Out of Africa: Human Capital Consequences of In Utero and Postnatal Conditions

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Abstract

This paper investigates the effects of environmental conditions during pregnancy and birth on later life outcomes by using quasi-experimental variation created by the immigration of Ethiopian Jews to Israel in the early 90's. Over the course of 36 hours (beginning on May 24th 1991) 14,400 Jews arrived to Israel from Ethiopia by Israeli airplanes, an operation which organized by the Israeli government. This immigration wave happened abruptly and was unexpected and therefore its timing is unlikely correlated with timing of pregnancy and birth of immigrant families. Children in utero in Ethiopia and in Israel faced dramatic differences in medical care technologies, prenatal conditions, early childcare and nutrition. We exploit this natural experiment to study how environmental conditions in utero affected the long term educational outcomes. We use a regression discontinuity design based on variation in exposure to in utero conditions in Israel and its consequences for education outcomes of children by end of high school. We find that children who were exposed to better environmental conditions during the critical period of the fetus brain development in utero (between weeks 8 and 25 of gestation) have much higher likelihood of completing high-school, obtaining a matriculation diploma and have higher quality education, especially in math and English. These effects are very large, robust to alternative definitions of the in utero treatment period and to using alternative identification strategy such as difference-in-differences that control for cohort effects. We also find large heterogeneity in treatment effects, as they are much larger for girls and for children from literate families.

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1. Introduction

There is growing epidemiological and economic literature that suggests that certain chronic conditions later in life can be traced to the course of fetal development.[1] The idea that the nine months in utero are critical period in a person's life and influence on health and other ability outcomes later in life have meaningful implications for individual and policy decisions. However it is a tough challenge to identify the casual effect of in utero conditions on later life outcomes since children's family background is most likely correlated with in-utero conditions but it may have also direct effect on human capital investments and outcomes.

Economists have expanded the epidemiological literature on this hypothesis by analyzing the effect of in utero conditions on non-health outcomes such as education and income while improving the identification strategies (see a review by Almond and Currie, 2011). Most of these studies use changes in the local environment caused by negative environmental shocks as exogenous variation in fetal health or in utero environmental conditions. Example include historical events well-defined with start and end points such as the 1918 Influenza Pandemic (Almond 2006), the 1986 Chernobyl accident (Almond, Edlund and Palme, 2009), the 19th century blight in French vineyards (Banerjee, Duflo, Postel-Vinay, and Watts, 2010) and the 1959-1961 China Famine (Almond, Edlund, Li, and Zhang, 2007). Other examples are the use of variation in infectious disease (Barreca 2010) or economic shocks around the time of birth (Baten, Crayen, and Voth, 2007).

In this paper we use a permanent out of Africa episode where the Jewish population in Ethiopia immigrated to Israel in May 1991. We exploit the quasi-experimental variation in the environmental conditions during pregnancy experienced by women who gave birth before or after arrival to Israel. More precisely, we focus on effects of in utero time of exposure to improved conditions in Israel on the academic achievements of children by the end of high school at age 18. This out of Africa immigration, called "Operation Solomon", was unexpected and occurred quickly over 36 hours when more than 14,000 Jews were airlifted to Israel. The operation was organized by the Israeli government and it brought to Israel almost all the Ethiopians Jews who lived in Ethiopia. Thus the immigrants were not a selected group and the sudden occurrence and timing of this operation did not allow families to

[1] Barker (1992) coned this relationship as the fetal origin hypothesis.

plan and time pregnancy. Therefore, the variation in the timing of the pregnancy and of births can be viewed as random. The children who were in utero in Israel were exposed to an advanced medical care technologies, prenatal condition and nutrition typical to a developed country. In contrast, children who were in utero in Ethiopia experienced in utero respective conditions in one of the poorest developing country. The goal of this paper is to exploit this unique natural experiment and examine whether these dramatic in utero environmental differences affected later life outcomes.

Using high school data linked to individual demographic records of Ethiopian children for cohorts born during 1989-1992, within a narrow time window before or after immigration, we use the birth date of each child to determine number of weeks of exposures in utero to conditions in Ethiopia or in Israel. Following evidence from epidemiological studies about the most critical period of pregnancy for child brain and cognitive development, we focus on the pregnancy period from weeks 8 of gestation as the critical exposure treatment period to Israeli in utero conditions. Therefore our treatment group includes children born between January and May 1992. The outcomes we examine include dropping out of high school, obtaining a matriculation diploma at end of high school, and the number of matriculation credit units obtained overall all and in Mathematics and English in particular. We view the latter outcomes as measure of quality of student's matriculation study program which is known to have a large payoff in terms of post secondary schooling and labor market outcomes later in life in Israel.

We find that the January to May 1992 birth cohort performed substantially better in all of these four outcomes. This treated group is almost 10 percents more likely to obtain a matriculation diploma than marginally older cohorts who were in utero in Ethiopia. This is a remarkably large effect since the average matriculation rate of the control sample is 20 percents. The January to May 1992 birth cohort also were 5 percents less likely to drop out of high school (versus 13 percent counterfactual) and engage in more challenging study program during high school. For example, the treatment effect on mathematics matriculation credit units is 0.4, an effect of about 33 percent, and the treatment effect on English matriculation units is 0.35, an effect of about 18 percent. We assess the robustness of these results by examining whether the estimated effects are sensitive to various definitions of the window of exposure to in utero conditions in Israel, and to controlling for birth cohort effects. Particularly, we also extend our regression discontinuity (RD) identification method to a differences in differences (DID) approach by altering the treatment group to include also children of respective cohorts from families that immigrated from Ethiopia to Israel prior to Operation Solomon. These analysis point clearly that the positive effect of the environmental condition in utero that we estimate is only for children who were in utero in Israel during the whole duration of the critical period, namely between weeks 8 and 25 of gestation and that cannot be explained by birth cohort effects. Finally we also compare treatment effect by gender and by parental education, as heterogeneity observed in previous studies[2]. We find that the effect of different environmental condition in utero is only significant among girls and stronger for children from high educated families.

This research contributes to the existing literature by investigating the long run education effects of different environmental conditions in utero in different stage of the pregnancy. Since immigration from developing countries to industrialized countries is common all around the globe, this analysis provides insight on one of the impacts of such immigration on next generation of immigrants.

The remainder of the paper is organized as follows. The next section presents related literature. Section 3 presents the historical background of Ethiopian Jews that immigrated to Israel in May 1991, and provides evidence on major environmental differences between their life in Ethiopia and their life in Israel upon arrival. Section 4 describes the data and Section 5 the empirical strategy. Section 6 presents the empirical estimates of the effect of environment condition in utero on a variety of high school outcomes as well as robustness checks. Section 7 concludes and Section 8 discusses future work.

2. Effect of in Utero Conditions: The Economic Literature

The recent economic literature contributes to the identification of the effects of in utero conditions. It often exploits a broader range of random shocks and circumstances and has found significant impacts on outcomes including test scores, educational attainment, income, and health. Earlier studies have shown that the fetal health can be affected by a variety of subtle and less subtle shocks [Lien and Evans (2005a), Lien and Evans (2005b) Camacho (2008) Currie and Walker (2009)]. These

[2] Currie and Hyson (1999), Case, Lubotsky, and Paxson (2002), and Currie and Moretti (2007). Almond, Edlund and Palme (2009)

studies used exogenous changes which influenced the environmental conditions of the mother and find that negative environmental shocks have negative effect on fetal health after birth, often measured by birth weight.

Other related studies evaluate the effect of fetal health (like birth weight) on long term outcomes of human capital. Currie and Hyson (1999), used the British National Child Development Survey and found that low birth weight children were more than 25 percent less likely to pass English and math O-level tests (equivalent to high school exit exams), and were also less likely to be employed at age 33. Behrman and Rosenzweig (2004), Black, Devereux, and Salvanes (2007) and Oreopoulos, Stabile, Walld, and Roos (2008) used sibling and twins samples in order to control for unobserved family characteristic which may be correlate with birth outcomes and long term outcomes and find significant effect of birth weight on varied outcomes on schooling and height; For example, Black, Devereux, and Salvanes (2007) found that 10 percent increase in birth weight increases high school graduation by 1.2 percent, IQ (of men) by percent, earnings by 0.9 percent, and height by 0.3 percent.

The evidence on the link between environmental conditions in utero and fetal health and the connection between fetal health and outcomes later in life led to studies that analyses the effect of environmental conditions in utero on long term human capital outcomes. Identification in these studies is based on comparing cohorts that were exposed to in utero shocks to cohorts that did not. For example Almond (2006) used the 1918 Influenza Pandemic as an unexpected shock to health of pregnant mothers. He compared the long-term outcomes of early 1919 birth cohort whose mothers were exposed to this shock while pregnant and and mothers who gave birth earlier in 1918, which had essentially no prenatal exposure to the 1918 Pandemic. Furthermore, he also used the variation of the Pandemic severity between States to control for time and cohorts effect by DID estimation. His finding shows that children of infected mothers were about 20% more likely to be disabled and experienced wage decreases of 5% or more, as well as reduced educational attainment. Almond with Edlund, Li, and Zhang (2007) estimated the effects of maternal malnutrition caused by the 1959-1961 Chinese famine. They found that fetal exposure to acute maternal malnutrition had was associated with greater risk of being illiterate, out of the labor force, marrying later (men), marrying spouses with less education (women) and lowered birth sex ratio (boys to girls) of not only the first but also the second generation. Almond, Edlund and Palme (2009) used the 1986

Chernobyl accident in Sweden as exogenous variation in prenatal radiation exposure to analyze the casual effect on cognitive ability. They used the geographic variation in the level of fallout and comparing different cohorts in different regions to evaluate the effect of radiation in utero on health status during the childhood and school performance. They also analyze within family effect. They found that the birth cohort who expose to this radiation between week 8 and 25 of gestation performed substantially worse in school but do not detect corresponding health damage.

