Out of Africa: Human Capital Consequences of In Utero Conditions*

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Abstract

This paper investigates the effects of environmental conditions during pregnancy on later life outcomes using quasi-experimental variation created by the immigration of Ethiopian Jews to Israel in May 24th 1991. Children in utero prior to immigration faced dramatic differences in medical care technologies, prenatal conditions, and prenatal care at the move from Ethiopia to Israel. One of the major differences was adequacy of micronutrient supplements, particularly iodine, iron and folic acid. We find that children exposed in earlier stage of the pregnancy to better environmental conditions in utero have higher educational attainment (lower repetition and dropout rates and higher *Baccalaureate* rate) and higher education quality (achieve a higher proficiency level in their *Baccalaureate* diploma). The average treatment effect we estimate is driven mainly by a strong effect on girls. We find however, no effect on birth weight for girls, suggesting that the main channel could be through brain development rather than health improvements of the fetus.

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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 a critical period in a person's life and influence health, cognitive and non-cognitive outcomes later in life has meaningful implications for individual and policy decisions. However, it is a 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 also have direct effects 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 negative environmental shocks with well-defined start and end points, e.g. the 1918 Influenza Pandemic in the US (Almond 2006) and in Taiwan (lin and Liu, 2014), 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 use variation in infectious diseases (Barreca 2010) and economic shocks around the time of birth (Baten, Crayen, and Voth, 2007). Few recent studies analyze positive or policy driven events, e.g. increasing family resources (Hoynes, Schanzenbach and Almod, 2012) and immigration to a developed country (Van Den Berg et al, 2012).These studies, however, focus mainly on the effects on later life health outcomes.

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 shortly after arrival to Israel. There is a large environmental difference between Ethiopia and Israel that may have affected pregnant mothers. One important difference is the micro nutrient supplements. While Ethiopia suffers from severely iodine and iron deficiencies and no vitamins consumption during pregnancy, in Israel, pregnant women received vitamins (mainly Iron and Folic acid) and the iodine level is adequate. It is well established that micronutrient supplements during pregnancy, especially iron, folic acid and iodine, are essential for normal fetal development, including brain development. Previews studies, in the medical and economics literature, investigated the effect of malnutrition during pregnancy. Neugebauer et al. (1999) and Rooij et al. (2010) studied the effect of the Dutch famine in the winter of 1944-45 on pregnant women and found that severe maternal nutritional deficiency early in gestation is associated with inferior brain and cognitive development of the offspring. Studies in the

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

economics literature that focus on nutritional changes during pregnancy, e.g. because of fasting during the Ramadan Moslem holiday (Almond and Mazumder, 2011; Almond et al., 2014) or because of supply of iodine for pregnant women (Field, Robles, and Torero, 2009 and Feyrer, Politi and Weil, 2013), found a positive relationship between appropriate nutrition of the mother during pregnancy and cognitive abilities of their children in the long term.

In our study, we examine the effects of in utero time of exposure to micronutrient supplement of iodine, iron and folic acid and to other improved conditions in Israel on birth outcomes (birth weight) and academic achievements of children by the end of high school. More specifically, our research question is how would improvement of in utero environmental conditions affect later life cognitive outcomes? To address this question, we exploit quasi-experimental variation in exposure to better environmental conditions in utero generated by the large and sudden immigration wave of Ethiopian Jews to Israel, called "Operation Solomon". This out of Africa immigration wave 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 plan or time pregnancy. Therefore, variation in the timing of pregnancy relative to date of immigration can be regarded as random.

Being in utero in Israel meant exposure to advanced medical care technologies, prenatal conditions and nutrition typical to a developed country. In contrast, being in utero in Ethiopia meant exposure to conditions of one of the poorest developing countries. The goal of this paper is to exploit this unique natural experimental setup and examine whether these dramatic in utero environmental differences affected later life outcomes.

We construct a dataset based on high school administrative data linked to individual demographic records of all Ethiopian children born between May 27th 1991 – February 15th 1992, within a narrow time window after the immigration (May 24th 1991). We use the birth date of each child to determine number of weeks of exposure in utero to better environmental conditions in Israel. According to epidemiological studies, the most critical period of pregnancy for child brain and cognitive development is the first trimester. We therefore examine how in utero exposure to micronutrient supplements and the Israeli environment during the first trimester of gestation (and afterwards) affects birth weight and medium-term cognitive outcomes relative to exposure at later stages of pregnancy. For this purpose, we define three treatment groups by the gestational age at the time of immigration: the first group includes children whose mothers arrived to Israel after conception during the first trimester of gestation, the second group includes children whose mothers arrived to Israel during the second trimester of gestation, and the third group includes children whose mothers arrived during the third trimester of gestation but before birth. We also estimate separate treatment effects for each of the three months of the first trimester.

The medium-term outcomes we examine include the likelihood of repeating a grade during high school, dropping out of high school, and obtaining a *Baccalaureate* diploma at end of high school, and the total number of *Baccalaureate* credit units in all subjects and in Mathematics and English in particular. We view the latter outcomes as a measure of student's ability and of quality of her *Baccalaureate* 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 also examine the impact on birth weight as a short-term outcome and an early health indicator.

We find that children exposed to better environmental conditions in utero during the first trimester of pregnancy performed substantially better in all medium-term cognitive outcomes relative to those exposed to these better conditions at a later stage of pregnancy. On the other hand, we do not find any effect on birth weight. Children who were in utero in Israel starting from the first trimester are about 12 percentage points more likely to obtain a *Baccalaureate* diploma than children who were in utero in Ethiopia during the first and second trimester but spent the rest of the pregnancy in Israel. This is a large effect since the average *Baccalaureate* rate of children who arrived at the second and third trimester is only 20 percent. Children who arrived to Israel during the first trimester also engage in more challenging study programs during high school relative to those who arrived at a later pregnancy stage. For example, they obtain 3.2 more credit units relative to those who arrived at the third trimester, an effect of about 33 percent. These individuals also attain 0.4 more credit units in Mathematics and 0.5 additional units in English, implying a gain of more than 50 percent. They are also 12 percentage points less likely to repeat a grade and 7 percentage points less likely to drop out of high school.

We assess the robustness of these results by controlling for birth cohort and seasonality effects. Particularly, we extend our regression discontinuity (RD) identification method by adding two comparison groups, which include children of the same birth cohorts from families that emigrated from Ethiopia to Israel prior to "Operation Solomon" and after "Operation Solomon". These analyses point clearly that the positive effect of the better environmental conditions in utero that we estimate is only for children who were in utero in Israel during the critical period, namely the first trimester and that cannot be explained by birth cohort or seasonality effects. We also examine heterogeneous treatment effects by gender. We find that the effect of better environmental conditions in utero is larger and significant mostly among girls. Finally, in a sort of a placebo exercise, we apply the same empirical strategy and estimate the same treatment effect for immigrants who arrived around the same time to Israel from the Former Soviet Union (FSU), where in utero environmental conditions were similar to those in Israel. Interesting, and reassuring our main hypothesis, we find that gestational age upon arrival to Israel has no effect on cognitive outcomes among immigrants from the FSU, in sharp contrast with our findings regarding the immigrants from Ethiopia.

This research contributes to the existing literature by investigating the effects of better environmental conditions and micronutrient supplements in utero in different stages of pregnancy on cognitive outcomes. The focus on children of immigrants is particularly important given the large immigration waves from developing to industrialized countries that are observed in this century. Our findings on the critical period of in utero conditions have paramount implications for the understanding of intergenerational effects of immigration and have policy implications for developed and developing countries. In the context of rich countries that have become destinations for legal and illegal immigrants from poor nations, it provides rationale for targeting resources at early childhood to children of immigrant families who were born abroad and especially, to pregnant immigrant women. For poor nations, it identifies a pre-birth period where improved conditions can have economically meaningful payoffs in the long-term.

The remainder of the paper is organized as follows. The next section summarizes the related literature. Section 3 provides some background on micronutrient deficiencies during pregnancy in developing countries, describes the historical background of Ethiopian Jews that immigrated to Israel in May 1991, and shows 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 describes the empirical strategy. Section 6 presents the results about the effect of environmental conditions in utero on a variety of high school outcomes as well as robustness checks and discusses some possible mechanisms. Section 7 examines potential alternative interpretations and discusses measurement issues, section 8 assesses the potential longer-term returns and section 9 concludes.

2. Effect of in Utero Conditions

2.1 The Medical Literature

The epidemiological literature has explored the fetal origins hypothesis analyzing different effects and timing. This hypothesis, introduced by Barker (1992), suggests that certain chronic conditions later in life can be traced to the course of fetal development. The medical literature analyzes the effects of different environmental shocks in utero on not only fetus health and health in adulthood but also on cognitive outcomes later in life.

Neugebauer et al. (1999) and Rooij et al. (2010) showed that cognitive function in later life is affected by prenatal under-nutrition caused by the Dutch famine after the end of World War II. Neugebauer et al. (1999) suggests that severe nutritional insults to the developing brain in utero may be capable of increasing the risk for antisocial behaviors in offsprings. Rooij et al. (2010) found that men and women exposed to famine during the early stage of gestation performed worse on a selective attention task. Nowakowski and Hayes (2008) and Loganovskaja and Loganovsky (1999) investigated the effect of radiation exposure during pregnancy on cognitive abilities of the offsprings and report that sub-clinical damage caused by radiation to human fetuses between 8 and 25 weeks of gestation can result in cognitive deficits that still manifest 16-18 years after birth. This period of gestation is critical since it is the major neuron genetic period of the developing human neocortex. Other researches have shown that maternal dietary deficiencies of micronutrient like iron, folic acid, and iodine are associated with a variety of poor fetal and infant health outcomes, mostly impacting brain development and function in infancy and often throughout life. Mihaila et al. (2011), for example, argue that a mother's iron deficiency early in pregnancy may have a profound and long-lasting effect on the brain development of the child, even if the lack of iron is not enough to cause severe anemia. Escobar et al. (2007) claims that an inadequate supply of iodine during gestation results in damage to the fetal brain and the birth of many children with learning disabilities may be prevented by advising women to take iodine supplements as soon as pregnancy starts.

2.2 The Economics Literature

Recent studies in economics contributes to the identification of the effects of in utero conditions on later life outcomes. It often exploits a range of random shocks and circumstances affecting pregnant mothers finding significant impacts on outcomes, including test scores, educational attainment, income, and health. Some studies use exogenous changes that influenced the environmental conditions of the mother and find that negative environmental shocks have a detrimental effect on fetal health after birth, often measured by birth weight [Lien and Evans (2005a), Lien and Evans (2005b) Camacho (2008) Currie and Walker (2009)]. Other related studies evaluate the long-term effects of newborn outcomes (e.g. birth weight) on human capital [Currie and Hyson (1999), Behrman and Rosenzweig (2004), Black, Devereux, and Salvanes (2007) and Oreopoulos, Stabile, Walld, and Roos (2008)].

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 examine 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) reports that children of Influenza Pandemic infected pregnant mothers were about 20% more likely to be disabled and experienced lower educational attainment and wages. Almond et al. (2007) report that acute maternal malnutrition caused by the 1959-1961 Chinese famine 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). Almond et al. (2009) examined the 1986 Chernobyl accident in Sweden and find that the birth cohort exposed to radiation between week 8 and 25 of gestation performed substantially worse in school but do not detect corresponding health damage. Banerjee et al. (2010) consider the 19th century blight to French vineyards from the phylloxera insect that decreased wine production and income and find that children born to affected families were 0.5 to 0.9 centimeters shorter in adulthood.

Our paper is related to these studies by focusing on the link between in utero environmental conditions and later life outcomes. A unique feature of this study is that it is based on a positive event of environmental differences caused by moving from a developing country with poor health care and living conditions to a western country with advanced medical care and better living conditions such as better hygienic and nutrition. One of the main differences that pregnant women faced upon immigration was the supplement of micronutrients. Previous economic studies that focus on nutrition during pregnancy [Almond and Mazumder (2011) and Almond, Mazumder and Ewijk (2014)] found a positive relationship between appropriate nutrition of the mother during the pregnancy and cognitive abilities of their children in the long term. Studies that focused on micronutrient supplementation examined only the effect of supplying iodine to pregnant women. Field, Robles, and Torero (2009) found that iodine supplementation for pregnant women in Tanzania have large educational impacts on cognition and human capital of their children: children of treated mothers attain more schooling relative to their siblings and older and younger peers. Furthermore, the effect appears to be substantially larger for girls, consistent with laboratory evidence indicating greater cognitive sensitivity of the female fetus to maternal thyroid deprivation. Feyrer, Politi and Weil (2013) examine the impact of a positive intervention of salt iodization on cognitive outcomes in the US and find that for the one quarter of the population most deficient in iodine, this intervention raised IQ by approximately one standard deviation. Our paper contributes to this literature by analyzing the overall effect of micronutrients (iodine, iron and folic acid) in utero and better environmental conditions on offspring cognitive outcomes in the medium run.

To date, there has been relatively little convincing empirical evidence about causal effects of a positive shock to in utero conditions. One such recent example is Hoynes et al. (2012) which evaluates the impact of the Food Stamps Program (FSP) as a positive policy-driven event that generated an increase in family resources available in utero and during childhood. Their findings suggest that access to the FSP in utero and in early childhood led to a large and statistically significant reduction in the incidence of "metabolic syndrome" (obesity, high blood pressure, heart disease, diabetes) as well as an increase in self-reported 'good health'. Van Den Berg et al (2012) estimates the effects of changes in environmental conditions of immigrant children to Sweden by comparing siblings who immigrated at different age. While these studies examine variation in exposure to better environmental conditions after birth, we focus on exposure during the pregnancy period.

3. Background

3.1. Micronutrient deficiencies during Pregnancy in developing countries

Vitamins and minerals, referred to collectively as micronutrients, have important influences on the health of pregnant women and the growing fetus. The World Health Organization (WHO) (2004) estimates that 1 out of 3 people in developing countries are affected by vitamin and mineral deficiencies. Some nutrients are more important than others during pregnancy, because they play a vital role in fetus development. The three most important micronutrients in terms of health consequences for poor people in developing countries are iodine, iron, and vitamin A. Iron, iodine and folic acid are among the most important micronutrients that are relevant for cognition and brain development. Undernutrition and micronutrient deficiencies among pregnant women in developing countries lead to high rates of low birth weight, and cause learning disabilities, mental, retardation, poor health and premature death (Black et al., 2013).

