30 at the time of the survey. Females aged 12 in 1997 is the youngest unaffected cohort. Each point on the solid line represents the coefficient of the interaction between the intensity measure in birth-province and a dummy for age at the time of the policy. Dashed lines are 95% confidence intervals.

Table 1: First Stage Coefficients: Effects of the CSL on Education

	Dep Var: Years of Education			Dep Var: Primary School Completion		
	(1)	(2)	(3)	(4)	(5)	(6)
*Treatment * Additional Classrooms*	0.020*	0.027**	0.028**	0.006***	0.006***	0.006***
	(0.010)	(0.013)	(0.013)	(0.002)	(0.002)	(0.002)
Control Variables:						
Province-specific time trends	No	Yes	Yes	No	Yes	Yes
Year of birth*Enrollment rate	No	No	Yes	No	No	Yes
F-statistics	3.68	3.94	4.60	16.42	10.49	11.31
R-square	0.380	0.504	0.505	0.324	0.394	0.397
Observations	4,537	4,537	4,537	4,537	4,537	4,537

*Significant at 0.1 level. ** Significant at 0.05 level. ***Significant at 0.01 level.

Dependent variable is either the completed number of years of education or a dummy variable indicating whether a female completed eight or more years of schooling (primary school completion). The F-statistics test the hypothesis that the coefficient of the interaction is zero. Standard errors (in parentheses) are adjusted for clustering on the province of birth. All specifications include respondent's ethnicity, and year-of-birth and province-of-birth fixed effects.

Table 2: Effects of Female Schooling on Fertility Outcomes: OLS and 2SLS Estimates

	(1) 18-30	(2) 18-30	(3) Exclude 22
Panel A: Fertility Before Age 18			
OLS	-0.095***	-0.095***	-0.093***
	(0.012)	(0.013)	(0.013)
2SLS	-0.348*	-0.370*	-0.347*
	(0.204)	(0.198)	(0.204)
Panel B: Fertility Before Age 17			
OLS	-0.048***	-0.049***	-0.047***
	(0.009)	(0.009)	(0.009)
2SLS	-0.252**	-0.240**	-0.267**
	(0.121)	(0.120)	(0.111)
Panel C: Fertility Before Age 16			
OLS	-0.020***	-0.020***	-0.020***
	(0.004)	(0.005)	(0.005)
2SLS	-0.242**	-0.218**	-0.203**
	(0.115)	(0.107)	(0.088)
Panel D: Probability of Having Kids Before Age 18			
OLS	-0.081***	-0.081***	-0.079***
	(0.009)	(0.009)	(0.009)
2SLS	-0.263*	-0.286**	-0.246*
	(0.151)	(0.145)	(0.148)
Control Variables:			
Ethnicity	Yes	Yes	Yes
Province-specific time trends	Yes	Yes	Yes
Year of birth*Enrollment rate	No	Yes	Yes
Observations	4,537	4,537	4,192

*Significant at 0.1 level. ** Significant at 0.05 level. ***Significant at 0.01 level.

Standard errors (in parentheses) are adjusted for clustering on the province of birth. All specifications include year-of-birth and province-of-birth fixed effects.

Table 3: Effect of the CSL on Fertility

	Dependent Variable			
	Before 19	Before 20	Before 21	Before 22
	(1)	(2)	(3)	(4)
Panel A: Treatment/Control	8-11/12-19	9-11/12-19	10-11/12-19	11/12-19
*Treatment * Additional Classrooms*	-0.003**	-0.004**	-0.003*	-0.005**
	(0.001)	(0.002)	(0.002)	(0.002)
Observations	4077	3684	3274	2962
Panel B: Comparison Group	8-11/12-14	9-11/12-14	10-11/12-14	11/12-14
*Treatment * Additional Classrooms*	-0.002*	-0.004*	-0.003*	-0.005
	(0.001)	(0.002)	(0.002)	(0.003)
Observations	2466	2073	1663	1351

Notes: All treatment and control groups are defined by age in 1997. Standard errors (in parentheses) are adjusted for clustering on the province of birth. All specifications include year-of-birth and province-of-birth fixed effects, respondent's ethnicity, province-specific time trends, and enrollment rates in the province of birth interacted with year of birth dummies.

Table 4: Heterogeneity of the impact and the CSL effect by pre-change levels of fertility and education

		Pre-Change Province of Birth Characteristics			
	Whole	Pre-change education		Pre-change fertility	
	Sample	<Median	>=Median	<Median	>=Median
	(1)	(2)	(3)	(4)	(5)
1) Effect of the CSL on Education					
*Treatment * Additional Classrooms*	0.006***	0.011**	0.010***	0.007**	0.008*
	(0.002)	(0.004)	(0.004)	(0.003)	(0.005)
2) Impact of Female Education on Fertility					
Primary School Completion	-0.370*	-0.437*	-0.089	-0.284**	-0.474*
	(0.198)	(0.262)	(0.195)	(0.127)	(0.242)

*Significant at 0.1 level. ** Significant at 0.05 level. ***Significant at 0.01 level.