Additional interesting effect found by Banerjee, Duflo, Postel-Vinay, and Watts (2010). They consider the 19th century blight to French vineyards from the phylloxera insect which spread slowly from across France as an exogenous decrease in wine production and thereby in income in different regions in different time. According to data on military recruits at age 20 children born to wine-growing families and born in the years and regions affected by the crisis were 0.5 to 0.9 centimeters shorter in adulthood (relative to the 2 centimeter secular increase in heights over the 19th century). Since height and income and even height and cognitive abilities are positvly correlated [Case and Paxson (2008)[3]] this is a very important implication of in utero effects also on non-health outcomes.

This paper is related to the studies which investigating the connection between in utero environmental differences to later life outcome. But unlike the studies present above the analysis in this study is based on environmental differences caused by moving from developing country with poor health care and leaving condition to western country with advance medical care and more appropriate leaving condition (such as better hygienic and nutrition). Analyzing the effect of these environmental differences is more relevant to policy in contrast to the effect of disasters.

3. Background

a. The Immigration of Ethiopians Jews to Israel[4]

The Ethiopians Jewish community, as known also as "Beta Israel" has lived in the region of Northern Ethiopia called Gondar for several centuries[5]. The origin of the

[3] Case and Paxson (2008) shows that throughout childhood, taller children perform significantly better on cognitive tests. Thus, as adults, taller individuals are more likely to select into higher paying occupations.

[4] For more details see Lavy, Gould and Peserman (2004).

Ethiopian Jews is obscure and according to some sources they relate to the lost tribe of Dan (one of the twelve tribes of Israel). The existence of this remote community became common knowledge in the American Jewish world only late in the 19th century. The Joint Distribution Committee (AJDC) sent money to the community, till World War II, when Ethiopia was regarded as a hostile country because of the Italian occupation. With the establishment of the state of Israel nothing was done to bring the Ethiopian Jews to Israel. Only on 1975 after the Chief Rabbinate ruling that the Beta Israel was in fact descendants of one of Israel's lost tribes, they were entitled to migrate to Israel as full citizens under the Law of Return.

The immigration of Ethiopian Jews to Israel began on a very small scale, mainly through Sudan. Figure 1 present the immigration trend of the Ethiopians Jews from Ethiopia to Israel during the years. In the early '80s, the drought and consequent famine in Ethiopia and the unstable political situation led the Israeli government to act to bring this community to Israel. Between November 1984 and the beginning of 1985, 6000 immigrants were airlifted from Sudan to Israel in a project known as "Operation Moses". They had left Gondar in circumstances of drought and hunger and trekked across hundreds of kilometers to South Sudan; many of the sick, the old and the weak died on their way to Israel. News of the rescue leaked out to the foreign media in November 1985, with the result that President Numeiri of Sudan halted the operation for fear of hostile reaction from the Arab states.

Between 1985 and 1989 the Ethiopian authorities limited the movement of all citizens, Jews included, making immigration almost impossible. The renewal of diplomatic relations between Israel and Ethiopia in November of 1989 opened new avenues, and allowed for political and public pressure on the Ethiopian government, which was struggling with civil war, draught and famine. Jewish communities in the USA and Canada became interested, and through their donations two organizations were working in Ethiopia: American Association for Ethiopian Jews (AAEJ), and North American Conference on Ethiopian Jewery (NACEJ).On May 1990 AAEJ hired busses, and brought Jews from their villages at north of the country to the capital Addis Ababa, then NACEJ opened a compound in Addis Ababa where Jewish families resided, waiting for permission to fly to Israel. They didn't know when they

[5] After the rise of Christianity in Ethiopia in the fourth century, the Jews who refused to convert were persecuted and withdrew to the mountainous Gondar region where they made their homes for more than 2000 years.

will be going to Israel and realized that they would be living in Addis Ababa for the time being. However, military events in Ethiopia pushed the Israeli government to act. In May 1991, after Ethiopian dictator Mengistu fled the country the Israeli government realized that the Ethiopians Jews should be rescued before rebels take over Addis Ababa. On May 24 1991, over fourteen thousand Ethiopian Jews (almost the entire Jewish population remaining in Ethiopia) were airlifted to Israel within 36 hours. This operation was named "Operation Solomon". Upon arrival to Israel the immigrants were placed in absorption centers all over the country where they stayed for few years until they moved to permanent housing.

b. Environmental Conditions of "Operation Solomon" Immigrants in Ethiopia and in Israel

Leaving conditions: Prior to "Operation Solomon" migration, the Ethiopians Jews were still living in hundreds of small, remote villages in northern Ethiopia. Their live had been virtually untouched by developments in the outside world. Their lifestyle and beliefs are more consistent with traditional rather than western societies. The men plowed their stony fields with primitive plows pulled by a brace of oxen. The women spent their days carrying jugs of water long distances to their huts (tukuls), foraging for the ever-diminishing scraps of firewood, spinning cotton, weaving their own cloth and taking care of their children. Less than 30 percent of the population was literate in their native languages and schools were not accessible to the majority of the population.

In May 1990 almost the entire Ethiopian Jewish community migrated to Addis Ababa, the Ethiopian capital, 300 miles away. In Addis Ababa they were housed in refugee camps scattered all over the city knowing that they are waiting for immigration to Israel but did not know when. They leaved in poor hygienic and overcrowded conditions where eight to ten people were crowded into shacks. After their arrival the immigrants were leaving in absorption centers (80 percent) and mobile home camps (20 percent) for the first few years.

Medical care: In rural villages local traditional practitioners provided most of the medical care utilizing traditional medications and treatments. The common western perception of disease causation was not prevalent. For many, the first exposure to western medical practices was through the AJDC's medical clinics in Addis Ababa before their evacuation to Israel.

At the beginning of their stay in Addis Ababa the medical services did not function and many of the Jews in the camps fell ill with diseases such as malaria, hepatitis and tuberculosis. In July 1990, 39 deaths occurred in this community of approximately 22,000 people[6]. In response, the AJDC rapidly developed a comprehensive medical program during a 3-week period commencing on August 20 1990. A vaccines program succeeded to reduce mortality. Israeli doctors trained Ethiopian community health practitioners that made home visits and provided medical services to approximately 4000 families. The major issues of concern were cases of tuberculosis and vaccination of children. These programs reduced significantly the death rate in the following months. [M.Myers (1993)].

After arrival to Israel the immigrants received modern medical care though gaps in culture or language presented a problem. The Israeli health authorities developed education health program to bridge these gaps and promote effectively the transfer to the immigrants skills regarding proper health care, nutrition, western perception of prescribed medications and personal hygiene [Levin-zamir, Lipsky, Goldberg and Melamed (1993)].

Nutrition: The traditional Ethiopian diet consisted of unrefined flours, legumes, grains, beans, vegetables, minimal meats, and few refined sugars and processed foods. Upon arrival in Israel, the immigrants' eating habits changed. Many of the traditional Ethiopian staples were unattainable. In the absorption centers in Israel they were served Israeli style food communally, some leaved in mobile home camps where they purchased food and cooked for themselves, incorporating Israeli food products into their diets. The traditional Ethiopian diet is based upon sour-dough pancake called injera, usually made from teff, an indigenous Ethiopian grain rich in protein, vitamins and iron. Since teff is not readily available in Israel, the immigrants make injera out of refined white flour [Levin-zamir, Lipsky, Goldberg and Melamed (1993)].

[6] Based on the Ethiopian crude death rate of 24/1000 population/year, the expected number of death in a population of 22,000 people would be 528 or 44 per month. In July 1990 there were 39 deaths in population of 22,000 people, approximately 88% of the 44 deaths, expected on the basis of national figures.

Pregnancy and Delivery: Ethiopians women who lived in rural areas view pregnancy as normal stage that does not require medical attention. They delivered their babies at home with support and assistance from female family and neighbors and a traditional birth attendant or lay midwife. In contrast, in Israel, pregnancy and delivery reflect a biomedical and technological approach including close monitoring and intervention throughout the pre- and post natal period.

The Ethiopian immigrant's beliefs that pregnancy outcomes are all at god's will and that medical care is irrelevant were unchanged upon arrival to Israel. Thus low utilization of pre- and postnatal health care in Israel was documented among the Ethiopian immigrants. However, most deliveries of Ethiopian babies were at hospitals with the assistance of formally trained professionals rather than traditional home delivery practices as in Ethiopia. Also, In Israel the practice is prescribing vitamin and iron supplement for pregnant women. The Ethiopian women who believed that in Ethiopia this was not needed because "the food was better, it contains more vitamins than the food in Israel" agree that these vitamins was needed in Israel because their lack in the Israeli food [Granot, Spitzer, J.Aroian, Ravid, Tamir and Noam (1996)].

4. Data

In this study we use a dataset using student administrative records collected by the Israeli Ministry of Education (2007-2011). Our data includes student's birth dates, the student's and the students' parent's immigration dates as well as country of origin. We use information on the immigration dates and country of origin of the student's parents to identify the students who's both parents immigrated to Israel from Ethiopia with "Operation Solomon" on May 24th 1991. Our sample includes students born up to year and half before or up to one year after the immigration date[7]. The administrative records also include data on student's demographics (parent's education, number of siblings), whether currently attending school, and whether the student dropped out or already graduated from high school. We link the administrative records to individual data on high school matriculation exams outcomes in the 2007-2011 school years including whether the student obtained a matriculation certificate, overall matriculation program credit units and credit units by subject.