Iron Deficiency (ID)

The WHO (2004) estimates that the highest proportion of individuals affected by anemia are in Africa. In Ethiopia, anemia is a severe problem affecting both pregnant (62.7%) and non-pregnant women of childbearing age (52.3%). According to the WHO report, more than half of this anemia burden is due to iron deficiency, the rest partly due to deficiency of folic acid, vitamin B12, vitamin A, and due to parasitic infections. Iron deficiency and untreated iron deficiency anemia during pregnancy have many negative consequences for the offspring and have been shown to be associated with a higher incidence of low birth weight and premature births (Banhidy et al., 2010) and long-term cognitive abnormalities (Lozoff and Georgieff, 2006). Many developing central nervous system (CNS) processes are highly dependent on iron-containing enzymes and proteins. Thus, iron deficiency might have multiple and varied effects, particularly during the brain growth spurt. The structures of the brain can become abnormal because of iron deficiency either in utero or in early postnatal life because iron is essential for proper neurogenesis and differentiation of certain brain cells and brain regions. The cells involved in building the embryonic brain are most sensitive to low iron levels during the first trimester. Hence, the period that begins in the weeks prior to conception and extends through the first trimester to the onset of the second trimester is considered as a critical period for brain development. Iron deficiency during the third trimester is unlikely to harm the developing brain (Mihaila et al., 2011).

Iodine Deficiency (IDD)

A WHO report from 2006 notes that more than two billion people (260 million of them in Africa) are estimated to be at risk of IDD. Iodine deficiency is now recognized by the WHO as the most common preventable cause of brain damage in the world today (Preedy et al., 2009). Populations who live in areas with low iodine content in soil and water are at highest risk for iodine deficiency. Dairy foods and certain fruits and vegetables can be rich in iodine but only if they originate from iodine rich areas where the nutrient can be absorbed into the foods (UNWFP, 2013, Ahmed et al., 2012).

In Ethiopia, a situational analysis carried out by Ministry of Health (MOH) and the United Nations Children's Fund (UNICEF) found that in 1993, 78% of the population of Ethiopia was exposed to iodine deficiency and 62% are iodine deficient. The high level of iodine deficiency in Ethiopia continues to be a major problem even in recent years (Yibrie et al., 2007).

Humans require iodine for biosynthesis of thyroid hormone. The thyroid hormones affect central nervous system development and regulate many physiological processes. In utero development of the central nervous system required for intellectual functioning depends critically on adequate supply of thyroid hormone, which influences the density of neural networks established in the developing of the brain (Lamberg, 1991). Up to mid-gestation, the mother is the only iodine source for the developing brain of the foetus. An inadequate supply of iodine during gestation results in damage to the fetal brain that is irreversible by mid-gestation unless timely interventions can correct the accompanying maternal hypothyroxinemia. Even mild to moderate maternal hypothyroxinemia may result in suboptimal neurodevelopment (Morreale de Escobara, 2007). A longitudinal study in China showed that iodine supplementation in the first and second trimesters of pregnancy decreased the prevalence of moderate and severe neurological abnormalities and increased developmental test scores through 7 years, compared with supplementation later in pregnancy or treatment after birth (Cao et al., 1994).

Folic Acid Deficiency

Although folic acid deficiencies are much less prevalent than iron deficiencies in the Third World, they nonetheless represent a major public health problem among two high-risk groups: pregnant women and young children. Adequate folic acid (folate) is critical to embryonic and fetal growth developmental stages characterized by accelerated cell division. It plays an important part in the development of the fetus' spinal cord and brain. In particular, folate is needed for closure of the neural tube early in pregnancy (Czeizel and Dudas, 1992, Czeizel et al., 2004). Folic acid deficiency in early pregnancy increases dramatically the chance of a spinal cord problem (Neural Tube Defect) or brain development problems. Therefore, folic acid supplement is advised for at least the first 12 weeks of pregnancy for all women - even if they are healthy and have a good diet. If folic acid supplementation starts after the first trimester of pregnancy, it will not help to prevent these poor birth outcomes.

3.2. The Immigration of Ethiopians Jews to Israel

The Ethiopian Jewish community, known also as "Beta Israel", has lived in the region of Northern Ethiopia called Gondar for several centuries.[2] The origin of the 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, until 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 in 1975, after the Chief Rabbinate ruling which determined that the Beta Israel were descendants of one of Israel's lost tribes, they were entitled to migrate to Israel as full citizens under the Law of Return. Since then, 92,000 Ethiopians were brought to Israel in organized immigration projects and become immediately Israeli citizens.

The immigration of Ethiopian Jews to Israel began on a very small scale, mainly through Sudan. Figure 1 presents 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, 6,000 immigrants were airlifted from Sudan to Israel in a project known as "Operation Moses". They 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. As a result, 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 more involved, working through two organizations 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 the north of the country to the capital Addis Ababa. Then NACEJ opened a compound in Addis Ababa where Jewish families

[2] 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.

resided, waiting for permission to fly to Israel. They did not know when they will be going to Israel and accommodated to the idea that they would be living in Addis Ababa for the time being. However, military events in Ethiopia pushed the Israeli government to act. On May 1991, after the Ethiopian dictator Mengistu fled from the country, the Israeli government realized that the Ethiopians Jews should be rescued before rebels take over Addis Ababa. On May 24 1991, over 14,000 Ethiopian Jews (almost the entire Jewish population remaining in Ethiopia) were airlifted to Israel within 36 hours. This sudden immigration wave can be seen in detail in Figure 2, which plots the number of immigrants arriving to Israel in May 1991. This operation was named "Operation Solomon". Upon arrival to Israel, the immigrants were placed in absorption centers where they stayed for a few years until they moved to permanent housing.[3] The immigration from Ethiopia to Israel continued after "Operation Solomon" but in small numbers, mainly from rural areas in Qwara near Gondar until 1999 and afterwards the immigration was mainly of the "Falash Mura" people while the last flight of immigrants from Ethiopia to Israel landed on August 2013.[4]

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

There are large environmental differences between Ethiopia and Israel that may have affected pregnant mothers. We conducted in depth interviews to fifteen women who immigrated on "Operation Solomon" while there were pregnant and asked them about the living conditions, nutrition, micro nutrient supplements, health care, and pregnancy monitoring before and after immigration. We describe below the main differences in environmental conditions during pregnancy based on the information collected in these interviews, the medial literature on environmental conditions in Ethiopia, the literature on medical treatment administered to Ethiopian Jews and pregnant women upon immigration to Israel, and on prenatal care in Israel at the time of immigration Salomon.

Living conditions: Prior to "Operation Solomon", the Ethiopian Jews were still living in hundreds of small remote villages in northern Ethiopia. Their lifestyle and beliefs were traditional, men plowed their fields with plows pulled by a brace of oxen, women spent their days carrying jugs of water long distances to their huts, foraging for 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.

[3] For more details see Gould, Lavy and Paserman (2004).

[4] "Falash Mura" is a name given to those of the "Beta Israel" community in Ethiopia who converted to Christianity under pressure from the mission during the 19th century and the 20th century. In 2003, the Israeli government gave to those who are descendants from Jewish mothers' lineage the right to immigrate to Israel under the Israeli Law of Return and to obtain citizenship only if they converted to Orthodox Judaism.

In May 1990, large part of this population migrated to Addis Ababa, where they were housed in refugee camps scattered all over the city, waiting for immigration to Israel without knowing the specific date. The living conditions in Addis Ababa were not better than in the rural areas they came from. After their arrival to Israel, immigrants were housed in in absorption centers (80 percent) and mobile home camps (20 percent) for the first few years.

General 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 common. 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. 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 health practitioners from the Ethiopian community that made home visits and provided medical services to approximately 4,000 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 (Myers, 1993).

After arrival to Israel, the immigrants received health coverage through the universal public health system and modern medical care though gaps in culture and language limited the utilization of these services by the immigrants. The Israeli health authorities developed an education health program to bridge these gaps and promote effectively the transfer of skills to the immigrants regarding proper health care, nutrition, western perception of prescribed medications, and personal hygiene (Levin-zamir, Lipsky, Goldberg and Melamed, 1993).

Nutrition: According to the International Food Policy Research Institute (IFPRI) in 1993 the calorie supply per capita in Ethiopia was 1,516 while in Israel it was twice as large, 3,089 (Israeli central bureau of statistics). The traditional Ethiopian diet consisted of unrefined flours, grains, vegetables, refined sugars, and processed foods and was limited in meat. These eating habits changed upon arrival to Israel as many of the traditional Ethiopian staples were not available at the time in Israel. In the absorption centers in Israel, they were served Israeli style food communally and those who prepared food at home had to use other ingredients, for example, refined white flour instead of teff (Levin-zamir, Lipsky, Goldberg and Melamed, 1993).

Micronutrient supplements for pregnant women: As described before there are three main micro nutrient supplements, which are important for cognition and their intake is recommended for pregnant women: iron, iodine and folic acid. According to DHS 2011 report, less than 1% of pregnant women aged 15-49 in Ethiopia took iron supplements. Furthermore, iodine deficiency disorder is a major public health problem in Ethiopia (WHO). In contrast, it was a standard practice to prescribe vitamin and iron supplement to pregnant women in Israel around the time of operation Salomon. Moreover, Ethiopian women agreed to take these supplements since they thought that in Ethiopia this was not needed because *"the food was better, it contains more vitamins than the food in Israel"* (Granot et al., 1996). In addition, there is no evidence of iodine deficiency disorders among pregnant women in Israel. The reason seems to be that Israel's food chain contains adequate amounts of iodine (Benbassat et al., 2004).[5]

Health Care and Pregnancy Monitoring: Ethiopian women who lived in rural areas shared the view that pregnancy does not require medical attention. They gave birth at home with assistance from family and neighbors, and a traditional birth attendant or lay midwife. In contrast, in Israel, pregnancy is closely monitored and the baby and mother are examined periodically before and after birth. At the years 1990-1991, the infant mortality rate was 12% in Ethiopia and 1% in Israel and child mortality rate was 20% in Ethiopia but only 1.2% in Israel (The World Bank, 1991). 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. All the women in our survey mentioned that in Ethiopia they did not receive any medical care related to the pregnancy while in Israel they were under medical monitoring which included blood tests and ultrasound.

4. Data

We construct a dataset based on the Israeli population registry of all the Ethiopian population in Israel born in Ethiopia or in Israel during the years 1980 to 2005 and their parents. Our data includes their birth date, date of immigration, and country of origin. It also includes the date of immigration and country of origin of the parents, the number of siblings, and the locality of residence of the mother upon arrival to Israel. We merge these data with administrative records on birth weight for children born in Israel collected by the Israeli Central Bureau of Statistics based on hospital deliveries and data on parent's income from the Israeli Tax Authority. We identify those children whose both parents

[5] Israel is one of the few western countries that have no iodization policy and where a national iodine survey was not done until 2013, largely because of the perception that Israel is an iodine-sufficient country due to its proximity to the Mediterranean (Zohar, 1994). According to Ovadia et al. (2013) only recently, there is some evidence for inadequate iodine intake in Israel (two thirds of the recommended dietary allowance). A possible explanation is the increasing proportion of desalinated seawater in Israeli's drinking water (desalination plants typically remove 90-98% of soluble minerals, including iodine, from seawater). However, desalination seawater in Israel started few years after the period in our analysis.

immigrated to Israel from Ethiopia in "Operation Solomon" on May 24th 1991 and link these data to administrative records collected by the Israeli Ministry of Education which include information on students parental education, yearly schooling status (graduated, currently attending school, dropped out) and high school *Baccalaureate* exams outcomes.[6] We focus on two types of school outcomes; the first measures schooling attainment by the following indicators: repeated a grade after primary school (after 6th grade), completed high school and received a *Baccalaureate* certificate. [7] The second type of outcomes measure quality of schooling attainment and includes the following variables: total credit units awarded in the *Baccalaureate* certificate and credit units awarded in mathematics and English. We do not use test scores as outcomes because a large proportion of our sample do not sit for the *Baccalaureate* exams or do only some of them.

Our primary sample includes 594 students who were born in Israel but their pregnancy was incepted in Ethiopia and their mothers immigrated to Israel in "Operation Solomon" (on 24th May 1991). That is, we select students born between May 27th 1991 and February 15th 1992. This yields cohorts that span a different share of time in the living standards of Israel between conception and birth. Table 1 presents summary statistics for the variables used in our analysis for our primary sample and for two other groups of children of Ethiopian origin born at the same period (between May 27th 1991 and February 15th 1992). Column 1 presents means of background and outcome variables for the children in our primary sample (students born in Israel between May 27th 1991 and February 15th 1992 whose mothers immigrated on May 1991). Column 2 presents the respective means for students born in Israel at the same time to Ethiopian parents who arrived to Israel before 1989, and column 3 presents the respective means for students born in Ethiopia at the same time who immigrated to Israel after 1991 but before 2000. In our main sample (column 1), the mothers are slightly older at birth relative to the mothers who conceived and gave birth in Israel (column 2) and to the mothers who conceived and gave birth in Ethiopia (column 3). The average mother ages are 30.7, 28.9 and 27.4, respectively. In addition, the age gap between parents is higher in our main sample (column 1): almost 11 years compared to 6.9 (column 2) and 9.4 (column 3) in the other two groups. In addition, parents average years of schooling is 2.3 and 2.5 which is less than a half of the average years of schooling of parents of children from Ethiopian origin born in Israel during that period (5.3 for the fathers and 5.03

[6] More precisely, since the immigration operation lasted 36 hours, we include children whose date of immigration was May 24 or May 25 1991. To simplify writing, we mention in the paper May 24 as immigration date (although we use the exact day – May 24 or May 25 for our calculations of gestational age).

[7] Since our sample includes children born between 1991 and 1992, they all should be high school graduates in 2011 or at least be high school students (compulsory schooling at that time was until 10th grade). A *Baccalaureate* certificate is a prerequisite for admission for academic post-secondary institutions. There are also many employers who require this certificate. Students award a matriculation certificate by passing a series of national exams in core and elective subjects during high school years. Students can choose to be tested in each subject at different levels of proficiency, with each test awarding the student between one and five credit units per subject, varying by the proficiency level of the exam (one is the lowest level and five the highest).

for the mothers in column 2) but it is similar to the average years of schooling of parents of Ethiopian born children who immigrated with their parents after May 1991 (column 3). These means are much lower in comparison to respective average years of schooling of parents of the Jewish Israeli native students, which are around 12 years of schooling. We also report in the table the mean of family income in 1995, which shows clearly that it is much higher for families that immigrated before 1989. We show below however that the mean of this variable is not statistically different across the samples of first, second and third trimesters.