Median pre-program education is 6.428; median pre-program fertility is 0.091. Standard errors (in parentheses) are adjusted for clustering on the province of birth. All specifications include year-of-birth and province-of-birth fixed effects, respondent's ethnicity, province-specific time trends, and enrollment rates in the province of birth interacted with year of birth dummies.

Table 5: Heterogeneity of the impact and the CSL effect by pre-change province characteristics

	Whole	Pre-Change Province of Birth Characteristics							
		Density		GDP		Urbanization		HH in Agriculture	
	Sample	<Median	>=Median	<Median	>=Median	<Median	>=Median	<Median	>=Median
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1) Effect of the CSL on Education									
*Treatment * Additional Classrooms*	0.006***	0.007**	0.006**	0.007**	0.006*	0.009***	0.006***	0.005**	0.006*
	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)
2) Impact of Female Education on Fertility									
Primary School Completion	-0.370*	-0.707**	-0.448*	-0.667**	-0.171	-0.640**	-0.274	-0.052	-0.413*
	(0.198)	(0.304)	(0.228)	(0.321)	(0.193)	(0.280)	(0.299)	(0.192)	(0.210)

*Significant at 0.1 level. ** Significant at 0.05 level. ***Significant at 0.01 level.

Median population density is 63.14 (per square kilometers); median GDP is $1908; median urbanization rate is 48.168%; median % HH engaged in agricultural activity is 73.744 %. Standard errors (in parentheses) are adjusted for clustering on the province of birth. All specifications include year-of-birth and province-of-birth fixed effects, respondent's ethnicity, province-specific time trends, and enrollment rates in the province of birth interacted with year of birth dummies.

Table 6: Effect of the CSL on Fertility Before Age 18, Marital Status, and No kids

Dependent Variable	(1) 18-30	(2) 18-30	(3) Exclude 22
Fertility Before Age 18	-0.002*	-0.002*	-0.002*
	(0.001)	(0.001)	(0.001)
(R-squared)	0.095	0.096	0.099
Probability of Being Married Before Age 18	-0.002*	-0.002*	-0.004**
	(0.001)	(0.001)	(0.002)
(R-squared)	0.081	0.083	0.082
Probability of Having No kids Before Age 18	0.002*	0.002*	0.002*
	(0.001)	(0.001)	(0.001)
(R-squared)	0.085	0.087	0.090
Control Variables:			
Ethnicity	Yes	Yes	Yes
Province-specific time trends	Yes	Yes	Yes
Year of birth*Enrollment rate	No	Yes	Yes
Observations	4537	4537	4192

*Significant at 0.1 level. ** Significant at 0.05 level. ***Significant at 0.01 level.
Standard errors (in parentheses) are adjusted for clustering on the province of birth. All specifications include year-of-birth and province-of-birth fixed effects.

Appendix A. Descriptive Statistics

	Mean
Treatment	0.423
Additional Classrooms	9.44
Female age	23.64
Female years of completed education	6.85
Completed eight or more years of education	0.46
Fraction of married women	0.57
Fraction of married women before age 18	0.18
Fraction of women having no kids at the time of the survey	0.52
Fraction of women having no kids before age 18	0.93
Number of children ever born	0.97
Number of children before age 18	0.09
Number of children before age 17	0.04
Number of children before age 16	0.02
Number of Observations	4537
Number of female with children	2184

Notes: The sample includes all females between the ages of 18 and 30 at the time of the survey.

Appendix B. The Effect of CSL on different levels of education

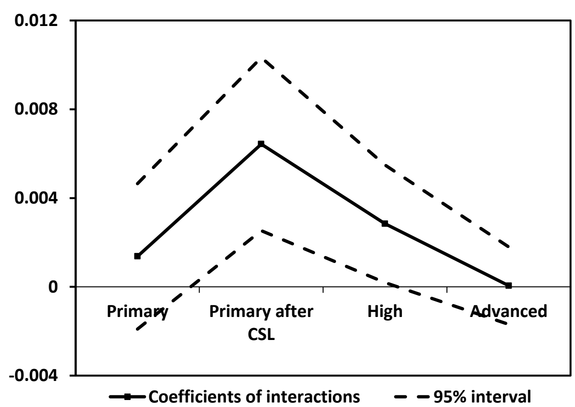
Following Duflo (2001), I estimate the equation below to check if the CSL succeeded in affecting mainly the targeted groups since the impact of the CSL on fertility depends on it.

$$E_{ijkm} = b + \alpha_j + \beta_k + (Intensity_j \times T_i)\kappa_m + \varepsilon_{ijk} \tag{4}$$

where E_{ijkm} is a schooling variable which takes value 1 if individual i, born in province j, in year k, completed m level of education, 0 otherwise. κ_m is the estimated impact of the CSL for 4 different levels of education (m): primary (5 years of education), primary after CSL (8 years of education), high (11 years of education), and advanced (11+ years of education). Figure A.1 presents the estimated probabilities from LPM with corresponding 95% confidence intervals.

The effect of the CSL is the highest for the probability of completing 8 years of education, at the level of the goal of the education policy. There is evidence that the CSL increased the likelihood of completing high school, and a negligible effect on the probability of completing advanced education. Despite the small spillovers, the program substantially increased schooling through the level of education associated with the CSL.

Figure A.1: Coefficients of the Interactions on Completing at Least "M" Level of Education



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