[7] Since our sample is on students born between 1989 and 1992 they all should be high school graduates on 2011 or at least be high school students.

A matriculation certificate is a prerequisite for admission for academic post-secondary schooling. There are also many employers who make it a condition of employment. Students complete the matriculation process by passing a series of national exams in core and elective subjects during high school years. Students choose to be tested in each subject at various levels of difficulty by his ability, with each test awarding the student between one and five credit units per subject, varying by the difficulty of the exam (one is the lowest level and five the highest).

In our analyze we focus on the following outcomes: whether the student dropped out of high school, whether received a matriculation certificate, total test credit units and credit units in mathematics and English. We view these two outcomes as a measure of the quality of the curriculum of studies. We do not use test scores as outcomes because the majority of our sample does not hold a matriculation certificate (about 70% according to table 1) and therefore have missing values for all or some of the tested subjects. Imputing zeros instead of missing values might bias the estimates and we rather therefore focus on using number of credit units received since zero is the true value if a student took no exam in a given subject.

Our primary sample includes students born between June 1990 and May 1992 (twelve month before and after immigration date), we refer to this sample as sample A. We define two additional samples[8], one that includes children born between January 1990 and May 1992[9] (sample B) and a second that includes children born between January 1989 and May 1992 (sample C). In sample A we face a measurement error in the date of birth because many of the Ethiopian children born during 1990 did not record exact birth date and received January 1990 as their birth date in the data. We therefore exclude all of these children from the sample, some of which may have actually born after June 1990. Therefore we define the two other samples B and C which include all cohorts within a year for the Ethiopia born children (January to December). In these two samples the exact month of birth is irrelevant.

In each one of these samples the treatment group includes students for whom both parents immigrated to Israel from Ethiopia in "Operation Salomon" on May 1991 and

[8] In all the three samples we excluded children that dropped out from school before 8 grade and children who are defined as elementary school students on 2011.

[9] We didn't include student born after May 1992 because almost half of the June to December 1992 cohort is still high school students in 2011 (On the other cohorts the mean is 10% who are still high school students). That means that we don't have the final school outcomes for them.

they were born in Israel at least 7 month after immigration date (from January 1992) but not after May 1992 which means they were in utero in Israel between 8 and 25 weeks of gestation (the critical period for the fetus brain development). The comparison group includes students whom their both parents immigrated to Israel from Ethiopia in "Operation Salomon" on May 1991 and they themselves were born in Israel or in Ethiopia before January 1991[10].

In Figure 2 we present the birth distribution in this sample. The mass of births occurring in January for the Ethiopian born children (everyone that was born before May 1991) can be explained by missing the exact birth date. As for the other months it can be seen that there is no difference in the distribution of births by months of births between children born during 1992 (the treatment group) to all the others (the comparison group). This is another evidence that indicates that the immigration did not affect the timing of the inception.

Table 1 presents the summery statistics for the variables used in our analysis, by treatment and comparison groups. Column 1 presents the means of background and outcomes variables for the treatment group (students born between January and May 1992). Columns 2-4 present the respective means for the comparison groups according to samples A, B and C. Importantly, the mean of father and mother years of schooling is the same in all four samples, about 2.5 years of schooling. Some difference is seen for number of siblings; in the treatment group it higher by 0.5 siblings. The boys and girls ratio is similar in both the treatment and the comparison groups.

Despite their similarly in observed characteristics, we find that the treatment group performed better in school. Only 8.6 percent of the treatment group dropped out of high school in comparison to 13 percent in the comparison group. The treatment group is 10 percent more likely to obtain matriculation diploma by the end of the 2011 school year. This difference grows larger when restricting that matriculation diploma is achieved after twelve years of schooling[11]. As for the quality of the study program, it is evident that the treatment group achieves matriculation with 3 more

[10] Children born in Ethiopia and immigrated to Israel on May 1991 and children born in Israel but less than 7 months after immigration date, May 1991, of their parents.

[11] In the regular matriculation track student should obtain his matriculation certificate after completing twelve grades. Thus, he should obtain his matriculation certificate after 12 years of schooling unless he repeated a class or completed the matriculation exams after graduate high school.

credit units on average. This quality premium is evident in gaining 0.5 credits more in both Mathematics and in English.

5. The Empirical Strategy

The main goal of this paper is to analyze the casual effect of different environmental conditions in utero on later life outcomes. However, it is often very difficult to identify the casual effect due to unobserved factors that are correlated with the environmental conditions of the mother and with the later life outcomes of the child. "Operation Solomon" crates a quasi-experimental framework where children born at the beginning of the 1990's (1989-1992) to Ethiopians immigrants with the same background experienced one important difference: some were in utero in Ethiopia and some were in utero in Israel. This difference was determined solely by the timing of pregnancy. Children that were in-utero in Ethiopia and were born a short time before or just after their mothers immigrated to Israel on May 1991 ‘missed’ the Israeli environmental conditions in utero but children that their mothers conceived a short time before or after they immigrated to Israel on May 1991 were in-utero in Israel and could benefit from these better Israeli environmental conditions in utero. In order to estimate the causal effect of these conditions in utero on later life outcomes by comparing those two groups we have to assume that children in both groups have the same characteristics. The key identifying assumption is that the children who were exposed to better environmental conditions in utero (the "treatment group") were not different from children who were not exposed to these conditions in utero (the "comparison group").

"Operation Solomon" was an unexpected event completed in a very short time. Therefore it is likely that the timing of immigration was not correlated with the timing of the pregnancy and birth[12], and there should not be any correlation between the immigrant's characteristics and the decision to immigrate which is often an issue in

[12] It is reasonable and important assumption that in the Ethiopian Jewish population who came from developing country there is no birth planning. In opposite to the claim that they could plan the pregnancy according to the events while waiting in Addis Ababa to immigrate or just after arriving to Israel. One fact that can support this assumption is an article published on "Yediout Hacharonot" Journal on January 2008, one of the main daily journals in Israel, which claiming that contraception Defoe gave systematically in suburb to Ethiopian women who migrated to Israel in recent years. The contraception Defoe received the FDA approval only in 1992 and starts to use in Israel only on 1996 so it has no effect on the cohorts under the analysis in this study. The story, even that the official's health authorities didn't confirm it, tells us that basically the Ethiopians women needed help in family planning.

immigration processes[13]. Therefore, comparing children that were in-utero in Ethiopia and were born a short time before or after their mothers immigrated to Israel to children that were in-utero in Israel a short time after their mothers immigrated to Israel allows us to identify the causal effect of environmental conditions on later life outcomes. In this paper we focus on schooling outcomes by age 18-20. It is interesting to analysis the effect on schooling outcome since it is a good measure for cognitive ability and skills. It is also conventional to use schooling outcomes as a proxy for the individual achievements as an adult in the job market. Since this event occurred 22 years ago we can observe the schooling outcomes of these children who were in utero at that time.

According to medical studies the nature of the developmental events occurring in the fetus brain during week 8 to week 25 of gestation has important effect on cognitive skills later in life[14]. Before week 8 of gestation (the 2–7 weeks post conception) the internal organs are developed. Changing in the environmental conditions in utero during this period may have an effect on health outcomes. However, since the fetus brain starts to develop on week 8 post conception and it is developed rapidly by week 25 of gestation, we call it "the critical period in-utero". Hence, we expect that changes in the environmental conditions in utero at that specific period will have an effect on cognitive ability. Therefore we define the treatment group as the birth cohort that was in utero in Israel between weeks 8 and 25 of gestation (i.e. from week 8 until birth). Since the immigration took place on the end of May 1991 and assuming a 38 weeks post conception gestation, those who were in utero in Israel from week 8 of gestation are those who were born from January 1992 on. Thus, we will consider the cohort born between January 1992 and May 1992[15] in Israel as the treatment group. The comparison group includes cohorts born in Ethiopia a short time before immigration or cohorts whose their mothers were beyond weeks 8 of gestation at the time of immigration to Israel, namely cohorts born before January 1992 but not earlier that 1989[16].

[13] We will test this assumption on the next section.
[14] Nowakowski RS and Hayes NL (2008), Loganovskaja TK and Loganovsky KN (1999) reported that sub-clinical damage to human fetuses between 8 and 25 weeks of gestation can result in cognitive deficits still manifest 16-18 years after birth.
[15] The reason for the cut off on May 1992 describe in footnotes on the data chapter.
[16] The idea is to compare between children that born close to each other as possible in order to avoid time trend or year of birth effects.

Our basic regression model is specified in the following equation:

$$(1) \qquad Y_i = \beta\, ISR(InUtero)_i + \gamma\, X_i + \delta\, MOB_i + u_i$$

Y_i is the school outcome of student i and $ISR(InUtero)_i$ is the key explanatory variable that takes the value 1 for the cohort born between January 1992 and May 1992 (treatment group) and the value 0 if student i was born before January 1992 (comparison group). The quasi-experimental variation in the environmental conditions during pregnancy guarantees that it is uncorrelated with the residual, thus the parameter β, which is the main effect, can be interpreted as causal and we expect it to be positive. X_i is a vector of student's i characteristics which can be correlated with school outcomes like parents' education, gender and number of siblings. Although the treatment is exogenous so β can be identified without further controls for the student's characteristics, these additional measures are included in order to reduce the standard errors of the estimates. Furthermore, because there is substantial seasonality in school performance by birth month we control for that too and MOB_i is the month of birth fixed effect.