The means of the outcome variables in our primary sample are also lower than those of children born in Israel to Ethiopian parents (column 2) but they are similar (though marginally lower) than those of the Ethiopian born sample (column 3). For example, the *Baccalaureate* rate at age 18 in our main sample is 30.5 percent, it is 35.1 percent for the Ethiopian origin Israeli born sample (column 2) and it is 32 percent for the Ethiopian born sample (column 3). However, these rates are much lower in comparison to the native Jewish population, 45.7 percent. The means of other high school outcomes follow the same pattern. For example, total credit units of the Israeli native population is above 17, while it is around 11.58 for our main analysis sample, 12.85 for children of Ethiopian parents who immigrated previous to "Operation Salomon" and 11.98 for children born in Ethiopia who immigrated with their parents after May 1991. Birth weight data is available only for children born in Israel. So we can only compare between "Operation Salomon" offspring and those born in the same period whose parents immigrated in the previous immigration wave. The average birth weight in our primary sample is 3.06 kg while 11 percent were born at low birth weight (less than 2.5 kg) and only 0.5 percent were born at very low birth weight (less than 1.5 kg). The birth weight of children born in Israel to Ethiopian parents who immigrated before 1989 is similar.

5. Empirical Strategy

5.1. Baseline Model and Specification

"Operation Solomon" crates a quasi-experimental framework where children of Ethiopian immigrants who shared the same background characteristics and were born shortly after arrival to Israel experienced one important difference: their mothers were at different stages of pregnancy on the day of immigration. That is, all these children experienced the same conditions at birth and at later life but faced dramatic differences in prenatal conditions in utero based on their gestational age upon arrival to Israel in May 1991. This difference was determined solely by the timing of the pregnancy in Ethiopia. Children who were in-utero in Ethiopia for a longer period and were born a short time after their mothers immigrated to Israel on May 1991 ‘missed’ the Israeli environmental conditions in utero and probably suffered more from micronutrient deficiencies of iron, folic acid and iodine. However, children whose mothers conceived a short time before they immigrated to Israel on May 1991 were in-utero in Israel for a longer period and could benefit from these better Israeli environmental conditions and micronutrient supplements.

In order to estimate the causal effect of these conditions in utero on later life outcomes we assume that children who were born in Israel but whose mothers were at different stages of pregnancy at the time of immigration have the same unobserved characteristics and would have the same mean potential outcomes. The key identifying assumption is that the timing of conception in Ethiopia relative to the timing of immigration was random.

Migration decision and the timing of migration are usually endogenous and correlate with immigrant's characteristics. However, "Operation Solomon" created a different setting of migration since it was an unexpected event, completed in a very short time. The operation was organized by the Israeli government and it brought to Israel almost all Ethiopians Jews who lived in Ethiopia. Thus, the immigrants were not a selected group. Moreover, the timing of immigration was unknown so that pregnancies could not be planned according to migration date and migration could not be planned according to the expected due date.[8] This sudden immigration event generated a unique exogenous improvement to in-utero environmental conditions allowing us to compare between children who were exposed to better environmental conditions at a different gestational age but experienced the same conditions on birth and later life to identify the causal effect of in utero environmental conditions on later life outcomes.

In this paper, we focus on schooling outcomes by age 18-20 which are good measures of cognitive ability and skills. Since the immigration event we study occurred 22 years ago, we are able to observe the schooling outcomes of children who were in utero at that time but it is still too early to analyze their labor market performance. Nevertheless, as we show below, schooling outcomes are a good predictor for adult achievement in the labor market. Our basic identification strategy differs from previous design-based studies in the fetal origins literature. Typically, natural experiments induced by famines, disease outbreaks, or droughts are episodic: they are turned on and then turned off. In contrast, once the mother immigrated to Israel the child was exposed to better environmental conditions of a western country not only in utero but also at birth and for his entire life course.

In order to estimate the impact of in utero environmental conditions on later life outcomes we focus only on children who differ in the timing of exposure to the improved environmental conditions in utero but experienced the same environmental conditions at conception and at birth and later in

[8] It is reasonable to assume that there was no birth planning among the Ethiopian Jewish population before immigration. The contraceptive prevalence rate in Ethiopia in 1990 was only 2.9 percent (CSA, 1991). Total fertility rate among Ethiopian immigrants was 5.2 (CBS 2003). An article published in January 2008 in the daily newspaper "Yediout Hacharonot", claimed that contraceptive injections of Depo-Provera were administered systematically to Ethiopian women before they migrated since the mid 1990's. We also note that Depo-Provera received the FDA approval only in 1992 and was first approved to be used in Israel as a contraceptive method in 1996. Therefore, it could not affect the timing of pregnancy of women in our samples and has no effect on the cohorts under the analysis in this study. For more information see Fidelman (2013).

life. That is, comparison is inherently about additional exposure to better environmental conditions in utero, conditional on being exposed at birth and later in childhood, similar to the approach in Hoynes et al. (2012). We also analyze the effect on birth weight in order to examine whether the main channel that explains our results comes from improved newborns health.

The key variable for our analysis is the gestational age of the child at immigration. The gestational age is measured as the difference between the date of immigration, which is May 24th 1991, and the individual's birth date. We transform the difference into numbers of weeks since it is the common measure for pregnancy duration. The weeks of gestation at the time of immigration (May 24th 1991) are computed assuming 38 weeks of post conception gestation (40 weeks of gestational age).[9]

In the medical literature, it is common to divide the pregnancy duration into three periods by trimesters. We therefore define treatment categories by gestational age at time of immigration according to the three trimesters as follows: (1) gestational age between conception time (week 2) and week 12 where exposure to the Israeli environmental conditions started during the first trimester, (2) gestational age between week 13 and week 26 and (3) gestational age between week 27 and birth. These three trimesters can be mapped into three groups defined by date of birth: the first trimester includes children born between December 4th 1991 and February 15th 1992, the second trimester includes children born between August 28th 1991 and December 4rd 1991, and the third trimester includes children born between May 27th 1991 and August 27th 1991. Figure 3 illustrates the definition of the three trimesters according to birth date and estimated conception date. One potential challenge regarding our definition of treatment is that we do not have exact information on conception date and we estimate it using date of birth. This means that we might misclassify some of the children regarding their length of exposure to the Israeli environment. We discuss the issue of misclassification in section 7 and show that our results are robust to potential misclassification of treatment status.

The medical literature, (e.g. Cunningham, Leveno, Bloom, 2009) suggests that the first trimester is a period of rapid growth, and the fetus main external features begin to take form including the brain. At the end of the first trimester, all major systems are developed, so this is a crucial time for the development of the offspring. In the second trimester, the fetus grows considerably in size. By the beginning of the third trimester, the fetus may survive if born premature. In this period, growth slows down but there is a substantial weight gain. We therefore refer to the first trimester group as the "fully treated" group; the second trimester group is "partly treated" and third trimester is "untreated". Our basic regression model is specified as follows:

[9] The most common measure of pregnancy age is based on gestational age, which counts number of weeks from the last menstrual period. The average pregnancy length computed by gestational age is 40 weeks, which means 38 weeks by fertilization age. Through the paper, we only focus on the 38 week period after fertilization since we do not want to include children whose mothers became pregnant upon arrival to Israel. We therefore drop weeks 0 and 1 of the sample but we still refer to gestational age to be consistent with common nomenclature.

$$(1)\ \ y_i = \beta_0 + \beta_1 First\_Trimester_i + \beta_2 Second\_Trimester_i + \gamma X_i^{'} + u_i$$

Where y_i is the outcome of child *i*. The dummy variables $First\_Trimester_i$ and $Second\_Trimester_i$ are the key explanatory variables. $First\_Trimester_i$ takes the value 1 for children whose mothers immigrated to Israel during the first trimester of gestation (group 1) and $Second\_Trimester_i$ takes the value 1 for children whose mothers immigrated to Israel during the second trimester of gestation (group 2). The omitted category is the third group $Third\_Trimester_i$ which includes children with the shortest exposure to better in utero conditions (i.e. those whose mothers spent most of their pregnancy in Ethiopia). The estimated parameters (β_1 and β_2) reflect the difference between being exposed to better environmental conditions and receiving micronutrient supplements starting from the first or second trimester respectively, relative to the third trimester. X_i is a vector of child i characteristics which includes mother age at birth, parents age gap, birth order, parents' education, socio-economic index of the mother's first locality of residence upon immigration to Israel, gender, and indicator for twins.[10]

If micronutrient supplements and better environmental conditions in utero enhance cognitive abilities, we will expect that children who were exposed to these conditions in utero for a longer period, especially during the first trimester, will have better schooling outcomes. In particular, we expect $\beta_1 > \beta_2 > 0$. The quasi-experimental variation generated by the unexpected date of immigration relative to conception date guarantees that duration of exposure to better conditions in utero is uncorrelated with the residual, thus the parameters β_1 and β_2 can be interpreted as causal.

This basic specification presented in equation (1) does not include cohort and month of birth effects because they are perfectly correlated with the treatment definition. Since we restrict our sample to children born in a range of nine months only, we believe that the scope for cohort effect is very small. Nevertheless, we address these issues below by adding additional comparison groups to estimate month of birth and cohort effects.

5.2. Controlling for cohort and months of birth effects

A potential concern about the baseline specification presented above is that the estimates may be confounded by unobserved cohort effects or seasonality in school performance by month of birth since the students in the full treatment group (first trimester) are younger. Such potential cohort or seasonality effects may be picked by the treatment effect estimates. To address these concerns we look for a comparison group that has no variation in gestational age at migration but was born within

[10] The Israeli Central Bureau of Statistics computes a socio-economic index of the Israeli localities based on several demographic and economic variables such as dependency ratio, average years of schooling of the adult population, percentage of academic degree holders, employment and income levels, etc.

the same window of interest. This allows for estimation of birth cohort and seasonality effects in a kind of Difference-in-Difference framework.

We consider two such comparison groups: comparison group A - second-generation immigrants from "Operation Moses" (immigrated before 1989) and comparison group B - Ethiopians who immigrated with their families after "Operation Solomon". The key assumption in this analysis is that the birth cohort and month of birth effects of these two groups are good proxies for the same effects in our main sample of in utero "Operation Solomon" immigrants.

The main wave of immigration prior to "Operation Solomon" was "Operation Moses" that took place between 1984 and 1985 and brought to Israel over 6,000 immigrants. We include in the comparison group the children born in Israel from May 27th 1991 to February 15th 1992 to Ethiopian families from this earlier wave of immigration. Since the entire pregnancy of these children was in Israel, they all were fully treated. Therefore, differences between young and older cohorts and between children born at different months should reflect cohort effects and month of birth (seasonality) effects in Israel. However, since the conception of our main sample was in Ethiopia, seasonality in the timing of conception will not be captured by this comparison group. We therefore add a second comparison group, children born in Ethiopia between May 27th 1991 and February 15th 1992 who immigrated to Israel after May 1991 but before 2000.[11] Since the entire gestation period of children of this second comparison group was in Ethiopia, they are all considered untreated and so the difference between the young and older cohorts in this group should only reflect cohort effects and seasonality in the timing of conception in Ethiopia.

The "Operation Solomon" group and the two comparison groups were different in many aspects. However, all the students in our sample – those who were born to parents who immigrated in "Operation Moses", those who were born to parents who immigrated in "Operation Solomon", and those who were born in Ethiopia and immigrated after "Operation Solomon" - originate from the same country, have the same genetic profile and culture and were raised by immigrant parents. Moreover, they were conceived at the same time as our treated sample Thus, we expect that cohort and seasonality effects would be similar for these three groups.

To net out seasonality effects from effects that derive from the differences between our main treated group and the comparison groups, we include also children of parents who came in these three different immigration waves (i.e. “Operation Solomon”, “Operation Moses” and “post-Operation Solomon”) who were born one year before our treated and comparison groups, but at the same months. That is, we add three additional groups of children born between May 27th 1990 and February 15th 1991. The first group includes children who immigrated to Israel with their families on May 1991.

[11] The immigration from Ethiopia to Israel continues after 2000 but we restricted it to the year 2000 in order to include only children who start the Israeli secondary education system in Israel and to exclude the "Flash murra" people.

These children were "untreated" since they were born in Ethiopia. However, they belong to the same population of our treatment group: "Operation Solomon" immigrants, and therefore have the same family background. The second group includes offspring of Ethiopian parents who immigrated before 1989 and were born in Israel. The third group includes children born in Ethiopia who immigrated with their parents after 1991.

We estimate the following model:

$$(2)\ \ y_i = \beta_0 + \beta_1 First\_Trimester_i + \beta_2 Second\_Trimester_i + \alpha_1 ETH_i + \alpha_2 pre\_cohort_i + \alpha_3 ETH_i * pre\_cohort_i + \alpha_4 GroupA_i + \alpha_5 GroupB_i + \gamma X_i^{'} + \delta MOB_i + u_i$$

Where $First\_Trimester_i$ and $Second\_Trimester_i$ are the same variables as described for equation (1). $X_i^{'}$ is a vector of child i characteristics (defined as in equation 1) and MOB_i is a vector of month of birth fixed effects.[12] ETH_i is an indicator for children born in Ethiopia. This includes children who immigrated in "Operation Solomon" (the respective older cohort of our main sample) and children who immigrated after 1991. pre_cohort_i is an indicator for children born between May 27th 1990 and February 15th 1991 (the older cohort). $GroupA_i$ is an indicator for children born in Israel to "Operation Moses" immigrants (the first comparison group) and $GroupB_i$ is an indicator for children born in Ethiopia and immigrated after "Operation Solomon" (the second comparison group). The coefficients β_1 and β_2 represent the treatment effect net of seasonality and cohort effects.

6. Results

6.1. Balancing Tests on Observables and Birth Frequencies

Our main identifying assumption is that the timing of pregnancy relative to immigration date can be seen as random within the group of mothers who were already pregnant at the time of immigration. We provide here supporting evidence to this claim by showing that children from the three treatment groups (according to gestational age, in trimesters, at time of immigration) are not different in their background characteristics. In addition, we show that the frequency of births in the three trimesters is similar to the observed frequencies in the two comparison groups who were born during the same period of interest.

Table 2 presents summary statistics for these observable characteristics, by the three trimester groups. Column 1 presents means of background variables for the children whose mothers arrived to Israel at the earliest stage of the pregnancy (during the first trimester). Column 2 presents the respective means for the children whose mothers arrived to Israel during the second trimester and columns 3 presents characteristics for children whose mothers arrived to Israel at the latest stage of

[12] Some of the children in our sample who were born in Ethiopia (about 10 percent) have a missing value in month of birth. We assign to these children a random month of birth and we include dummy for it in the specification.

the pregnancy (during the third trimester). The median gestational age is roughly in the middle of the range for each group, so no group suffers from over-representation of only one part of the period. In Columns 4, 5 and 6 we report the difference in means and their standard errors between these three groups.