Finally, since we include different cohorts in our analysis we should consider also controlling for the year of birth to account for secular trend in outcomes[17]. The basic specification presented in equation (1) does not include cohort effect because it is perfectly correlated with the treatment definition[18]. But note that we are restricting our sample to children who were born up to year and half before they immigrated to Israel, therefore we think that the scope for their timing differential cohort effects is very small.

6. Results

a. Balancing Tests on Observables

We provided evidence that suggest that exposure to the improved in utero environmental conditions following "Operation Solomon" was random. We provide here supporting evidence to this claim by showing that children exposed to better environmental conditions in utero in Israel are not different in their observable characteristics from the children who were in utero in Ethiopia. Specifically, we test

[17] Usually regressions that estimate effects on school outcome includes year of birth effect i.e. cohort effect because of secular trends.

[18] We will address a potential solution to that problem later on.

whether there is a significant correlation between the observable characteristics of children and the timing of the pregnancy. Of course the absence of such statistically significant correlations is not a full proof for treatment status being random but lack of correlations with observables raises the likelihood of no correlation between treatment status and unobservable confounders.

The results of these balancing tests are presented in Table 2 for gender and three family backgrounds variables: father's years of schooling, mother's years of schooling and number of siblings. We present results based on three samples of analysis. Sample A includes children born between May 1990 and May 1992. Sample B expands sample A by adding children born between January 1990 and May 1990 and sample C is adds also children born during 1989. The treatment group, which is the same in all three samples, includes children born between January and May 1992.

The estimates presented in Table 2 reveals that gender and parent's years of schooling is not significantly correlated with the treatment in all three samples. However, the third row indicates that the number of siblings is significantly correlated with the treatment as children exposed to better environmental conditions in utero have on average 0.3 more siblings. This imbalance can simply reflect a mechanical relationship as children born at a later date will naturally have more siblings than children born earlier. We will show below that controlling for number of siblings does not change the estimated treatment effect, suggesting that this imbalance is not a confounder of treatment effect.

We think that these results support our claim that exposure to treatment is indeed as good as randomly assigned in this natural experimental setting. We will however subject our findings to a more demanding identification model by using within family older siblings as a control group. In this empirical model a family fixed effect will control for any observed and unobserved family background.

b. Baseline Model and Specification

Table 3 presents the results for our baseline specification (equation (1)). Columns 1, 4 and 7 presents estimates from an OLS regression without any controls, columns 2, 5 and 8 add to the regressions month of birth fixed effects and in columns 3, 6 and 9 the estimates are from regressions that include also student characteristics as controls.

The OLS estimates in column 1 show significant positive effect of in utero environmental conditions on all school outcomes. For example, being in utero in Israel from week 8 of gestation lowers by4.3 percentage points (sd= 0.022) the likelihood to drop out of high school. This estimate is almost unchanged when controlling for month of birth (column 2), when controlling for student's characteristics and when expending the sample to include older children in the control group.

The second to last row in Table 3 show that exposure to better environmental conditions in utero from week 8 of gestation have positive and significant effect on all our measured matriculation outcomes. Treated students are 13.6 percent (sd=0.03) more likely to obtain a matriculation diploma by end of high school[19]. When month of birth dummies are added, this effect decline to 9.2 percent but when including student's characteristics as controls, the estimated treatment effect is lowered further only to 8.1 percent. The results based on samples B and C are very similar. We note further that the decline in treatment estimates is totally due to the inclusion of the gender indicators and that the control for the other characteristics does not move at all the estimated treatment effect. This pattern is interesting as the balancing test indicated an equal proportion of genders in the treatment and control group. We will return later to discuss point when presenting heterogeneity treatment effect by gender that reveal much larger treatment effect on girls.

The estimated treatment effect on the matriculation rate represents a very large effect size relative to the mean of this outcome in the control group which is about 21 percent. Therefore exposure to better in utero conditions in Israel improved the matriculation rate by 40 percent. It also lowered as we have seen above the high school dropout rate by from 13 percent to about 8 percent, also about 40 percent change. These are dramatic effect size in absolute term and relative to any studied and well identified educational program.

The above gains are accompanied by improvements in other measures of quality of the high school matriculation study program. The total matriculation exams credit units increased by 2.5 (sd=0.941), a gain of about 20 percent, the math and English

[19] The intention is to avoid potential bias due to the possibility of students that did not complete the matriculation exams in the normal track by the end of high school to complete it later in "second chances" programs. Obviously the older cohorts have advantage in this matter to obtain matriculation certificate by 2011 which can bias the treatment effect on the first variable downward. Furthermore, students who repeat class and have the advantage of studying more years are also counts as not obtaining matriculation certificate.

credit units are up by about a third unit, a gain of about 25 percent in math and 15 percent in English. These are important and large quality gains.

c. Robustness Checks with Alternative Definitions of the Treatment Group

So far we defined treatment as exposure to better environmental conditions in utero during the critical period of the fetus brain development (between weeks 8 and 25 of gestation). This is an appropriate definition if exposure during the critical period for brain development is what matters for cognitive schooling outcomes. With this definition, the comparison group includes children whom all their gestation period and birth were in Ethiopia, as well as children who were in utero beyond week 8 of gestation in Ethiopia but their mothers immigrated to Israel sometime after week 8 and gave birth in Israel. But what if exposure to better conditions in utero during some period after week 8 and at birth matters as well for cognitive outcomes? If this is true than the estimates presented in Table 3 underestimate the effect of conditions in utero[20].To test whether conditions in utero are also important during other than the critical gestation defined above, we define a second treatment measure, $ETH(InUtero)_i$ which equals 1 if student i was born between June 1991 and December 1991 in Israel and 0 otherwise. This second treated group was in utero in Israel only during part of critical period (from week 8 of gestation). The regressions we estimate include now two treatment measures as follows:

$$(2) \qquad Y_i = \beta ISR(InUtero)_i + \alpha ETH(InUtero)_i + \gamma X_i + \delta MOB_i + u_i$$

When $ISR(InUtero)_i$ is our original treatment measure used in equation (1). Note that the group defined by $ETH(InUtero)_i$ as exposed to treatment was before part of the comparison group and now it is a treated group. Therefore, the estimate of β, the effect of being in utero during all the critical period in Israel might be different from the estimates presented in Table 3 if α is different from zero[21]. However, if the estimate of β from equation (2) will be similar to the reported estimates in table 3 and the estimate of α will not be significantly different from zero, it will imply that conditions in utero matters for cognitive ability only during the critical period of the fetus brain development.

[20] As describe in section 3 of the paper, Ethiopians women from Operation Solomon chose often after arrival to Israel to give birth at hospitals rather than at home as they used to do in Ethiopia.
[21] The average week of gestation in immigration of that group is 23.4.

The results of estimating the two treatment effects jointly are presented in Panel A of Table 4 for the two first samples[22]. Columns 1 and 5 presents the estimates of β, and columns 2 and 6 the estimates of α. In the last two rows of the table we report the number of children included in each of the two treatment groups, and the median number weeks of gestation in Israel for each treatment group. The regression specification in this table includes student characteristics and month of birth as controls. The estimates of β in both samples are positive and statistically significant, and are almost identical for all outcomes to the respective estimates reported in table 3. The estimates of α however are small, sometime positive and sometime negative and are not statistically significant for all outcomes. These estimates demonstrate clearly that better environmental conditions in utero after the beginning of the critical period and at birth do not have any significant effect on school outcome. The median duration of in utero in Israel for this group is 15 weeks while for the first treatment group it is 38 weeks.

In sample A the estimate of for obtaining a matriculation certificate is 7.7 percent (sd=0.035) in comparison to 8.1 percent (sd=0.036) reported in table 3. The estimate of α in Table 4 however, is -2.3 percent (sd=0.034). Note also that the estimates of β and α in the matriculation rate outcome regression presented in Table 4 are statistically different. This pattern of significant estimated β, practically zero α and no overlap in the 95 percent confidence interval of these two estimates is replicated for all the other outcomes in Table 4, columns 5-6 in sample B results.

As reported on the bottom of table 4, the two treatment groups are similar in size, 280 students were in utero during all the critical period in Israel and 307 students were born in Israel but were in utero in Ethiopia at least the first 8 weeks of gestation[23]. The first group indeed spent the most if not all the pregnancy in Israel and of course for all the students in this group 100 percent of the critical period in utero was in Israel. However the second treatment group immigrated to Israel on average in the 23rd week of gestation which is the end of the critical period. These statistics can explain our sharp finding that it is the environmental conditions in utero during the whole critical period that matters for cognitive performance later in life. Our findings

[22] The results for sample C were similar thus we do not report them.

[23] The size of the treatment group is the same for all samples since only the size of the students who were born in Ethiopian is changing between the samples.

also support a conclusion that giving birth in Israel does not make a difference for cognitive performance as measured by the matriculation outcomes.

In panel B we report results that allow us to test the robustness of the results with respect to the definition of the two treated groups. Instead of including in the second treatment group all children who were in utero upon arrival to Israel in the critical period (between weeks 8 to 25) or after week 25, we include in it only the former group. The results using this alternative definition for treatment are reported in columns 3-4 and 7-8. The estimates in columns 3 and 7 are similar to those reported in columns 1 and 5 respectively. The estimates in columns 4 and 8 are statistically insignificant, similarly to the estimates reported in columns 2 and 6 respectively. These results support our earlier conclusion that environment conditions in utero have an effect on cognitive outcomes only if exposure is over the full length of the critical period.

d. Is It in Utero Environmental Conditions Differences or Birth Cohorts Effects?