Fathers' average years of schooling is 1.19 for the group who arrived to Israel at the earliest stage of the pregnancy (first trimester), 0.28 years lower than the mean of second trimester and 0.10 higher than the mean of the third trimester. Mothers' average years of schooling is 1.17 for the first trimester group, which is about 0.6 years lower from the second trimester (1.74 years) and 0.03 years lower from the third trimester (1.20 years). Differences in parental education between children who arrived in the different trimesters are not statistically significant, except for a disadvantage of mothers who arrived in the first trimester relative to the second. So overall, this works against our concern for positive selection bias if better family background correlate with arrival to Israel at earlier stages of pregnancy. The mean SES index of the initial locality of residence of the mother upon immigration is also lower for the first trimester group (though not statistically significant). On the other hand, the family annual income four years after immigration is slightly higher in the first trimester group by more than 1000 NIS (equal to $250) compared to the second and third trimester groups. However, differences in income are not statistically significant. Unfortunately, family income in 1995 is the earliest year available in the administrative income data. We note that since this income variable is measured post treatment, we do not include it as a control in the regressions.

The proportion of girls in the first and the third trimester is the same (0.462) and it is lower from the second trimester (0.506) but these differences are insignificant. The mean age of the mother at birth is the first trimester group is 31.3, slightly higher but not significantly different from the other two groups (31.3 versus 30.5 in the second and third trimester). The mean of parents age gap in the first trimester group is 9.9 which is significantly lower by 1.5 years from the second trimester group, and it is also lower by almost 1 year from the third trimester group, although this last different is insignificant. There are also no statistical differences in the average birth-spacing, number of siblings and birth order.

Overall, differences in parental characteristics and family structure do not point to any particular advantage of one group relative to the others. Moreover, there is no clear trend showing an association between better family background and a longer exposure in utero to the Israeli environment (e.g. arrival at earlier stages of pregnancy).

The results presented in this table support our claim that exposure to treatment is indeed as good as randomly assigned in this natural experimental setting, by showing that children from the three trimesters groups are not different in their observable characteristics. Specifically, they show that there is no significant correlation between the observable characteristics of children and the timing of pregnancy according to our definition of the three "treatment" groups. 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.

Figure 4 plots the frequency of births of our main analysis sample (Operation Salomon children) and the comparison groups who were born in the same period: second generation of Ethiopian parents who immigrated in the previous immigration wave (Group A) and Ethiopian children who immigrated in later periods (Group B). The figure show how births are classified by the three trimesters according to gestational age. As can be seen in the figures, frequency of births in the three trimesters are similar in our main sample and the two comparison groups and there is no clear evidence of selection of births across the trimester cutoffs.

To look at this issue in a higher resolution, we plot in Figure 5 the share of births by gestational week upon immigration to Israel (May 24 1991) for our main analysis sample and the equivalent gestational age computed at that same date for the two comparison groups. The vertical lines denote the trimesters. The figure shows two important facts: (i) there is no clear discontinuity around the trimester cutoffs in our main analysis sample; (ii) The share of births by week are not significantly different between our main sample and the two comparison groups. To formally test this issue, we also estimated a model where the dependent variable is the share of births by week, and examined whether there were significant differences by trimesters between our main sample and the two comparison groups. Results (not reported here but available upon request) show no significant differences in none of the three trimesters.

6.2. Main results

First, we discuss the results for our baseline model without controlling for seasonality effects. Table 3 presents the results for our baseline model (equation (1)) with and without controls for students' observable characteristics. In all specifications, the omitted category is the third trimester group. Columns 1, 3, 5, 7, 9 and 11 present estimates for equation (1) without controls and columns 2, 4, 6, 8, 10 and 12 present estimates for equation (1) including controls. We report the estimates of β_1 and β_2, and a p-value for the test of equality of these two coefficients.

The estimates reported in columns 1 through 6 show that exposure in utero to micronutrient supplements and to the Israeli environmental conditions starting from the first trimester of pregnancy has positive and significant effects on schooling attainment relative to a late exposure at the third trimester. Students who were exposed to this treatment starting from the first trimester (group 1) are 10.3 percentage points (se =0.036) less likely to repeat a grade during high school and 5.4 percentage points (se =0.037) less likely to drop out of high school before completing 12^{th} grade compared to students exposed to treatment only during the third trimester (group 3). These effects increase slightly to 11.8 percentage points (se =0.038) and 6.9 percentage points (se =0.039) respectively when controlling for background characteristics. Exposure to treatment during the second trimester is also associated with lower likelihood of grade repetition and school drop-out compared to the third trimester, but the effects are much smaller than those obtained for exposure from the first trimester and are not significant. On the other hand, we cannot reject the hypothesis of equality of coefficients between the effects of the first and second semester, probably due to a lack of power.

Performance in the *Baccalaureate* exams is also improved by a longer exposure to treatment. Students who were exposed to the Israeli environment starting from the first trimester are 12 percentage points (se =0.052) more likely to obtain a *Baccalaureate* diploma by the end of high school compared to students exposed in the last trimester. These effects are larger than the effect of arriving during the second trimester although not statistically different.

The estimated effect for the fully treated group (first trimester) on the *Baccalaureate* rate is very large relative to the mean of this outcome in the two other groups, which is about 20 percent: it means that exposure to micronutrient supplements (mainly iron, iodine and folic acid) and better in utero conditions in Israel from the first trimester improved the *Baccalaureate* rate by 65 percent. This is a dramatic effect size in absolute terms and relative to any studied and well identified educational program. Moreover, as we discuss in the data section, the *Baccalaureate* rate in our sample is substantially low compare to the *Baccalaureate* rate among all Jewish students in Israel and the additional 12 percentage points for the fully treated group represents almost half way of closing this gap.

The above gains are accompanied by improvements in other measures of quality of the high school *Baccalaureate* study program as shown in columns 7 through 12. The total *Baccalaureate* credit units of children who arrived in the first trimester are 3.3 points higher (s.e. =1.047) than those of children who arrived in the third trimester, a gain of almost 40 percent. The math and English credit units are up by about 0.4 and 0.5 units, a gain of about 30 percent. These are important and large quality gains. The effect of the second trimester is positive and significant (except for Math) and smaller than the effect of the first trimester although we cannot reject the hypothesis of equality between these two effects.

Table 4 presents the results for the DID specification (equation (2)) that controls for cohort and month of birth fixed effects. The DID estimates for the schooling attainment outcomes are very similar to the respective OLS estimates and are more precise except for the estimates for obtaining *Baccalaureate* diploma by the end of high school which are slightly smaller. The DID estimates for the quality of the *Baccalaureate* program are slightly lower from the respective OLS estimates but not statistically significant different. Again, the results suggest that early exposure to better environmental conditions and micronutrients improve the quality of the *Baccalaureate* diploma. On the other hand, for most of the outcomes, after controlling for seasonality and cohort effects, we obtain significant differences between the effects obtained in the first trimester and the second trimester probably due to the increase in precision. While the impacts of the first trimester are large and significant, the impacts of the second trimester are smaller and not significantly different from the impacts of the third trimester. These results suggest that the first trimester of pregnancy constitutes a critical period for cognitive development.

In Table A2 we explore an alternative simpler specification where we estimate a linear model using as a main explanatory variable gestational age at time of immigration. As in our main sample we include weeks 2 through 40 of gestational age since weeks 1 and 2 include children who in fact were conceived in Israel. In line with our main results from the specification stratified by trimesters, the estimate for gestational age is negative for all outcomes suggesting beneficial effects for earlier exposure to better in-utero conditions. This model however, assumes a constant marginal effect by number of weeks of exposure and does not allow capturing the differential effects of the different gestational periods. We also experimented with additional specifications where we included higher order polynomials instead of a linear effect but their fit to the data was inferior (lower adjusted R-squared and higher AIC values). In addition, we tried specifications that look formally for a structural break in the data but given that we have only 594 children they turned to be noisy and provided inconsistent results across outcomes.

6. 3. Heterogeneity in the Effect of In-utero Environmental Conditions by Gender

Table 5 presents estimates by gender for our two main specifications: the baseline OLS and the DID controlling for students background characteristics. We also report the means of the outcome variables for each sample and the p-value of the difference in the coefficient between boys and girls. Results reported in columns 1, 3, 5, 7, 9 and 11 of table 6 are based on equation (1) - OLS model. Results reported in columns 2, 4, 6, 8, 10 and 12 are based on equation (2) - DID model. The estimates of the effect of earlier exposure to better environmental conditions in utero reveal an interesting differential pattern by gender. We observe a large impact of exposure in the first trimester for girls in all outcomes. In contrast, the impact for boys is smaller and not statistically significant. Differences in magnitude of the estimated effects between boys and girls are not always significant but all estimates point to the same overall pattern: exposure to better environmental conditions in utero starting from the first trimester improves dramatically outcomes for girls but not for boys. In addition, we observe a smaller but still positive and even sometimes significant effect for girls in the second trimester while there is no equivalent effect for boys. It is worth noting that girls have higher performance relative to boys in all the outcomes analyzed here. So that the scope for improvement should be higher for boys. On the other hand, it might be the case, that early exposure to better environmental conditions improves boys' outcomes in other dimensions not analyzed here.

Evidence for a larger impact for girls is consistent with the findings of Field et al. (2009) who also investigate the effect of in utero micronutrient supplement (iodine) and find that that delays in resupply of iodine for pregnant women in Tanzania has large educational impacts on their children, with larger improvements for girls. Our results are also consistent with other related literature. For example, Baird, Friedman and Schady (2011) find that in developing countries girls infant mortality is significantly more sensitive to aggregate economic shocks during pregnancy relative to boys. In addition, studies that analyzed long term outcomes of negative environmental shocks found higher effects on girls. For example, Oreopoulos et al. (2008) show that effects of infant health on reaching grade 12 by age 17 appear to be stronger for females than males. Hoynes et al. (2012) find that increasing family resources during early childhood improve health at adulthood for both men and women but have positive significant effect on economic self-sufficiency only for women. Gould et al. (2011) also find that early childhood living conditions affected only girls among families that emigrated from Yemen to Israel in 1948-49. The positive effect on girls that they found was evident in short term outcomes such as schooling and in long term outcomes such as employment and earnings at age 55-60.

Why are the effects on girls large and significant? Recent scientific evidence highlights biological gender differences in iodine sensitivity in utero. Results from laboratory studies in animals show greater sensitivity of the female fetus to maternal thyroid deprivation with negative consequences for cognitive development. Friedhoff et al. (2000) found that the effect of artificially restricting maternal thyroid hormone in utero on fetal neurodevelopment and behavioral outcomes was significantly larger in female relative to male rat progeny. Although the mechanism underlying sex-selective effects of maternal nutrient deprivation on brain development could not be directly addressed by their experiment, a recent study of gene expression in nutrient deprived fetal guinea pigs by Chan et al (2005) provides insight into the cellular pathways. Less conclusive evidence of biologically-driven gender differences in iodine sensitivity based on human studies includes earlier studies, Bautista et al. (1982) and Shrethsa (1994). Therefore, the gender differences we observe in the impact of the gestation period in Israel may reflect physiological differences in the importance of iodine for fetal brain development similar to those observed in animal studies. Field et al. (2009) suggest the same explanation for their finding that reducing the deficiency of iodine among pregnant women had a large impact on girls schooling but not on boys.

We also should note that our finding that the effect of exposure to better in utero conditions is mainly for treatment at early stages of pregnancy is consistent with the findings from these animal studies that suggest that cognition is sensitive to iodine deficiency exclusively during early fetal life (prior to mid-gestation) whereas growth and psychomotor development are believed to be most affected by deficiency in infancy (Cao et al., 1994 and Zaleha et al., 2000).

There is also a medical literature assessing the differential effects of iron deficiency in utero by gender based on animal models. Consistent with our findings, Kuik-Uribe et al. (2000) find that iron deficiency is more detrimental for female mice fetuses as it was possible to totally reverse this deficiency for male mice by 8-week of postnatal iron supplementation while not for female mice.
A more detailed examination and discussion of the physiological mechanisms that lead to the different effects by gender is beyond the scope of this paper and is addressed by the medical literature.

6.4. Placebo tests

To test for the validity of the design we estimate the model based on a sample with placebo treatment. The placebo treatment can be captured by immigrants to Israel who arrived around the same time of "Operation Solomon" but from a more developed part of the world where in utero conditions at that time were similar to Israel. We implement this idea by focusing on a sample of immigrants who arrived to Israel during the massive immigration wave from the former Soviet Union (FSU) in 1991-1992. Relevant evidence suggests that in utero conditions in the Soviet Union (especially in those places were the immigrants lived) were relatively similar to those in Israel.[13] In addition, parental background characteristics of children of FSU immigrants are not different from the Israeli native population. For example, parental years of schooling of USSR immigrants in these years was about 11 years, close to the respective mean in the relevant Israeli population. Therefore, we expect to find no effect of treatment defined by length of gestation in Israel.

In Table 6, we present evidence from this placebo test. The sample includes children of women who were pregnant upon arrival to Israel from the USSR in 1991-1992. We define the treatment groups for the placebo test in the same way we define the original treatment definition. We compute the gestational age of the child at immigration as the difference between the date of the mother immigration and the child's birth date. For example, $First\_Trimester_i$ equals 1 if the mother immigrated to Israel during the first 10 weeks after conception. Unlike "Operation Solomon", immigration from USSR did not take place in a single date, hence the treatment groups are not defined relative to a single specific immigration date. We can therefore control for cohort and month of birth effects within this sample.

In Appendix Table A2 we perform balancing tests for this sample where we regress students' background characteristics on the trimester indicators while controlling for month and year of birth

[13] More than 80% of the FSU immigrants arrived from the European republics, mainly Russia and Ukraine, and mainly from urban areas (Israeli Central Bureau of Statistics 2007). Infant and child mortality rates in these areas were 1.5% and 1.1% respectively (versus 1.0% and 1.2% in Israel and 12% and 20% in Ethiopia) (UNICEF 2003). Pre-natal care in FSU was also relatively similar to Israel (The World Bank – Data catalog). Until the deterioration of the Soviet Union there was iodization of salt policy (UNICEF 2011). Also anemia in pregnant women has increased significantly only after the collapse of the Soviet Union (FAO 2003).

fixed effects. The results show no evidence for differential selection in the timing of immigration according to gestational age. Namely, parental schooling, number of siblings and the proportion of boys is similar for children who were in utero at different trimesters of pregnancy upon immigration.[14]

Table 6 presents estimates for the effects of exposure in the first and second trimester based on equation (1), under two specifications, without controls and with controls. The two specifications include cohort and month of birth fixed effects. The controls include parents' years of schooling, gender and number of siblings. The treatment estimates are much smaller, most of them very close to zero, and they are all insignificant relative to the results obtained for Ethiopian immigrants. Overall, we can safely conclude that these placebo tests show no systematic association between gestational age at time of immigration and outcomes among children who were born in the same period of interest but did not experience a significant change in in-utero conditions upon immigration to Israel. These results show that our main findings for Ethiopian children are unlikely to be confounded with other factors that could be associated with date of birth and could affect students' outcomes.

In Table 7 we present similar placebo evidence while stratifying the USSR sample by gender given that our main results for Ethiopian children were mainly concentrated among girls . In sharp contrast to the results for Ethiopians, there are no effects for boys and for girls. All estimates are small and are not statistically different from zero.

6.5. Effect on Additional Outcomes/Possible Mechanisms

a. Birth outcomes

As discussed above, the medical literature stresses the crucial role of maternal health and in-utero conditions during the first trimester since the fetus develops all of its organs in this period. In particular, the first trimester is crucial for brain development. In light of this, we explore whether the enhanced cognitive outcomes of Ethiopian children exposed to a better environment from the first trimester derive from health conditions. To examine this channel, we explore the effect of length of exposure to the Israeli environment using birth weight as a proxy of fetal health.

Table 8 presents the estimates of the treatment effect on birth weight (measured in grams) for the baseline RD specification and a DID specification that includes only the cohorts born in Israel between May 27th 1991 and February 15th 1992.[15] In addition, the table shows estimates for the probability of low birth weight (less than 2500 grams) and very low birth weight (less than 1500 grams). We also report means of the outcome variables for each sample. Results reported in columns 1, 2, 5, 6, 9 and

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[14] We cannot use the richer set of covariates that we used for the Ethiopian sample, since we only have the administrative data from the ministry of education for the Soviet sample. Nevertheless, since we find no evidence for differential selection in none of the available covariates, it is reasonable to assume that there is unlikely to have selection in other covariates or unobserved characteristics.

[15] We include only cohorts born in Israel because there are no administrative records on birth weight of children born in Ethiopia.

10 of table 9 are based on equation (1). Results reported in columns 3, 4, 7, 8, 11 and 12 are based on equation (1) and include also an indicator for comparison group A (children born in Israel whose parents immigrated before Operation Salomon) and month of birth fixed effects. The estimates from models that control for month of birth fixed effects are insignificant and not different from zero.

In Table A3 we present the results on birth weight by gender. Most estimates for girls are not significant. If anything, we find a positive effect for those who arrived during the first trimester on the likelihood of low birth weight, which goes against our findings of better cognitive outcomes. Estimates for boys show some positive effect on birth weight from exposure in the second trimester but no effects from the first trimester, the significant effects on birth weight among boys are at the opposite direction of the selection that might drive the results for schooling outcomes.

Overall, results reported in Table 8 and Table A3 suggest that the large effect of early exposure to better prenatal conditions on schooling outcomes is unlikely to derive from improved fetal health. It also reduces the concerns that our estimated effects on schooling outcomes are due to selection since if selection is driving our results, we should see this also in terms of an effect on birth weight.

Our results of no effect on birth weight are in line with other studies that examine the effect of environmental conditions in utero on long-term human capital outcomes that did not find effects on fetal and later life health. Field, Robles, and Torero (2009) showed that delays in iodine supplementation during pregnancy have large and robust educational impacts, but no effect on health at school age. Almond et al. (2009) found that radiation exposure between week 8 and 25 of gestation harmed school achievement but do did not affect birth weight and hospitalizations.

A possible explanation for our lack of results on birth weight, is that higher exposure to all the three micronutrient supplements (iron, iodine, and folic acid) affects brain development at the first trimester while all other improved environmental conditions have a positive effect on nutrition even if exposed during the second or third trimester. The evidence documented in Akter et al. (2012) that nutrition counseling among urban poor women in Bangladesh during the third trimester of their pregnancy reduces the probability of low birth weight supports this interpretation.

b. School quality

The gains in cognitive outcomes to children exposed to better environmental conditions in utero from the first trimester of pregnancy could result from enrollment of these children in better schools. The mechanism we envision here is that the affected children revealed higher cognitive ability achievements at a young age and therefore they were assigned to or were able to be admitted to schools of higher quality. If this is correct then part of the final gains in outcomes of these students reflects the contribution of these 'better' schools. Gould, Lavy and Paserman (2004) show that there was no selection of families of "Operation Solomon" into the different absorption centers in the country and as a result, allocation of their children into the different neighboring primary schools can be seen as random. However, enrollment in secondary schools was endogenous, determined by choice, and therefore secondary school quality could be a mechanism through which the children included in our first trimester group improved their cognitive outcomes.

Table 9 presents results for equations (1) and (2) using various alternative measures of high school quality as the dependent variable. We compute four measures of high school quality for the years 2003-2005, before students in our sample enrolled in high school: school mean *Baccalaureate* rate, school mean total *Baccalaureate* units, school mean math *Baccalaureate* units and school mean *Baccalaureate* test scores.

All estimates reported in the table show no evidence for an association between gestational age at time of immigration and high school quality. Therefore, we conclude that the long term gains of children in utero in Israel since the first trimester of pregnancy are not mediated through *'nurturing'* in better primary or secondary schools. Since the home environment after birth of these treated children was not different from that of children who arrived to Israel in utero in the second or third trimester of gestation, it suggests that *'nature'* is mostly responsible for the long-term treatment effects that we demonstrated above. By *'nature'* we mean enhanced brain development during early gestation due to the better in utero conditions in Israel relative to those in Ethiopia.

7. Alternative Interpretations and Measurement Issues

Our results show that children with a smaller gestational age at the immigration day had better outcomes relative to those whose mothers arrived at more advanced stages of pregnancy. We interpret this as a positive impact of in-utero conditions. An alternative interpretation is that mothers who arrived at an early pregnancy stage had more time to adjust and prepare for birth and were able to build social networks to get proper assistance and care for their newborns. We view this as a low likelihood explanation because all new Ethiopian immigrants were placed in absorption centers where they stayed for at least 18-24 months. In these centers immigrants received assistance from social and health workers and conducted their social life. Therefore, we can safely assume that all women who gave birth within the nine-month window upon arrival to Israel received the same post-natal care and had the same social network.

We also show in Table A4 that length of stay in Israel did not affect child outcomes by examining the outcomes of Ethiopian children born to Operation Salomon mothers who were conceived in Israel and born within 10 to 20 months upon the mother arrival. We cannot use a longer end point in this time interval because these children are too young and we do not have their end of high school outcomes yet. In addition, we want to limit the sample to children conceived within a short time window upon immigration to make sure that all mothers were still in absorption centers and therefore received similar prenatal care. We also want to look at a similar time span to the one observed in our main analysis sample in terms of time in Israel when the children were born. We estimate OLS regressions of all outcomes on mother's weeks in Israel at the time the child was born. The regressions control for the same family background characteristics that we include in all our previous models. Even though the sample analyzed here could suffer from selection into pregnancy we believe that, if anything, the bias should work in the direction of generating upward biased estimates for the effect of time in Israel when the child was born (with better unobservables for mothers who waited some time until they have a child in Israel after immigration). Despite of this, we find that for all the outcomes, including birth weight, the mother's length of stay had small, varying in sign, and not statistically significant coefficients. This finding shows that, at least for births occurring within 20 months upon immigration, mothers' longer stay in Israel upon the child birth did not improve child's outcomes. It therefore reduces the concern that our main results are driven by the longer stay of the mother in Israel when the child was born.

An additional confounding effect could be related to stress. Children who were in utero at different stages of pregnancy were exposed to the stressing event of immigration. Several recent studies emphasize the negative impact of maternal stress on child outcomes. For example, Aizer et al. (2014) and Persson and Rossin-Slater (2014) find that in utero exposure to maternal stress has detrimental effects on children's cognitive outcomes and mental health. In contrast, Balck et al. (2013) find small adverse effect on birth outcomes and no effects on education and earnings among children whose mothers lost one of her parents during pregnancy. These studies, however, do not examine the differential effect of maternal stress by gestational age. Medical studies have looked at maternal stress in different stages of pregnancy. For example, Glynn et al. (2004) reported that the gestational ages of newborns whose mothers were exposed to an earthquake in their first trimester were shorter than those whose mothers were exposed in their third trimester. This is also consistent with Laplante et al. (2004) who find that high levels of prenatal stress exposure, particularly in early pregnancy, may negatively affect the brain development of the fetus resulting in lower intellectual and language abilities of toddlers. Other studies such as King et al (2012) arrive to the same conclusion: exposure to stress is more detrimental in early stages of pregnancy. If the effect of stress during immigration follows the same pattern, it works against finding an effect of improved in utero conditions during the first semester. An additional piece of evidence that reduces the possibility that our results could be explained by differential exposure to stress is that we do not find any difference in sex ratios between children born in the first and the third trimester while various studies have found that maternal stress increases the chances of male miscarriages (see e.g., Liu et al., 2015 and Kraemer, 2000). We also find no differences in birth weight even though the stress literature shows that maternal stress also causes lower birth weight (King et al. 2012).

Additional challenges to our design derive from measurement issues. As opposed to recent studies that have a close approximation of gestational age based on clinical records on last menstrual period or estimation of fetal age from a first trimester ultrasound scan, we compute gestational age based on date of birth. This means that we might misclassify some of the children who were born preterm and assign them to the wrong trimester of gestational age upon arrival to Israel. The question is whether we are more likely to have more misclassifications or preterm births in a specific trimester. We suspect that this is not the case since we find no associations between the trimester of gestation upon arrival to Israel and birth weight (which is a good proxy for preterm births). Still, we might be worried that we could include in the first trimester some children who were conceived in Israel and were born ahead of time. Children conceived in Israel who were born preterm are more likely to be born in February or late January 1992. We therefore stratify the first trimester into three groups: weeks 2-4, weeks 5-8 and weeks 9-12 of gestation and estimate our main models examining the differential impacts of different periods in the first trimester. Estimates reported in Appendix Table A5 show that the beneficial effects of the first trimester do not particularly come from the first weeks after conception reducing the concern that our results derive from misclassified preterm children who were actually conceived in Israel.

Another potential source of bias stems from the fact that we do not observe miscarriages or stillbirths. If these events were more likely to occur to mothers who arrived to Israel during the first trimester, we might get a positively selected sample of children who arrived in the first trimester of gestation. First, we note that children who were in utero during the first trimester of gestation upon immigration do not have higher birth weight, which could be a sign of positive selection. Second, since boys are more likely to be miscarried and die prematurely in hard times, we hypothesize that if there were more miscarriages and stillbirths among mothers who arrived in their first trimester, we should observe a lower sex ratio (males to females) for the first trimester children relative to the third trimester. However, as shown before, the sex ratio of children in the first trimester is equal to that of the third trimester. Third, as discussed above, we do not find significant differences in the share of births by calendar week between our main analysis sample and the two comparison groups. Last, we claim that if anything, the better environmental conditions upon arrival to Israel might probably lowered the incidence of miscarriages among women who arrived at earlier stages of pregnancy relative to those who arrived at a later stage. In that case, we should actually observe more marginal children born among mothers who arrived in their first trimester, a fact that would work against us finding any positive impact on longer term outcomes for this group.

8. Potential Longer Term Returns

What are the longer term economic payoffs at adulthood of the gains due to the better in utero environmental conditions? Since the individuals in our sample are only 22 years old, we cannot yet analyze their post-secondary schooling and labor market outcomes. Hence, we examine the relationship between improved high school outcomes, and post-secondary schooling and earnings based on older cohorts of individuals who were born in Ethiopia between 1981 and 1984 and emigrated from Ethiopia during Operation Salomon. Note that these individuals arrived to Israel between ages 7 and 10 and therefore received most of their schooling in Israel. We use administrative records provided by the National Insurance Institute of Israel (NII) which include information on post-secondary enrollment and earnings. We linked these data to administrative records collected by the Israeli Ministry of Education, which include information on individuals' *Baccalaureate* outcomes.

Table 10 presents the relationship between *Baccalaureate* outcomes as explanatory variables, and post-secondary schooling and earnings by the ages 28-31. All the estimates are based on regressions that control for gender, parents years of schooling, number of siblings and year of birth effect. Column 1 shows the estimates for any type of post-secondary schooling enrollment and column 2 shows the equivalent estimates for university enrollment.[16] Individuals with a *Baccalaureate* diploma are 21.7 percentage points more likely to continue schooling in some type of post-secondary schooling and 11.6 percentage points more likely to enroll to university. The total credit units in the *Baccalaureate* study program and the number of credits in advanced classes (5 credit units) are also positively and significantly associated with each of the two higher education outcomes.

Column 3 shows the estimates from a regression of the *Baccalaureate* outcomes on annual earnings in 2012. Individuals with a *Baccalaureate* diploma earned about 5,000 shekels more a year (about $1250), or 10 percent more relative to the outcome mean. An additional credit unit in the *Baccalaureate* program is associated with 376 shekels (about $100) and a respective unit in advanced courses is associated with 6800 shekels ($1700) although this estimate is imprecise. Estimated returns to *Baccalaureate* outcomes are much higher for females than for males but this is due to the fact that males serve longer in the army and begin their post-secondary education at an older age. So that returns to education among men may still not fully realized.

These estimates cannot be interpreted as causal but they are economically meaningful and most are also precisely measured. Even though these estimates are much lower than the respective estimates obtained from a sample of native Israelis, they are much larger than the cost of providing the better in utero environmental conditions, particularly the cost of the three micronutrient supplement - iron, iodine and folic acid, during pregnancy. Of course a proper cost-benefit analysis of the rate of return to these pre-birth investments must rely on causal relationship while ours are simple associations and should also include an estimation of the costs of providing prenatal care. In addition, it is important to note that because of the Israeli job market structure our analysis cohort might still be in the track of academic schooling and therefore we not observed a full time employment earnings, mainly for men.

[16] In Israel, post-secondary schooling includes universities, colleges and professional colleges. Admission to university is much more selective relative to all other post-secondary institutions in terms of the quality of the matriculation program required.

9. Conclusions

This paper examines the role of in utero environmental conditions and micronutrient supplements (mainly iron, iodine and folic acid) on offspring cognitive achievement. The analysis is based on exogenous variation in environmental conditions in utero caused by the sudden immigration of Ethiopian Jews to Israel in May 1991. Children, who were already in utero at the immigration date, were exposed to better environmental conditions upon arrival to Israel. Some children were exposed to these better conditions from the early weeks of gestation while others were exposed to these conditions only at the last stage of their mother's pregnancy. We exploit this variation to examine the relationship between weeks of in utero exposure to better environmental conditions and high school outcomes. We also examine the impacts on birth weight.