An important potential concern about the results presented above is that the estimates may be confounded by unobserved cohort effects since the treated students are younger even if it is a small difference that range from few months to two years. However, if children born later perform better at school than their older peers, such potential cohort effects may be picked by the treatment effect estimates. Against this threat we produced alternative estimates using DID estimation and including in the sample Ethiopians Jews immigrated to Israel before May 1991. The main wave of immigration prior to "Operation Solomon" was "Operation Moses" between 1984 and 1985 and it brought to Israel over 6,000 immigrants. We add to the sample of analysis the children born in Israel to this earlier wave of immigration during the same period of births in our previews samples (1989 - May 1992). Since these children were born in Israel they can all be viewed as treated and so the difference between the young and older cohorts in this group should only reflect cohort effects[24]. The "Operation Moses" and the "Operation Solomon" group were different in many aspects. However, all the students in our sample – those who were born to parents immigrated in "Operation Moses" and those who were born to parents immigrated in "Operation Solomon" - originate from the same country, have the same genetic profile and

[24] This group contains students born in Israel from 1989 to 1992 but whose parents emigrated from Ethiopia before 1989.

culture and were born to immigrant parents. Thus we can assume that students' trends would be the same in both groups in the absence of the "treatment". In other words, if the treatment effect captures only the cohort effect then the gaps between the treatment group and the control group on the same birth cohort will be the same for all birth cohorts. We therefore estimate the following DID model:

$$(3)\quad Y_i = \beta_1 Solomon_i + \beta_2 Post_i + \beta_3 ISR(InUtero)_i + \gamma X_i + \delta MOB_i + u_i$$

Where $Solomon_i$ is an indicator variable for students in the sample that they or their parents immigrated to Israel as part of "Operation Solomon", and $Post_i$ is an indicator variable for students born from January 1992. $Treat_i$ is the treatment indicator which equals 1 for the treated students[25], including children from "Operation Solomon" and of parents from "Operation Moses" who were in utero in Israel during the critical period. Hence, the coefficient β_3 represents the treatment effect estimate that corresponds to β in equation (1) but the former is net of cohort effects.

First we present in Table 5 the balancing tests on observables for the DID samples of treatment and control. The estimates for father’s and mother's years of schooling and number of siblings are not statistically significantly correlated with the treatment in all three samples. We note that in RD sample the number of siblings was significantly correlated with treatment and in the current DID sample it is not. This confirms our earlier suspicion that this correlation reflected a birth effect, namely that younger children are more likely to have more siblings. In row four we observe also that the gender indicator is no balanced between the two groups, with higher ration of boys in the control group.

Table 6, column 1 and 3 reports the estimates of β_3 from equation (3) without controls and in columns 2 and 4 with controls.[26] The latter estimates are marginally different from the former and we focus here on the columns 2 and 4 estimates. The estimate for the dropout rate is negative and very similar to the respective estimate in Table 3, -0.050 and -0.048, respectively in sample A. The estimates for all high school cognitive outcomes are positive, significant and importantly very similar to the respective estimates in Table 3. The consistency of evidence across Table 3 and Table 6 suggests that the treatment effect we estimate and present in table 3 is not picking

[25] The treatment definition is the original treatment measure used in equation (1), i.e. the student was in utero from week 8 of gestation in Israel.

[26] The results for sample C were similar thus we do not report them.

up birth cohorts effect. For example, the effect of treatment on high school matriculation rate in Table 6 is 7.4 percent (sd=0.045) in sample A versus 8.1 percent in table 3, and 8.7 percent (sd=0.044) in sample B versus 9 percent in table 3. The effect on the English credits is 0.35 units in Table 6, exactly equal to the respective estimate in Table 3 in both samples. For the other outcomes the estimates in Table 6 are marginally lower than the respective estimates in Table 3. Overall, we conclude that the RD estimates are fully consistent with the DID estimates.

In Table 7 we present the cross section regressions of pre and post samples where the treatment indicator gets value 1 for "Operation Solomon" kids. The simple differences in differences of means of the "Operation Solomon" and "Operation Moses", pre and post (columns 3 and 6) are equivalent to the DID estimate of equation (3) without controls (columns 1 and 3 in table 6). The most notable results in the table are that the treatment estimates on the post sample (columns 2 and 5) are small and in all but one (high school dropout rate) they are also not statistically different from zero. This an important result because it implies that at post treatment the two groups are indistinguishable in terms of these outcomes and therefore all the DID gains are due the gaps between the two groups in the pre period. Indeed the estimates in columns 1 and 4 are all negative and significant on the matriculation outcomes and positive on the dropout rate. Therefore we conclude that the improvement in environmental conditions in utero in Israel relative to Ethiopia practically eliminated the pre-existing gap between treatment and control in potential outcomes.

e. Heterogeneity in the Effect of In-utero Environmental Conditions

In this section we examine potential heterogeneity in treatment effect. Since the results we presented in Table 3 were sensitive to control for gender, we allow first for heterogeneous treatment effect by gender. Table 8 present the treatment effect estimates by gender for samples A and B. The results reported in columns 1-4 of table 8 are based on equation (1) and includes month of birth fixed effects and students characteristics as controls. The estimates of effect of environmental conditions in utero reveal an interesting differential pattern by gender. The effect on school dropout rate is large but insignificant for boys (-0.071, sd=0.048) and it is practically zero for girls (-0.012, sd=0.026). The effect on dropping out of high school is much higher for boys then in the full sample (-0.071 versus -0.048 in the full sample A), but it is less precise. However, the effect on the matriculation outcomes is positive and significant for girls, but for boys the estimates are much smaller and mostly insignificant. For example in sample A, improving environmental conditions in utero for girls during the critical period increases by 10.1 percent (sd=0.056) their probability of getting a matriculation diploma. The respective effect for boys is lower, 4.6 percent and imprecisely measured (sd=0.043). Perhaps it is worth noting the very large effect on girls on math matriculation units, almost half a unit versus the much smaller effect on boys and the rather similar effect by gender on English matriculation units. All these evidence is interesting because we would have expected that environmental conditions in utero will have the same effect on both genders, in particular in our context where these outcomes are not likely to be affected by pre birth sex discrimination[27]. However this evidence is consistent with earlier findings in related literature. For example, studies on infant health outcomes indicate the same pattern. Baird, Friedman and Schady (2011) find that in developing countries the mortality of girl's infants is significantly more sensitive to aggregate economic shocks during pregnancy than that of boys. Also studies that analyzed the long term outcome found higher effect on girls. Field, Robles, and Torero (2009) report findings that delays in re-supply of iodine for pregnant women in Tanzania during the 1980's has large and robust educational impacts (on average about a half a year of schooling), with larger improvements for girls[28]. Oreopoulos, Stabile, Walld, and Roos (2008) show that effects of infant health on reaching grade 12 by age 17 appear to be somewhat stronger for females than males. Gould, Lavy and Paserman (2011) also find that early childhood living conditions affected only girls and not boys in families that immigrated from Yemen to Israel in 1948-49. The positive effect on girls was evident in short term outcomes such as schooling and on long term outcomes such as employment and earnings at age 55-60. Note however, that the treatment in this case is post birth as all these treated children were born in Yemen and then immigrated to Israel. However, several studies in the medical literature suggest that from conception and during

[27] The development of technologies that allow knowing the sex of the fetus before birth developed made possible prenatal sex determination towards son preferences. Such discrimination can affect birth outcomes but it is not relevant in our context because as noted in section 3 of the paper Ethiopian women in Israel did not make much use of prenatal care except of the delivery of the babies in hospitals.

[28] Iodine supplement during pregnancy has meaningful effect on the brain development and thus on cognitive ability later in life. However studies that evaluate the effect of fetal health on later life outcome found greater effect among men than women, probably due to gender discrimination against girls [Lin, Liu, Chou (2007)].

pregnancy, males are more vulnerable than females. For example, Kraemer (2000) discusses how the human male is, on most measures, more vulnerable than the female, a vulnerability that is attributed in part to the biological fragility of the male fetus and argues that girls are more likely to survive adverse in utero health conditions.[29]

In columns 5-8 of table 8 we report treatment effect heterogeneity of environmental conditions in utero by family education which is a good proxy for family socio-economic status. The samples are divided by father education. Most of the fathers in our sample do not have an education at all (more than 50% have zero years of schooling) and for some of them this information is missing (10 percent of the sample). Thus, we define a low education family when father's years of schooling is equal to zero or has a missing value. The High education group includes at least one year of schooling or more. Perhaps a better definition for these two groups is literate and illiterate families since the average years of schooling years among the high education group is only 6.4 years.

The evidence, interestingly, shows that the effect on the dropout rate is the same for both groups and insignificant but the effect of environmental conditions in utero on matriculation outcomes is much larger and significant among children from families with higher levels of parent's education and is practically negligible for the low education group. For example, the effect on matriculation rate on children from high education families is 14.1 percent while for low education families it is 4.1 percent and not precisely measured. Similar differential effects in favor of the high education group are observed for all other outcomes.