The results suggest that children who were exposed to micronutrient supplements and to better environmental conditions in Israel during the first trimester of pregnancy had substantially higher educational outcomes by age 18 relative to those exposed to these conditions at later stages of pregnancy. The higher educational outcomes include a lower likelihood of school repetition and dropout, a higher likelihood of obtaining a *Baccalaureate* diploma and of graduating with a higher quality *Baccalaureate* study program. The impact is significantly larger for girls. The effects sizes are very large, especially compared to the low counterfactuals for this group. Moreover, the expected gains are high in terms of the relationship between *Baccalaureate* outcomes and post-secondary schooling and earnings at adulthood. These results are robust with respect to alternative comparison groups that attempt to control for seasonality of births and cohort effects. We find no effect of early exposure to better environmental conditions in utero on birth weight. This result is consistent with the fact that fetal growth and weight gain takes place in the second and third trimester so that children who immigrated during more advanced stages of gestation were able to catch up on this outcome.

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 conditions in utero caused by immigration, especially from a very poor African country to a western style economy. The implications of these findings are especially relevant for many industrialized countries that experience large immigration waves from the developing countries. In addition, the evaluation of the impacts of differences in environmental conditions in utero between developing and developed countries can shed light on the early origins of gaps in human capital and health outcomes.

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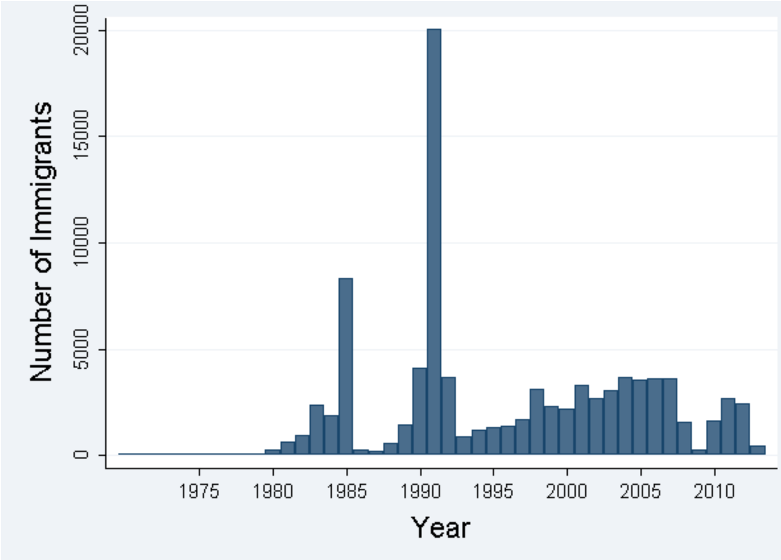
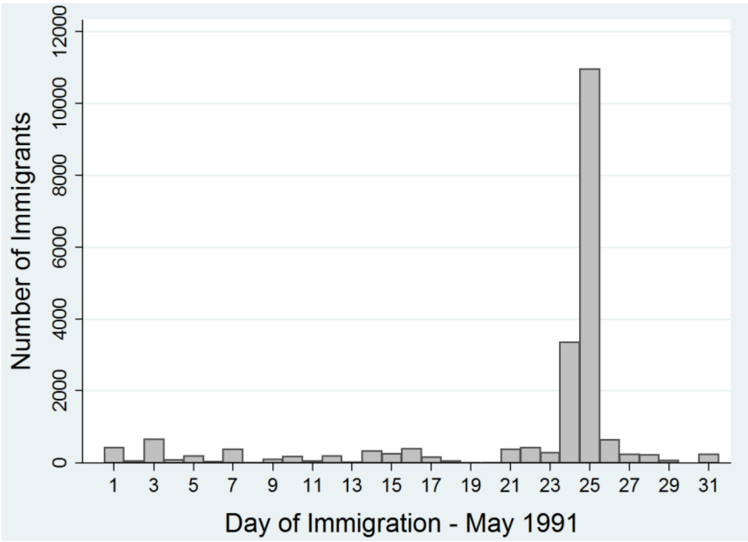
Figure 1. Immigration of Ethiopians Jews from Ethiopia to Israel during the years 1975 - 2010



Source: Israel Central Bureau of Statistics.

Figure 2. Immigration Flow of the Ethiopians Jews from Ethiopia to Israel during May 1991



Source: Israel Central Bureau of Statistics.

Figure 3: Definition of the three trimester groups

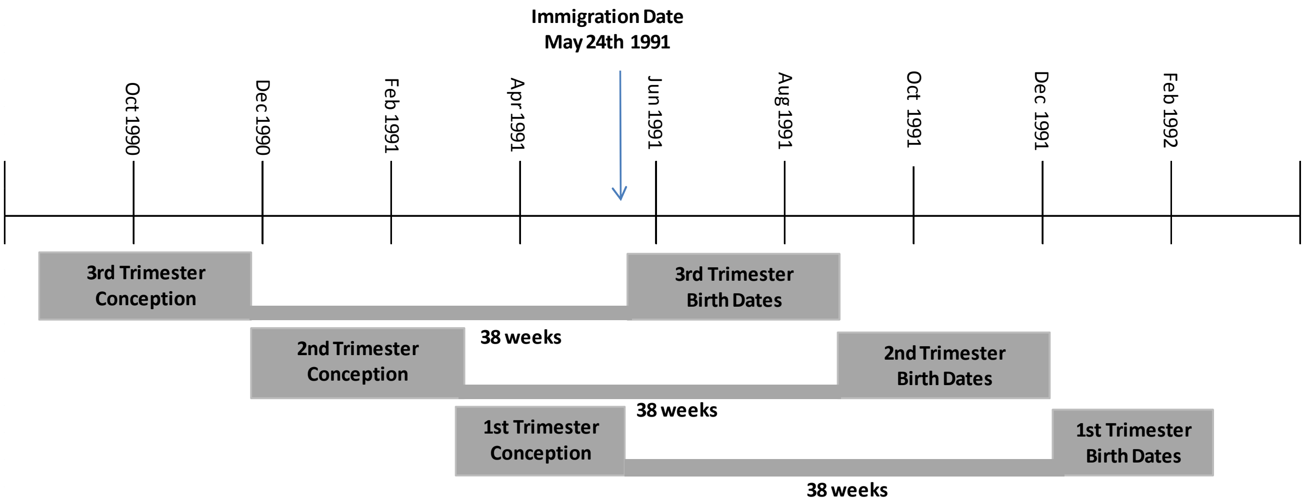


Figure 4. Birth Distribution of Main Sample and two comparison groups

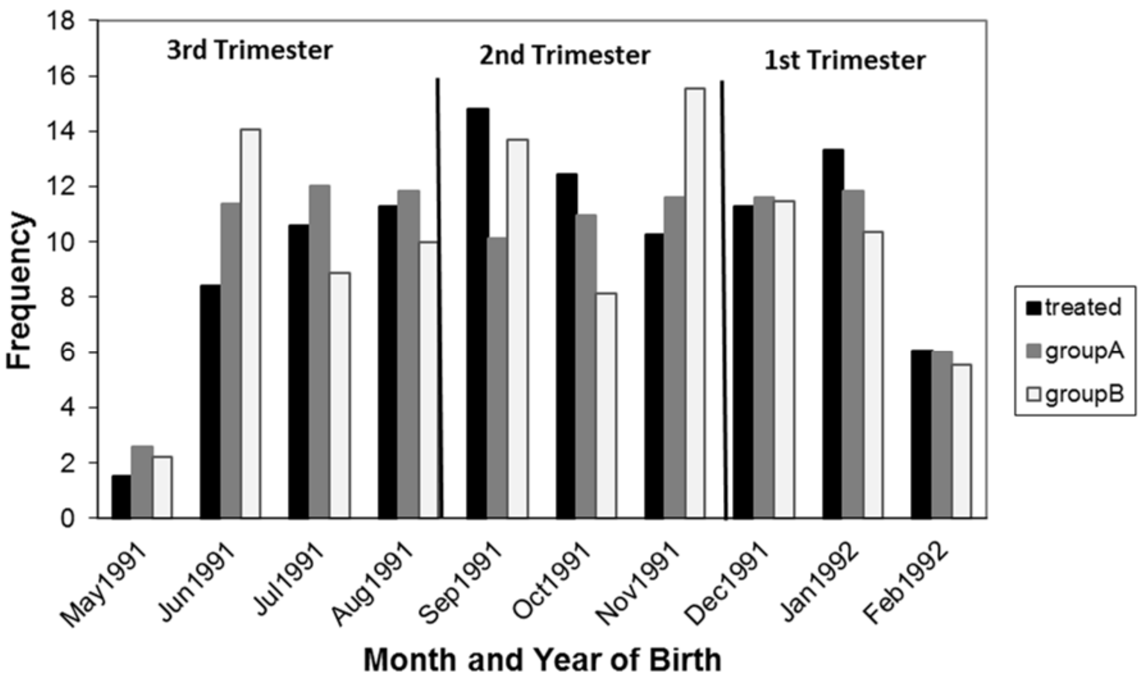


Figure 5. Share of births by gestational week on May 24 1991

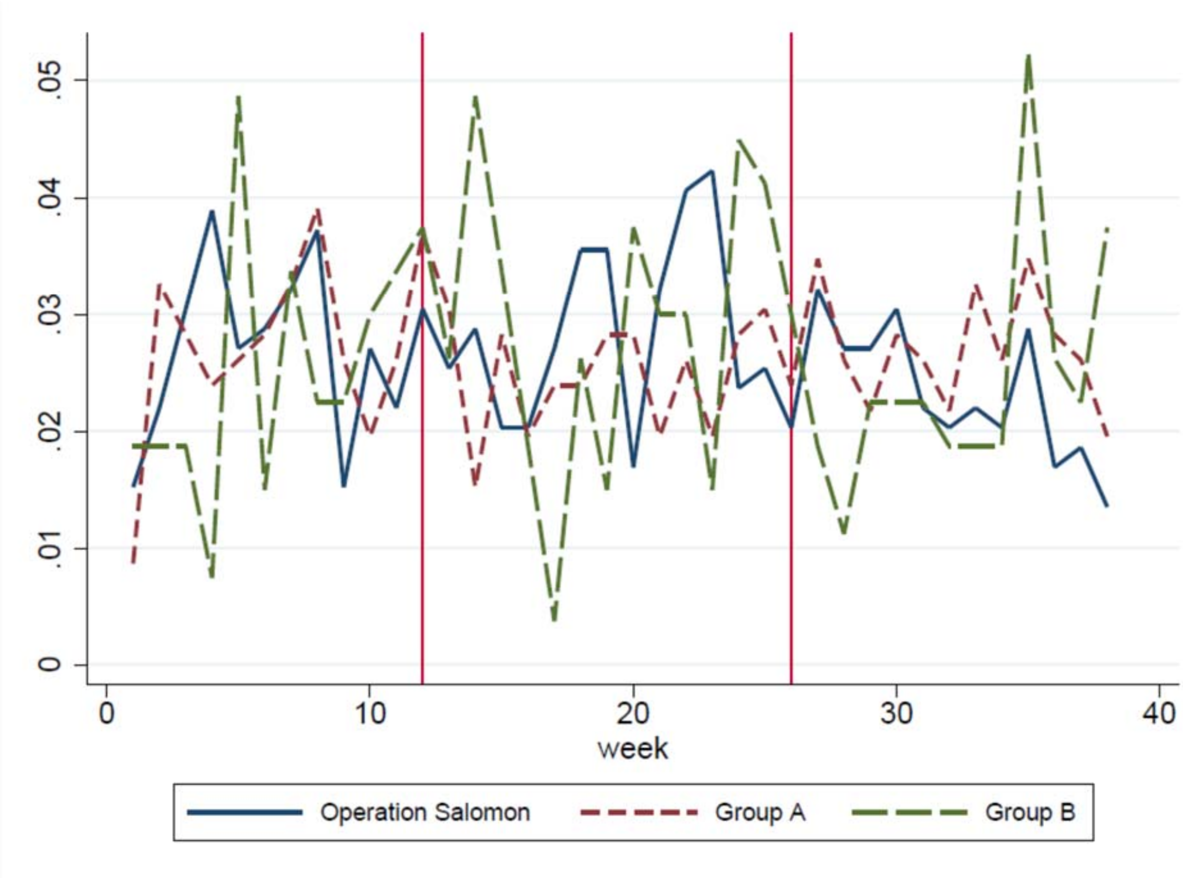


Table 1. Descriptive statistics

	Main Sample	Comparison Samples - Ethiopian Origin	
	"Operation Solomon" children	Israeli Born children (parents immigrated before 1989)	Ethiopian Born children (parents immigrated after 1991)
	(1)	(2)	(3)
A. Background Characteristics			
Female	0.480	0.505	0.415
	(0.500)	(0.501)	(0.494)
Mother's age at birth	30.73	28.88	27.540
	(8.892)	(7.027)	(7.919)
Mother's age at first birth	23.10	21.37	21.05
	(5.426)	(4.239)	(5.122)
Parents age gap	10.90	6.957	9.493
	(7.315)	(5.777)	(6.256)
Number of siblings	5.345	4.391	4.933
	(1.928)	(1.891)	(1.691)
Birth order	3.682	3.415	3.322
	(2.200)	(1.910)	(1.925)
Birth-spacing (years to the next birth)	2.462	2.838	2.418
	(2.201)	(2.805)	(1.820)
Father's years of schooling	1.272	3.997	1.440
	(3.043)	(5.285)	(3.487)
Mother's years of schooling	1.412	3.789	1.192
	(3.240)	(5.000)	(3.070)
SES of the mother's first locality of residence upon immigration	-0.039	-0.004	0.115
	(0.546)	(0.556)	(0.473)
Family income in 1995 (NIS)	16,397	47,255	6,896
	(14274.3)	(33537.3)	(12238.9)
B. Outcomes			
Did not repeat 6-12th grade	0.806	0.824	0.800
	(0.395)	(0.382)	(0.401)
Did not drop out of high school before completing 12th grade	0.848	0.873	0.859
	(0.359)	(0.333)	(0.348)
Obtained a Baccalaureate diploma	0.305	0.351	0.319
	(0.461)	(0.478)	(0.467)
Total Baccalaureate units	11.58	12.85	11.98
	(11.14)	(10.84)	(11.12)
Math Baccalaureate units (0 to 5)	1.276	1.465	1.289
	(1.508)	(1.507)	(1.554)
English Baccalaureate units (0 to 5)	1.978	2.374	1.944
	(1.876)	(1.907)	(1.831)
Birth Weight (gr)	3068.2	3101.5	
	(480.2)	(566.7)	
Low birth weight (<2500gr)	0.110	0.111	
	(0.313)	(0.314)	
Very low birth weight (<1500gr)	0.005	0.017	
	(0.0715)	(0.131)	
Number of children	594	465	270

Notes: Standard deviations are presented in parenthesis. Children in all samples were born between 27th May 1991 and 15th February 1992.