These results are consistent with previews findings in the literature. Studies in health economics found that the negative impact of poor fetal health [Currie and

[29] This article summarizes evidence that suggest that at conception there are more male than female embryos. This may be because the spermatozoa carrying the Y chromosome swim faster than those carrying X. The male's pole position is, however, immediately challenged. External maternal stress around the time of conception is associated with a reduction in the male to female sex ratio, suggesting that the male embryo is more vulnerable than the female. From this point on it is downhill all the way. The male fetus is at greater risk of death or damage from almost all the obstetric catastrophes that can happen before birth. Prenatal brain damage, cerebral palsy, congenital deformities of the genitalia and limbs, premature birth, and stillbirth are commoner in boys, and by the time a boy is born he is on average developmentally some weeks behind his sister: "A newborn girl is the physiological equivalent of a 4 to 6 week old boy." The male brain is heavier, with a larger hypothalamus, probably from the influence of a surge of testosterone in the third trimester of pregnancy, which also promotes greater muscle bulk. Similar differences have been observed in chimpanzees. At term the excess has fallen from around 120 male conceptions to 105 boys per 100 girls.

Hyson (1999)] or exposure to negative shock in utero [Almond, Edlund and Palme (2009)] effect on human capital accumulation is greater in low-education or low-income families. The explanation given for this finding is that higher educated families tend to compensate for negative shocks to fetal health or to poor birth health outcome. Moreover, negative shocks usually affect less on children in high income families because they are less vulnerable.

7. Conclusions

This paper examines the role of in utero environmental condition on long term academic achievements. The analysis is based on exogenous variation in environmental conditions in utero caused by the immigration of Ethiopian Jews to Israel in May 1991. The results suggest that children of gestational age 8–25 weeks who were exposed to better environmental condition in Israel had substantially higher educational outcomes by age 18, including a much higher likelihood to complete high school, to obtain a matriculation diploma and to graduate with a higher quality matriculation study program. The effects sizes are very large, especially against the low counterfactuals. These results are robust with respect to identification methods.

Our findings have external validity beyond the Israeli context. This paper adds to the growing economic literature investigating the fetal origin hypothesis by providing compelling evidence from an unusual natural experiment. To the best of our knowledge this is the first paper that attempts to estimate the effect of different environmental condition in utero caused by immigration, especially from a most poor African country to a western style economy. The external validity of these findings relate importantly to the experience of many industrialized countries with recent increases in immigration rates from the developing countries. Thus evaluating the effect of differences in environmental condition in utero between the country of origin and the country of immigration may explain existing gaps and has important implications for policy decisions.

8. Future work

This paper presents preliminary and incomplete findings. We plan to expand the analysis in the following directions: discuss other potential mechanism, such as high school quality and quality of the local area. Secondly, we will use siblings data with family fixed effects as an additional robustness check to our identification strategy.

Finally we plan to use military enlistment records on cognitive ability tests and health indicators like height and body mass index at age 17 as outcomes.

9. References

Almond, Douglas (2006) "Long-term Effects of In Utero 1918 Influenza Exposure in the Post-1940 U.S. Population" *The Journal of Political Economy,* vol.114, pp.672-712.

Almond, Douglas and Currie, Janet (2011) "Killing Me Softly: The Fetal Origins Hypothesis" *Journal of Economic Perspectives*, vol.25, no.3, pp.153-172.

Almond Douglas, Edlund, Lena, Li, Hongbin and Zhang, Junsen (2007) "Long-Term Effects of The 1959-1961 China Famine: Mainland China and Hong Kong" *NBER Working Paper*, no.13384

Almond, Edlund, Lena and Palme, Mårten (2009) "Chernobyl's Subclinical Legacy: Prenatal Exposure to Radioactive Fallout and School Outcomes in Sweden" *The Quarterly Journal of Economics*, vol.124, no.4, pp.1729-1772.

Alkan, ML. and Shvarts, S. (2007) "Medical Services for Rural Ethiopean Jews in Addis Ababa, 1990-1991" *Rural and Remote Health*, 7: 829 (Online).

Angrist, Joshua D. and Pischke, Jörn-Steffen (2009) "Mostly Harmless Econometrics: An Empiricist's Companion" Princeton University Press.

Baird, Sarah, Friedman, Jed and Schady, Norbert (2011) "Aggregate Income Shocks and Infant Mortality in the Developing World" *The Review of Economics and Statistics,* vol.93, no.3, pp.847-856,

Banerjee, Abhijit , Duflo, Esther , Postel-Vinay, Gilles and Watts, Tim (2010) "Long-Run Health Impacts of Income Shocks: Wine and Phylloxera in Nineteenth-Century France" *Review of Economics and Statistics*, vol.92, no.4, pp.714-728.

Baten, Jörg, Crayen, Dorothee and Voth, Joachim (2007) "Poor, Hungry and Stupid: Numeracy and the Impact of High Food Prices in Industrializing Britain, 1780-1850" Economics Working Papers 1120, Department of Economics and Business, Uniersitat Pompeu Fabra.

Barker, David .J.P. (1992) "Fetal and Infant Origins of Adult Disease" BMJ Books, London.

Barreca, Alan I. (2010) "The Long-Term Economic Impact of In Utero and Postnatal Exposure to Malaria" *The Journal of Human Resources*, vol.45, no.4, pp. 865-892.

Behrman, Jere R. and Rosenzweig, Mark R. (2004) "Returns to Birth weight" *The Review of Economics and Statistics*, vol.86, no.2. pp.586–601.

Black, Sandra E., Devereux, Paul J. and Salvanes, Kjell G. (2007) "From the Cradle to the Labor Market? The Effect of Birth Weight on Adult Outcomes" *The Quarterly Journal of Economics*, vol.122, no.1, pp.409-439.

Camacho, Adriana (2008) "Stress and Birth Weight: Evidence from Terrorist Attacks" *American Economic Review: Papers & Proceedings*, vol.98, no.2, pp.511–515.

Case, Anne, Lubotsky, Darren and Paxson, Christina (2002) "Economic Status and Health in Childhood: The Origins of the Gradient" *American Economic Review*, vol.92 pp.1308-1334.

Case, Anne and Paxson, Christina (2008) "Stature and Status: Height, Ability, and Labor Market Outcomes" *The Journal of Political Economy*, vol.116, no.3, pp.499-532.

Case, Anne and Paxson, Christina (2009) "Early Life Health and Cognitive Function in Old Age" *American Economic Review Papers and Proceedings*, vol. 99, no.2, pp. 104-109

Currie, Janet and Hyson, Rosemary (1999) "Is the Impact of Shocks Cushioned by Socioeconomic Status? The Case of Low Birth Weight" *American Economic Review*, vol.89, no.2, pp. 245-250.

Currie, Janet, and Walker, Reed (2011) "Traffic Congestion and Infant Health: Evidence from E-ZPass" *American Economic Journal: Applied Economics*, vol.3, no.1, pp.65-90.

Field, Erica, Robles, Omar and Torero, Maximo (2009) "Iodine Deficiency and Schooling Attainment in Tanzania" *American Economic Journal: Applied Economics*, vol.1, no.4, pp.140-169.

Granot, Michal, Spitzer, Ada, J.Aroian, Karen, Ravid, Carol, Tamir, Batya and Noam, Revka (1996) "Pregnancy and Delivery Practices and Beliefs of Ethiopian Immigrant Women in Israel" Western Journal of Nursing Research, vol.18, no.3, pp.299-313.

Kraemer, Sebastian (2000) "The fragile male" *British Medical Journal*, vol.321, no.7276, pp.1609-1612.

Lavy, Victor, Gould, Eric and Paserman, Daniele (2004) "Immigrating to Opportunity: Estimating the Effect of School Quality Using A Natural Experiment on Ethiopians in Israel" *Quarterly Journal of Economics*, vol.119, no.2, pp.489-526.

Levin-zamir, Lipsky, Goldberg and Melamed (1993) "Health Education for Ethiopian Immigrants in Israel, 1991-92", Israeli Journal of Medical Science, vol.29, no.6-7, pp.422-428.

Lien Diana S. and Evans, William N. (2005a) "Estimating the Impact of Large Cigarette Tax Hikes" *The Journal of Human Resources*, vol.40, no.2, pp.373-392.

Lien Diana S. and Evans, William N. (2005b) "The Benefits of Prenatal Care: Evidence from the PAT bus Strike" *The Journal of Econometrics*, vol.125 no.1-2, pp. 207-239.

Lin, Ming-Jen, Liu, Jin-Tan and Chou, Shin-Yi (2007) " As Low Birth Weight Babies Grow, Can 'Good' Parents Buffer this Adverse Factor? A Research Note" NBER Working Papers 12857.

Myers, M. (1993) "A Medical Care Program for Ethiopian Jewish Migrants in Addis Ababa", *Israeli Journal of Medical Science*, vol.29, no.6-7, pp.334-338.

Oreopoulos ,Phil, Stabile, Mark, Walld, Randy and Roos, Leslie (2008) "Short, Medium, and Long-term Consequences of Poor Infant Health: An Analysis Using Siblings and Twins" *Journal of Human Resources*, vol.43, no.1, pp.88-138.

Figure 1: Immigration Trend of the Ethiopians Jews from Ethiopia to Israel.

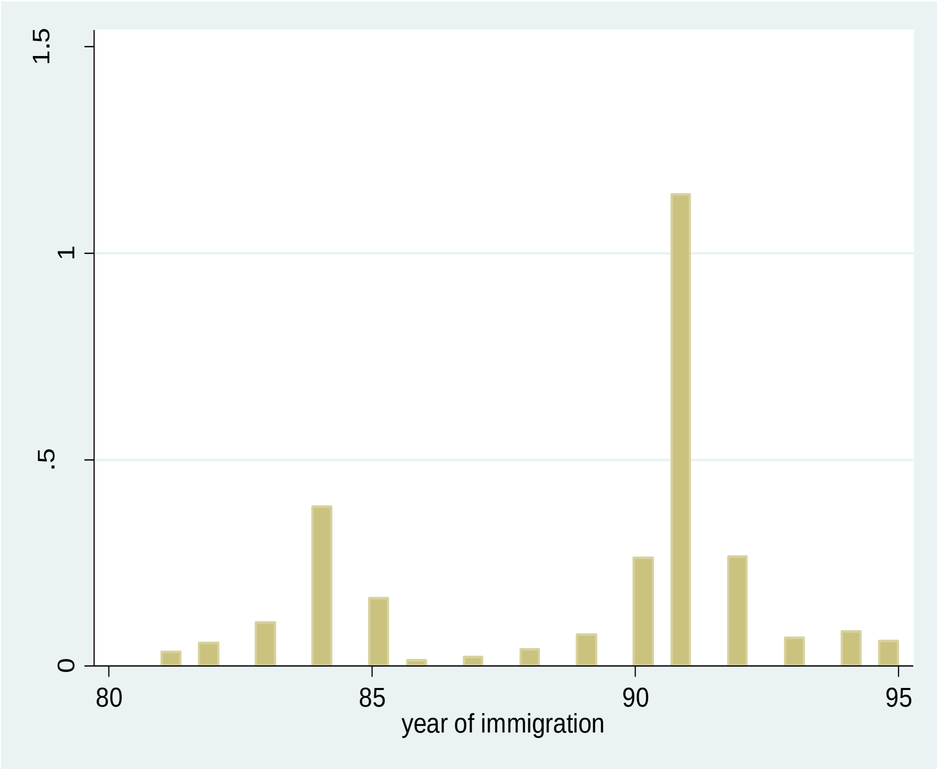
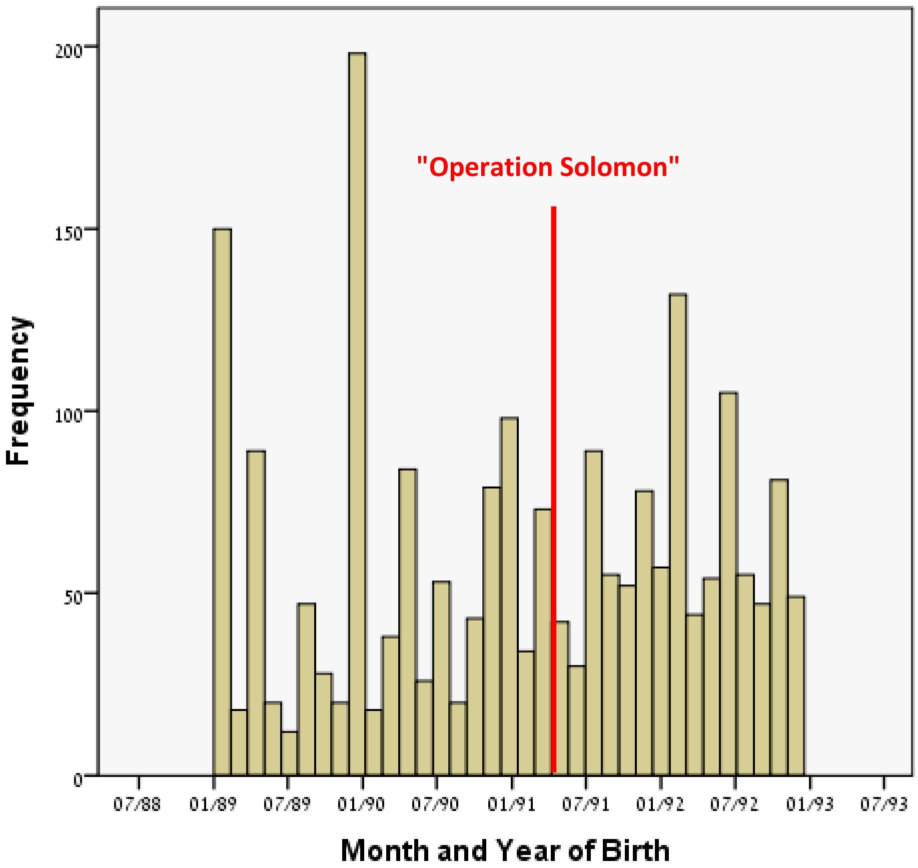


Figure 2: Birth Distribution between 1989 and 1992.



Notes: Includes both Ethiopians children who arrived to Israel on "Operation Solomon" and children of Ethiopians immigrants who arrived to Israel on "Operation Solomon"

Table 1: Descriptive statistics - Treatment Group and Comparison group Characteristics

	Treatment Group	Comparison group		
		Sample A	Sample B	Sample C
	January 1992 - May 1992 Cohorts	May 1990 - December 1991 Cohorts	January 1990 - December 1991 Cohorts	January 1989 - December 1991 Cohorts
Background Characteristics				
Father's years of schooling	2.392	2.448	2.395	2.385
	(3.752)	(3.934)	(3.879)	(3.872)
Mother's years of schooling	2.506	2.532	2.518	2.424
	(3.892)	(3.923)	(3.884)	(2.830)
Number of siblings	2.220	1.960	1.920	1.870
	(1.684)	(1.576)	(1.616)	(1.692)
Boys	0.464	0.509	0.509	0.515
	(0.450)	(0.500)	(0.500)	(0.500)
Outcomes				
Dropped out of high school before completing 12th grade	0.086	0.129	0.128	0.130
	(0.280)	(0.335)	(0.334)	(0.337)
Obtained a matriculation diploma by end of 2011 school year	0.386	0.282	0.280	0.285
	(0.488)	(0.450)	(0.449)	(0.452)
Obtained a matriculation diploma after 12 years of schooling	0.343	0.207	0.204	0.207
	(0.476)	(0.405)	(0.403)	(0.405)
Total matriculation units	15.51	12.55	12.81	12.93
	(11.85)	(11.43)	(11.46)	(11.52)
Math matriculation units (0 to 5)	1.582	1.174	1.196	1.241
	(1.615)	(1.541)	(1.547)	(1.572)
English matriculation units (0 to 5)	2.364	1.936	1.972	1.976
	(1.858)	(1.902)	(1.907)	(1.900)
Number of students	280	784	1067	1472

Notes: Standard deviations are presented in parenthesis. Treatment group includes students who their parents immigrated to Israel from Ethiopia on May 1991 and born between January 1992 to May 1992. Comparison group includes students who they or their parents immigrated to Israel from Ethiopia on May 1991 and born before 1992.

Table 2: Balancing Tests

	Sample A	Sample B	Sample C
	May 1990 - May 1992 Cohorts	January 1990 - May 1992 Cohorts	January 1989 - May 1992 Cohorts
Dependent variable	(1)	(2)	(3)
Father's years of schooling	-0.057	-0.04	0.006
	(0.279)	(0.267)	(0.259)
Number of students	1008	1275	1654
Mother's years of schooling	-0.027	-0.013	0.081
	(0.282)	(0.27)	(0.259)
Number of students	1003	1268	1644
Number of siblings	0.268**	0.305***	0.351***
	(0.112)	(0.109)	(0.107)
Number of students	1064	1347	1752
Gender	-0.045	-0.045	-0.051
	(0.035)	(0.034)	(0.033)
Number of students	1064	1347	1752

Notes: Standard errors are presented in parenthesis. Each Parameter is from different regression of the treatment variable on the student's background characteristic. The results does not change when controlling for month of birth.
*Significant at 10%; **significant at 5%; ***significant at 1%

Table 3: Estimated Effect of In-Utero Environment on High School Outcomes

	Sample A			Sample B			Sample C		
	May 1990 - May 1992 Cohorts			January 1990 - May 1992 Cohorts			January 1989 - May 1992 Cohorts		
	No Controls	Control for Month of Birth	Control Also for Student Characteristics	No Controls	Control for Month of Birth	Control Also for Student Characteristics	No Controls	Control for Month of Birth	Control Also for Student Characteristics
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dropped out of high school before completing 12th grade	-0.043*	-0.055**	-0.048*	-0.042*	-0.042	-0.036	-0.045**	-0.050**	-0.041*
	(0.022)	(0.027)	(0.027)	(0.022)	(0.050)	(0.024)	(0.021)	(0.024)	(0.023)
Obtained a matriculation diploma after 12 years of schooling	0.136***	0.092***	0.081**	0.139***	0.102***	0.09***	0.136***	0.111***	0.099***
	(0.030)	(0.036)	(0.035)	(0.028)	(0.032)	(0.031)	(0.027)	(0.030)	(0.03)
Total matriculation units	2.960***	2.899***	2.490***	2.703***	2.463***	2.026***	2.577***	2.363***	1.869***
	(0.804)	(0.976)	(0.941)	(0.775)	(0.885)	(0.849)	(0.755)	(0.843)	(0.810)
Math matricualtion units (0 to 5)	0.409***	0.389***	0.347***	0.386***	0.352***	0.307***	0.342***	0.317***	0.266***
	(0.109)	(0.132)	(0.013)	(0.105)	(0.12)	(0.117)	(0.103)	(0.115)	(0.113)
English matriculation units (0 to 5)	0.428***	0.423***	0.358**	0.392***	0.357***	0.288**	0.388***	0.347***	0.274**
	(0.132)	(0.159)	(0.155)	(0.127)	(0.145)	(0.140)	(0.123)	(0.138)	(0.133)
Number of students		1064			1347			1752	

Notes: Standard errors are presented in parenthesis. Each Parameter is from different regression. Columns 1 present specifications without any controls, Columns 2 present specification with month of birth dummies only and columns 3 include also both parents' years of schooling (0 if unknown and a dummy for whether the parents' education is unknown), gender dummy and number of siblings (by mother).
*Significant at 10%; **significant at 5%; ***significant at 1%