Table 2. Summary Statistics for the Observable Characteristics broken down by Treatment Groups

	First Trimester (1)	Second Trimester (2)	Third Trimester (3)	Difference between First and Second (4)	Difference between First and Third (5)	Difference between Second and Third (6)
Female	0.462	0.506	0.462	-0.044	0.001	0.045
	(0.500)	(0.501)	(0.500)	(0.050)	(0.053)	(0.049)
Mother's age at birth	31.29	30.51	30.47	0.779	0.816	0.038
	(9.616)	(8.464)	(8.748)	(0.895)	(0.975)	(0.845)
Mother's age at first birth	23.50	23.11	22.70	0.388	0.794	0.405
	(5.954)	(5.295)	(5.058)	(0.557)	(0.585)	(0.511)
Parents age gap	9.965	11.53	10.96	-1.562**	-0.991	0.571
	(6.305)	(8.188)	(6.928)	(0.744)	(0.704)	(0.755)
Number of siblings	5.422	5.301	5.330	0.121	0.092	-0.028
	(2.021)	(1.829)	(1.972)	(0.191)	(0.212)	(0.186)
Birth order	3.653	3.640	3.764	0.013	-0.111	-0.124
	(2.222)	(2.159)	(2.243)	(0.218)	(0.237)	(0.216)
Birth-spacing (years to the next birth)	2.457	2.363	2.597	0.095	-0.139	-0.234
	(2.167)	(2.152)	(2.299)	(0.215)	(0.237)	(0.218)
Father's years of schooling	1.190	1.476	1.082	-0.286	0.108	0.395
	(2.781)	(3.417)	(2.744)	(0.316)	(0.293)	(0.309)
Mother's years of schooling	1.173	1.744	1.203	-0.571*	-0.030	0.541
	(2.912)	(3.573)	(3.051)	(0.331)	(0.317)	(0.330)
SES of the mother's first locality of residence upon immigration	-0.091	-0.013	-0.023	-0.078	-0.068	0.010
	(0.549)	(0.598)	(0.465)	(0.058)	(0.054)	(0.054)
Family income in 1995 (NIS)	17335	15880	16184	1455	1151	-304
	(14923)	(14298)	(13632)	(1453)	(1515)	(1378)
Median Week of Gestation on Arrival to Israel	5	18	31			
Number of Days in trimester	73	97	93			
Number of boys	93	118	98			
Number of girls	80	121	84			
Number of children	173	239	182			

Notes: Standard deviations are presented in parenthesis. First trimester includes children born between December 4th 1991 and February 15th 1992, second trimester includes children born between August 28th 1991 and December 3th 1991 and third trimester includes children born between May 27th 1991 and August 27th 1991.

Table 3. Estimated Effect of In-Utero Environment on Schooling Outcomes by Age 18 - Baseline Sample (OLS)

	Did not repeat 6-12th grade		Did not drop out before completing 12th grade		Obtained a Baccalaureate diploma		Total Baccalaureate units		Math Baccalaureate units		English Baccalaureate units	
	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
First Trimester	0.103***	0.118***	0.054	0.069*	0.134**	0.120**	3.616***	3.270***	0.469***	0.442***	0.565***	0.517***
	(0.036)	(0.038)	(0.037)	(0.039)	(0.053)	(0.052)	(1.047)	(1.047)	(0.146)	(0.153)	(0.169)	(0.170)
Second Trimester	0.053	0.057	0.029	0.033	0.065	0.063	2.093**	2.141**	0.270	0.267	0.343**	0.348**
	(0.038)	(0.038)	(0.038)	(0.037)	(0.052)	(0.056)	(1.009)	(1.034)	(0.160)	(0.173)	(0.150)	(0.147)
p-value: First Trimester = Second Trimester	0.116	0.062	0.399	0.250	0.186	0.256	0.126	0.228	0.136	0.197	0.132	0.231
Number of children	594		594		594		594		594		594	

Notes: Standard errors reported in parenthesis are clustered at week of pregnancy. Each column is from a different regression. Controls include both parents' years of schooling, gender dummy, mother's age at birth, parents' age gap, SES of first locality in Israel, birth order and dummy for twins. The Baseline sample includes the cohort born between May 27th 1991 and February 15th 1992. The baseline category is the third trimester of pregnancy.

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

Table 4. Estimated Effect of In-Utero Environment on Schooling Outcomes by Age 18 - Two Cohorts Sample (DID)

	Did not repeat 6-12th grade		Did not drop out before completing 12th grade		Obtained a Baccalaureate diploma		Total Baccalaureate units		Math Baccalaureate units		English Baccalaureate units	
	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
First Trimester	0.094***	0.110***	0.055*	0.069**	0.075	0.077	2.416**	2.556***	0.397***	0.422***	0.266	0.287*
	(0.015)	(0.018)	(0.030)	(0.028)	(0.044)	(0.048)	(0.866)	(0.866)	(0.100)	(0.113)	(0.159)	(0.165)
Second Trimester	0.034	0.030	0.018	0.012	0.015	0.008	1.162	1.096	0.176*	0.169	0.149	0.147
	(0.034)	(0.037)	(0.034)	(0.037)	(0.042)	(0.044)	(0.785)	(0.806)	(0.089)	(0.106)	(0.160)	(0.159)
p-value: First Trimester = Second Trimester	0.076	0.028	0.208	0.051	0.209	0.159	0.115	0.059	0.010	0.010	0.356	0.295
Number of children	2,389		2,389		2,389		2,389		2,389		2,389	

Notes: Standard errors reported in parenthesis are clustered at month and year of birth. Each column is from a different regression that includes month of birth and year of birth fixed effects. Controls include both parents' years of schooling, gender dummy, mother's age at birth, parents' age gap, SES of first locality in Israel, birth order and dummy for twins. The two years cohorts sample includes cohorts born between May 27th 1991 and February 15th 1992 and cohorts born between May 27th 1990 and February 15th 1991. The baseline category is the third trimester of pregnancy.

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

Table 5. Estimated Effect of In-Utero Environment on Schooling Outcomes by Age 18 by Gender

	Did not repeat 6-12th grade		Did not drop out before completing 12th grade		Obtained a Baccalaureate diploma		Total Baccalaureate units		Math Baccalaureate units		English Baccalaureate units	
	Baseline Sample (OLS)	Two Cohorts Sample (DID)	Baseline Sample (OLS)	Two Cohorts Sample (DID)	Baseline Sample (OLS)	Two Cohorts Sample (DID)	Baseline Sample (OLS)	Two Cohorts Sample (DID)	Baseline Sample (OLS)	Two Cohorts Sample (DID)	Baseline Sample (OLS)	Two Cohorts Sample (DID)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A. Boys												
Mean of Dependent variable	0.738	0.728	0.786	0.780	0.214	0.221	9.052	8.971	1.042	1.020	1.553	1.572
First Trimester	0.061	0.038	0.039	0.046	0.067	-0.013	1.571	0.541	0.230	0.149	0.214	-0.107
	(0.072)	(0.045)	(0.063)	(0.051)	(0.053)	(0.062)	(1.303)	(0.963)	(0.193)	(0.152)	(0.211)	(0.123)
Second Trimester	-0.002	-0.019	0.001	-0.011	0.020	-0.054*	0.708	-0.162	0.166	0.120	0.033	-0.167
	(0.068)	(0.049)	(0.055)	(0.039)	(0.052)	(0.029)	(1.287)	(0.656)	(0.208)	(0.103)	(0.167)	(0.157)
p-value: First Trimester = Second Trimester	0.267	0.212	0.482	0.151	0.358	0.499	0.413	0.500	0.720	0.829	0.349	0.645
Number of children	309	1224	309	1224	309	1224	309	1224	309	1224	309	1224
B. Girls												
Mean of Dependent variable	0.881	0.895	0.916	0.931	0.404	0.421	14.32	15.12	1.530	1.677	2.439	2.575
First Trimester	0.183***	0.202***	0.097**	0.100**	0.175*	0.185**	5.062***	5.049***	0.680***	0.765***	0.821***	0.778**
	(0.043)	(0.027)	(0.041)	(0.044)	(0.089)	(0.087)	(1.683)	(1.358)	(0.241)	(0.223)	(0.278)	(0.281)
Second Trimester	0.113**	0.086**	0.050	0.032	0.120	0.077	3.786**	2.710*	0.427*	0.256	0.688***	0.535*
	(0.045)	(0.035)	(0.043)	(0.048)	(0.095)	(0.089)	(1.591)	(1.443)	(0.236)	(0.218)	(0.231)	(0.279)
p-value: First Trimester = Second Trimester	0.045	0.007	0.206	0.170	0.457	0.168	0.392	0.066	0.218	0.007	0.593	0.235
Number of children	285	1165	285	1165	285	1165	285	1165	285	1165	285	1165
C. P-value for difference in the coefficient between boys and girls												
First Trimester	0.180	0.022	0.431	0.490	0.279	0.113	0.083	0.010	0.143	0.065	0.072	0.007
Second trimester	0.176	0.040	0.447	0.418	0.324	0.210	0.121	0.090	0.352	0.625	0.024	0.047

Notes: Standard errors reported in parenthesis are clustered at week of pregnancy for the OLS regressions and at month and year of birth for the DID regressions. Each column is from different regression. Panel A reports estimates for boys and panel B reports estimates for girls. Panel C reports p-values from F-tests that check the difference between coefficients of boys and girls. All specifications control also for both parents' years of schooling , mother's age at birth, parents' age gap, SES of first locality. The baseline sample includes children born between May 27th 1991 and February 15th 1992 and the two cohorts sample includes children born between May 27th 1991 and February 15th 1992 and children born between May 27th 1990 and February 15th 1991. The baseline category is the third trimester of pregnancy.

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

Table 6. Estimated Effect of in-Utero Environment among USSR Immigrants

	Did not repeat 6-12th grade		Did not drop out before completing 12th grade		Obtained a Baccalaureate diploma		Total Baccalaureate units		Math Baccalaureate units		English Baccalaureate units	
	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Mean of dependent variable	0.885		0.704		0.368		20.14		2.538		3.363	
First Trimester	0.003	0.002	0.004	0.004	0.011	0.016	0.126	0.270	0.049	0.078	0.011	0.038
	(0.023)	(0.023)	(0.018)	(0.017)	(0.026)	(0.025)	(0.665)	(0.626)	(0.105)	(0.100)	(0.110)	(0.103)
Second Trimester	0.043*	0.044*	0.009	0.009	-0.002	-0.004	0.244	0.157	0.039	0.025	0.163	0.150
	(0.022)	(0.023)	(0.017)	(0.017)	(0.026)	(0.025)	(0.656)	(0.618)	(0.104)	(0.098)	(0.109)	(0.102)
Number of children	2,039	2,039	2,039	2,039	2,039	2,039	2,039	2,039	2,039	2,039	2,039	2,039

Notes: Standard errors reported in parenthesis are clustered at week of pregnancy. Each column is from a different regression. Controls include both parents' years of schooling, gender, number of siblings, year and month of birth fixed effects. The baseline category is the third trimester of pregnancy.
*Significant at 10%; **significant at 5%; ***significant at 1%

Table 7. Estimated Effect of in-Utero Environment among USSR Immigrants by Gender

	Did not repeat 6-12th grade		Did not drop out before completing 12th grade		Obtained a Baccalaureate diploma		Total Baccalaureate units		Math Baccalaureate units		English Baccalaureate units	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
First Trimester	-0.015	0.024	0.014	-0.004	0.008	0.022	0.679	-0.177	0.048	0.092	0.097	-0.027
	(0.035)	(0.030)	(0.029)	(0.020)	(0.036)	(0.035)	(0.972)	(0.806)	(0.150)	(0.133)	(0.160)	(0.133)
Second Trimester	0.053	0.035	0.020	-0.003	0.023	-0.024	0.943	-0.529	0.059	0.011	0.272*	0.051
	(0.034)	(0.030)	(0.028)	(0.020)	(0.035)	(0.035)	(0.943)	(0.808)	(0.145)	(0.134)	(0.156)	(0.133)
Number of children	1,012	1,027	1,012	1,027	1,012	1,027	1,012	1,027	1,012	1,027	1,012	1,027

Notes: Standard errors reported in parenthesis are clustered at week of pregnancy. Each Colum is from a different regression. Controls include both parents' years of schooling, number of siblings, year and month of birth fixed effects. The baseline category is the third trimester of pregnancy. Odd columns report estimates for boys and even columns report estimates for girls.
*Significant at 10%; **significant at 5%; ***significant at 1%

Table 8. Estimated Effect of In-Utero Environment on Birth Weight

	Birth weight (in grams)				Low birth weight (<2500 gr)				Very low birth weight (<1500 gr)			
	Baseline Sample (OLS)		Baseline Sample + 2nd generation "Operation Moses" (DID)		Baseline Sample (OLS)		Baseline Sample + 2nd generation "Operation Moses" (DID)		Baseline Sample (OLS)		Baseline Sample + 2nd generation "Operation Moses" (DID)	
	No Controls (1)	With Controls (2)	No Controls (3)	With Controls (4)	No Controls (5)	With Controls (6)	No Controls (7)	With Controls (8)	No Controls (9)	With Controls (10)	No Controls (11)	With Controls (12)
Mean of Dependent variable	3,068		3,082		0.110		0.110		0.005		0.011	
First Trimester	59.585	95.764**	40.260	41.377	0.021	-0.015	0.054	0.044	-0.006	-0.008	-0.014	-0.017
	(62.319)	(46.184)	(72.607)	(60.444)	(0.039)	(0.032)	(0.048)	(0.035)	(0.006)	(0.007)	(0.012)	(0.012)
Second Trimester	106.506*	102.006**	81.766	55.335	-0.024	-0.029	-0.034	-0.027	0.002	0.002	-0.023	-0.019
	(61.597)	(50.008)	(83.799)	(70.861)	(0.037)	(0.027)	(0.044)	(0.037)	(0.008)	(0.008)	(0.015)	(0.012)
p-value: First Trimester = Second Trimester	0.352	0.858	0.659	0.836	0.183	0.566	0.073	0.018	0.159	0.097	0.541	0.880
Number of children	584		1,045		584		1,045		584		1,045	

Notes: Standard errors reported in parenthesis are clustered at week of pregnancy for the OLS regressions and at month and year of birth for the DID regressions. Each column is from a different regression. All specifications control also for both parents' years of schooling, gender dummy, mother's age at birth, parents' age gap, SES of first locality. The baseline sample (reported in clumns 1, 2, 5,6, 9 and 10) includes cohorts born between May 27th 1991 and February 15th 1992. The two cohorts sample (reported in columns 3, 4, 7, 8, 11 and 12) includes cohorts born between May 27th 1991 and February 15th 1992 and controls also for months of birth fixed effects. The baseline category is the third trimester of pregnancy.