Table 4: Estimated Effect of In-Utero and Birth Environment on School Outcomes by Different Stages of the Pregnancy

	Sample A				Sample B			
	May 1990 - May 1992 Cohorts				January 1990 - May 1992 Cohorts			
	Panel A: Effect of Critical Period and Birth		Panel B: Effect of Critical Period Only		Panel A: Effect of Critical Period and Birth		Panel B: Effect of Critical Period Only	
	Arriving to Israel on Week 8 of Gestation or Earlier[1]	Arriving to Israel Between Week 8 of Gestation and Birth[2]	Arriving to Israel on Week 8 of Gestation or Earlier[1]	Arriving to Israel Between Week 8 and 25 of Gestation[3]	Arriving to Israel on Week 8 of Gestation or Earlier[1]	Arriving to Israel Between Week 8 of Gestation and Birth[2]	Arriving to Israel on Week 8 of Gestation or Earlier[1]	Arriving to Israel Between Week 8 and 25 of Gestation[3]
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dropped out of high school before completing 12th grade	-0.047*	0.005	-0.047*	0.004	-0.036	0.003	-0.036	0.002
	(0.027)	(0.026)	(0.027)	(0.032)	(0.024)	(0.025)	(0.024)	(0.030)
Passed high school matriculation exams after 12 years of schooling	0.077**	-0.023	0.072**	-0.062	0.088***	-0.015	0.086***	-0.048
	(0.036)	(0.034)	(0.036)	(0.042)	(0.032)	(0.032)	(0.032)	(0.039)
Total matriculation exams units	2.417***	-0.469	2.446***	-0.338	1.978**	-0.483	1.998***	-0.364
	(0.952)	(0.906)	(0.953)	(1.121)	(0.854)	(0.861)	(0.853)	(1.043)
Math exam units (0 to 5)	0.344***	-0.018	0.339***	-0.061	0.305***	-0.024	0.302***	-0.062
	(0.132)	(0.125)	(0.132)	(0.155)	(0.118)	(0.119)	(0.118)	(0.144)
English exam units (0 to 5)	0.360**	0.013	0.353**	-0.036	0.291**	0.022	0.288**	-0.009
	(0.156)	(0.149)	(0.156)	(0.184)	(0.141)	(0.142)	(0.141)	(0.172)
Number of students	1064				1347			
Size of the treatment group	280	307	280	183	280	307	280	183
Median weeks of gestation in Israel	38	15	38	20	38	15	38	20

Notes: Standard errors are presented in parenthesis. All specifications include both parents' years of schooling (0 if unknown and a dummy for whether the parents' education is unknown), gender dummy, number of siblings (by mother) and month of birth dummies. In each row the estimates on columns 1 and 2 are from the same specification, and the estimates on columns 3 and 4 are from the same specification.

[1] Equals 1 if the student were in utero from week 8 of gestation in Israel

[2] Equals 1 if the student was in utero beyond week 8 of gestation in Ethiopia but was born in Israel

[3] Equals 1 if the student was in utero beyond week 8 of gestation in Ethiopia but arrived to Israel before week 26 of gestation

*Significant at 10%; **significant at 5%; ***significant at 1%

Table 5: Balancing Tests for the Difference-in-Differences Specification

	Sample A	Sample B	Sample C
	May 1990 - May 1992 Cohorts	January 1990 - May 1992 Cohorts	January 1989 - May 1992 Cohorts
Dependent variable	(1)	(2)	(3)
Father's years of schooling	-0.442	-0.443	-0.467
	(0.518)	(0.496)	(0.481)
Number of students	1772	2141	2840
Mother's years of schooling	-0.514	-0.553	-0.604
	(0.499)	(0.480)	(0.461)
Number of students	1776	2284	2840
Number of siblings	0.118	0.111	0.147
	(0.47)	(0.159)	(0.155)
Number of students	1889	2284	3033
Gender	-0.107*	-0.098*	-0.110**
	(0.054)	(0.052)	(0.051)
Number of students	1889	2284	3033

Notes: Standard errors are presented in parenthesis. Each Parameter is from different regression of the DID setting as define in equation (2) on the student's background characteristic. The results does not change when controlling for month of birth.
*Significant at 10%; **significant at 5%; ***significant at 1%

Table 6: Difference-in-Differences Estimated Effect of In-Utero Environment on School Outcomes

	Sample A		Sample B	
	May 1990 - May 1992 Cohorts		January 1990 - May 1992 Cohorts	
	No Controls	With Controls	No Controls	With Controls
Dependent variable	(1)	(2)	(3)	(4)
Dropped out of high school before completing 12th grade	-0.063*	-0.050	-0.055	-0.044
	(0.035)	(0.034)	(0.034)	(0.034)
Passed high school matriculation exams after 12 years of schooling	0.096**	0.074*	0.111***	0.088*
	(0.046)	(0.045)	(0.045)	(0.044)
Total matriculation exams units	2.076*	1.609	1.843	1.469
	(1.231)	(1.181)	(1.201)	(1.153)
Math exam units (0 to 5)	0.308*	0.259	0.305*	0.264
	(0.170)	(0.166)	(0.165)	(0.162)
English exam units (0 to 5)	0.429**	0.365*	0.383*	0.339*
	(0.204)	(0.196)	(0.199)	(0.192)
Number of students	1889		2284	

Notes: Standard errors are presented in parenthesis. Specifications with controls includes both parents' years of schooling (0 if unknown and a dummy for whether the parents' education is unknown), gender dummy, number of siblings (by mother) and month of birth dummies.
*Significant at 10%; **significant at 5%; ***significant at 1%

Table 7: Difference-in-Differences Estimated Effect of In-Utero Environment on School Outcomes

	Sample A			Sample B		
	May 1990 - May 1992 Cohorts			January 1990 - May 1992 Cohorts		
	Cross-Section Regression: "Solomon" versus "Moses" Difference		Differences in Differences of Means	Cross-Section Regression: "Solomon" versus "Moses" Difference		Differences in Differences of Means
	Pre: May 1990 - December 1991 Cohort	Post: January 1992 - May 1992 Cohort		Pre: May 1990 - December 1991 Cohort	Post: January 1992 - May 1992 Cohort	
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
Dropped out of high school before completing 12th grade	0.013	-0.051*	-0.063	0.004	-0.051*	-0.055
	(0.018)	(0.029)		(0.016)	(0.029)	
Passed high school matriculation exams after 12 years of schooling	-0.051***	0.045	0.096	-0.066***	0.045	0.111
	(0.022)	(0.044)		(0.02)	(0.044)	
Total matriculation exams units	-1.767***	0.309	2.076	-1.534***	0.309	1.843
	(0.608)	(1.104)		(0.545)	(1.104)	
Math exam units (0 to 5)	-0.256***	0.052	0.308	-0.253***	0.052	0.305
	(0.084)	(0.151)		(0.075)	(0.151)	
English exam units (0 to 5)	-0.393***	0.036	0.429	-0.347***	0.036	0.383
	(0.103)	(0.173)		(0.092)	(0.173)	
Number of students	1412	477		1807	477	

Notes: Standard errors are presented in parenthesis. Column 1 and 2 specifications are cross-section differences without control. Columns 3 present the difference between column 1 and column 2.

*Significant at 10%; **significant at 5%; ***significant at 1%

Table 8: Heterogeneity in Estimated Effect of In-Utero Environment on School Outcomes: by Gender and Family Education

	Gender				**Family Education**			
	Sample A		Sample B		Sample A		Sample B	
	May 1990 - May 1992 Cohorts		January 1990 - May 1992 Cohorts		May 1990 - May 1992 Cohorts		January 1990 - May 1992 Cohorts	
	Boys	Girls	Boys	Girls	Low Family Education	High Family Education	Low Family Education	High Family Education
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dropped out of high school before completing 12th grade	-0.071	-0.012	-0.056	-0.009	-0.051	-0.042	-0.035	-0.036
	(0.048)	(0.026)	(0.043)	(0.023)	(0.033)	(0.046)	(0.031)	(0.040)
Passed high school matriculation exams after 12 years of schooling	0.046	0.101*	0.047	0.114*	0.038	0.141***	0.024	0.187***
	(0.043)	(0.056)	(0.038)	(0.051)	(0.044)	(0.060)	(0.039)	(0.053)
Total matriculation exams units	1.185	3.266***	1.165	2.415**	1.037	4.746***	0.705	3.911***
	(1.367)	(1.329)	(1.232)	(1.203)	(1.207)	(1.508)	(1.101)	(1.342)
Math exam units (0 to 5)	0.163	0.483***	(0.200)	0.368**	0.122	0.686***	0.071	0.645***
	(0.18)	(0.192)	(0.161)	(0.175)	(0.164)	(0.216)	(0.149)	(0.194)
English exam units (0 to 5)	0.285	0.356	0.248	0.262	0.132	0.690***	0.114	0.528***
	(0.223)	(0.221)	(0.203)	(0.200)	(0.199)	(0.246)	(0.182)	(0.222)
Number of students	528	534	672	673	679	383	866	479

Notes: Standard errors are presented in parenthesis. All specifications in columns 1 and 2 include both parents' years of schooling (0 if unknown and a dummy for whether the parents' education is unknown), gender dummy, number of siblings (by mother), month of birth dummies and year of birth dummies.All specifications in columns 3 and 4 include gender dummy, number of siblings (by mother) and month of birth dummies.

*Significant at 10%; **significant at 5%; ***significant at 1%