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

Table 9. Estimated Effect of In-Utero Environment on High School Quality

	Baccalaureate diploma rate		Mean total Baccalaureate units		Mean math Baccalaureate units		Mean Baccalaureate test scores	
	Baseline Sample (OLS)	Two Cohorts Sample (DID)	Baseline Sample (OLS)	Two Cohorts Sample (DID)	Baseline Sample (OLS)	Two Cohorts Sample (DID)	Baseline Sample (OLS)	Two Cohorts Sample (DID)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
First Trimester	-0.012	-0.041	0.125	-0.360	-0.020	-0.091	-0.459	-0.401
	(0.031)	(0.033)	(0.646)	(0.714)	(0.061)	(0.064)	(1.020)	(1.348)
Second Trimester	-0.007	-0.012	-0.311	-0.250	-0.026	-0.065	-0.928	-1.089
	(0.029)	(0.030)	(0.545)	(0.541)	(0.048)	(0.056)	(0.841)	(1.137)
Number of children	463	1905	484	1986	482	1977	484	1985

Notes: Standard errors reported in parenthesis are clustered at week of pregnancy for the OLS regressions and at month of birth for the DID regressions. Each column is from a different regression. All specifications include also both parents' years of schooling, gender dummy, mother's age at birth, parents' age gap, SES of first locality. Models reported in clumns 2, 4, 6, and 8 control also for month and year of birth fixed effects.The Baseline sample includes children born between May 27th 1991 and February 15th 1992 and the two years sample includes children born between May 27th 1991 and February 15th 1992 and children born between May 27th 1990 and February 15th 1991. The baseline category is the third trimester of

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

Table 10. Potential Longer Term Returns

	All			Males			Females		
	Post-secondary education (1)	University (2)	Annual income (2012) (3)	Post-secondary education (4)	University (5)	Annual income (2012) (6)	Post-secondary education (7)	University (8)	Annual income (2012) (8)
Mean of Dependent variable	0.632	0.056	52,002	0.622	0.026	58,577	0.642	0.087	45,102
Baccalaureate Diploma	0.217***	0.116*	4782.4**	0.236***	0.046***	1449.1	0.201***	0.180***	7649.1**
	(0.026)	(0.017)	(2304.6)	(0.038)	(0.017)	(3952.2)	(0.035)	(0.028)	(3140.6)
Baccalaureate Units	0.016***	0.004***	376.9***	0.015***	0.002***	304.33*	0.017***	0.008***	481.79***
	(0.001)	(0.001)	(105.6)	(0.002)	(0.001)	(162.0)	(0.002)	(0.001)	(135.32)
Advance Math (5 units)	0.171	0.134***	6824.7	0.222***	0.082**	-6896.1	0.139***	0.169***	15914***
	(0.024)	(0.039)	(4636.3)	(0.037)	(0.042)	(6976.9)	(0.027)	(0.051)	(5530.7)
Number of observations	1,115	1,115	1,115	553	553	553	562	562	562

Notes: Standard errors clustered at month and year of birth are reported in parenthesis . Each column is from different regression. All specifications control also for both parents' years of schooling and number of siblings. Models in columns 1-3 control also for gender.

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

Table A1. Estimated Effect of In-Utero Environment on Schooling Outcomes by Age 18 by Weeks of Exposure to the Israeli Environment

	Did not repeat 6-12th grade		Did not drop out before completing 12th grade		Obtained a Baccalaureate diploma		Total Baccalaureate units		Math Baccalaureate units		English Baccalaureate units	
	Baseline Sample (OLS)	Two Cohorts Sample (DID)	Baseline Sample (OLS)	Two Cohorts Sample (DID)	Baseline Sample (OLS)	Two Cohorts Sample (DID)	Baseline Sample (OLS)	Two Cohorts Sample (DID)	Baseline Sample (OLS)	Two Cohorts Sample (DID)	Baseline Sample (OLS)	Two Cohorts Sample (DID)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Week	-0.004***	-0.004***	-0.0026*	-0.0029***	-0.0035*	-0.0022	-0.0976**	-0.0741**	-0.0146***	-0.0137***	-0.0152**	-0.0078
	(0.001)	(0.001)	(0.0014)	(0.0008)	(0.0018)	(0.0019)	(0.0374)	(0.0335)	(0.0053)	(0.0040)	(0.0067)	(0.0071)
Number of children	594	2389	594	2389	594	2389	594	2389	594	2389	594	2389

Notes: Standard errors reported in parenthesis are clustered at week of pregnancy for the OLS regressions and at month and year of birth for the DID regressions. Each column is from a different regression. All specifications control also for both parents' years of schooling , gender dummy, mother's age at birth, parents' age gap, SES of first locality in Israel, birth order and dummy for twins. The baseline sample includes children born between May 27th 1991 and February 15th 1992. The two years sample includes children born between May 27th 1991 and February 15th 1992 and children born between May 27th 1990 and February 15th 1991. The main explanatory variable is week of gestation upon immigration to Israel (ranging from 2 to 40).

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

Table A2. Balancing Tests for the USSR Sample

	Father's years of schooling (1)	Mother's years of schooling (2)	Number of siblings (3)	Boy (4)
Mean dependent variable	10.61	11.61	0.885	0.496
	(5.933)	(5.086)	(0.950)	(0.500)
First Trimester	-0.386	-0.416	-0.051	-0.033
	(0.318)	(0.273)	(0.051)	(0.027)
Second Trimester	-0.036	-0.014	0.056	-0.018
	(0.317)	(0.272)	(0.051)	(0.027)
Number of children	2,039	2,039	2,039	2,039

Notes: The table reports differences in covariates between children born in the first or second trimester and children born in the third trimester. Standard errors clustered at month and year of birth are reported in parenthesis. The baseline category is the third trimester of pregnancy.

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

Table A3. Estimated Effect of In-Utero Environment on Birth Weight by Gender

	Birth weight (in grams)				Low birth weight (<2500 gr)				Very low birth weight (<1500 gr)			
	Baseline Sample (OLS)		Baseline Sample + 2nd generation "Operation Moses" (DID)		Baseline Sample (OLS)		Baseline Sample + 2nd generation "Operation Moses" (DID)		Baseline Sample (OLS)		Baseline Sample + 2nd generation "Operation Moses" (DID)	
	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls	No Controls	With Controls
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A. Boys												
Mean of Dependent variable	3,106		3,112		0.109		0.117		0		0.009	
First Trimester	42.514	85.272	9.936	30.051	-0.002	-0.054	0.031	0.009	-	-	-0.017	-0.026
	(91.565)	(73.234)	(109.826)	(105.843)	(0.063)	(0.049)	(0.065)	(0.052)	-	-	(0.015)	(0.017)
Second Trimester	168.467*	174.916**	222.399**	195.472**	-0.064	-0.075*	-0.092	-0.075	-	-	-0.044**	-0.044**
	(91.447)	(73.887)	(95.143)	(86.860)	(0.061)	(0.043)	(0.062)	(0.055)	-	-	(0.018)	(0.020)
p-value: First Trimester = Second Trimester	0.080	0.051	0.111	0.143	0.217	0.426	0.057	0.073			0.227	0.452
Number of children	303		531		303		531		303		531	
B. Girls												
Mean of Dependent variable	3,026		3,051		0.110		0.103		0.011		0.012	
First Trimester	77.625	93.259	56.129	37.159	0.050	0.030	0.103*	0.096*	-0.013	-0.017	-0.014	-0.012
	(62.655)	(72.517)	(89.307)	(92.840)	(0.049)	(0.049)	(0.058)	(0.057)	(0.013)	(0.016)	(0.019)	(0.018)
Second Trimester	42.799	32.064	-87.407	-114.295	0.020	0.017	0.050	0.052	0.004	0.004	-0.002	0.001
	(59.989)	(60.533)	(96.132)	(92.566)	(0.041)	(0.042)	(0.045)	(0.049)	(0.017)	(0.017)	(0.024)	(0.021)
p-value: First Trimester = Second Trimester	0.536	0.309	0.156	0.125	0.500	0.720			0.150	0.112	0.545	0.433
Number of children	281		514		281		514		281		514	
C. P-value for difference in the coefficient between boys and girls												
First Trimester	0.967	0.651	0.830	0.924	0.700	0.251	0.621	0.276	0.331	0.278	0.550	0.308
Second trimester	0.104	0.035	0.006	0.029	0.262	0.109	0.086	0.140	0.813	0.819	0.056	0.069

Notes: Standard errors reported in parenthesis are clustered at week of pregnancy for the OLS regressions and at month and year of birth for the DID regressions. Each column is from a different regression. All specifications control also for both parents' years of schooling, gender dummy, mother's age at birth, parents' age gap, SES of first locality. The baseline sample (reported in clumns 1, 2, 5,6, 9 and 10) includes cohorts born between May 27th 1991 and February 15th 1992. The two cohorts sample (reported in columns 3, 4, 7, 8, 11 and 12) includes cohorts born between May 27th 1991 and February 15th 1992 and controls also for months of birth fixed effects. The baseline category is the third trimester of pregnancy.

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

Table A4. Estimated Effect of Mothers' Length of Stay in Israel before the Birth on Schooling Outcomes

	Did not repeat 6-12th grade (1)	Did not drop out before completing 12th grade (2)	Obtained a Baccalaureate diploma (3)	Total Baccalaureate units (4)	Math Baccalaureate units (5)	English Baccalaureate units (6)	Birth Weight (7)
			A. All				
Weeks in Israel	-0.000	-0.000	-0.000	-0.011	-0.000	-0.001	-0.321
	(0.000)	(0.000)	(0.000)	(0.014)	(0.002)	(0.002)	(0.544)
Number of children	980	980	980	980	980	980	980
			B. Boys				
Weeks in Israel	0.000	0.000	0.000	0.009	0.002	-0.000	-1.191*
	(0.001)	(0.001)	(0.001)	(0.017)	(0.003)	(0.003)	(0.677)
Number of children	495	495	495	495	495	495	495
			C. Girls				
Weeks in Israel	-0.001*	-0.001**	0.000	-0.021	-0.002	-0.001	0.483
	(0.000)	(0.000)	(0.001)	(0.016)	(0.002)	(0.003)	(0.822)
Number of children	485	485	485	485	485	485	485

Notes: Standard errors reported in parenthesis are clustered at month and year of birth. Each column is from a different regression. All specifications control also for both parents' years of schooling , gender dummy, mother's age at birth, parents' age gap, SES of first locality in Israel, birth order and dummy for twins. The sample includes children born between March 1992 and October 1994. The main explanatory variable is the number of weeks since the mother immigrated to Israel (ranging from 43 to 127) when the child was born.

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

Table A5. Estimated Effect of In-Utero Environment on Schooling Outcomes by Age 18 - Spliting the First Trimester into Three Months

	Did not repeat 6-12th grade		Did not drop out of high school before completing 12th grade		Obtained a Baccalaureate diploma		Total Baccalaureate units		Math Baccalaureate units		English Baccalaureate units	
	No Controls (1)	With Controls (2)	No Controls (3)	With Controls (4)	No Controls (5)	With Controls (6)	No Controls (7)	With Controls (8)	No Controls (9)	With Controls (10)	No Controls (11)	With Controls (12)
A. The Baseline Sample (OLS)												
First Month	0.063	0.088	-0.002	0.033	0.032	0.227***	4.733***	3.253*	0.623***	0.525**	0.661***	0.514*
	(0.038)	(0.057)	(0.039)	(0.059)	(0.068)	(0.039)	(1.252)	(1.624)	(0.182)	(0.214)	(0.158)	(0.256)
Second Month	0.105**	0.113**	0.054	0.062	0.123***	0.126***	3.803***	3.863***	0.537***	0.548***	0.677***	0.676***
	(0.043)	(0.045)	(0.047)	(0.046)	(0.032)	(0.041)	(1.076)	(1.038)	(0.133)	(0.138)	(0.218)	(0.189)
Third Month	0.126**	0.142***	0.093**	0.101***	0.122**	0.079	2.603	2.517	0.275	0.253	0.356	0.313
	(0.048)	(0.043)	(0.042)	(0.037)	(0.046)	(0.101)	(1.729)	(1.656)	(0.194)	(0.196)	(0.238)	(0.225)
Second Trimester	0.053	0.057	0.029	0.033	0.032	0.065	2.097**	2.144**	0.271	0.268	0.344**	0.349**
	(0.038)	(0.038)	(0.038)	(0.037)	(0.049)	(0.053)	(1.010)	(1.036)	(0.161)	(0.173)	(0.150)	(0.148)
Number of students	594		594		594		594		594		594	
B. Two Cohorts Sample (DID)												
First Month	0.072***	0.114***	0.009	0.061	0.169***	0.174***	3.784***	3.491***	0.512***	0.553***	0.387	0.367
	(0.021)	(0.035)	(0.029)	(0.042)	(0.048)	(0.046)	(0.943)	(1.005)	(0.081)	(0.109)	(0.258)	(0.267)
Second Month	0.104***	0.118***	0.055*	0.067**	0.077**	0.086**	2.549**	2.999**	0.501***	0.541***	0.434**	0.503***
	(0.016)	(0.017)	(0.027)	(0.025)	(0.028)	(0.032)	(1.059)	(1.075)	(0.112)	(0.121)	(0.154)	(0.149)
Third Month	0.095***	0.098***	0.084***	0.078**	0.011	0.006	1.370**	1.444**	0.199***	0.199**	-0.014	-0.019
	(0.017)	(0.020)	(0.028)	(0.030)	(0.031)	(0.032)	(0.559)	(0.541)	(0.069)	(0.073)	(0.131)	(0.130)
Second Trimester	0.034	0.029	0.018	0.012	0.014	0.007	1.151	1.085	0.174*	0.167	0.146	0.144
	(0.034)	(0.037)	(0.034)	(0.037)	(0.042)	(0.045)	(0.789)	(0.809)	(0.090)	(0.107)	(0.161)	(0.160)
Number of children	2,389		2,389		2,389		2,389		2,389		2,389	

Notes: Standard errors presented in parenthesis are clustered at week of pregnancy for the OLS regressions and at year and month of birth for the DID regressions. Each column is from a different regression. All models control also for both parents' years of schooling, gender dummy, mother's age at birth, parents' age gap, SES of first locality in Israel, birth order, and dummy for twins. The Baseline sample includes children born between May 27th 1991 and February 15th 1992. The two cohorts sample includes children born between May 27th 1991 and February 15th 1992 and cohort born between May 27th 1990 and February 15th 1991. The baseline category is the third trimester of pregnancy.
*Significant at 10%; **significant at 5%; ***significant at 1%