"THE EFFECT OF BREASTFEEDING ON EDUCATIONAL – AND LABOUR MARKET SUCCESS"

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Abstract

Does being breastfed as a baby lead to better achievements in education and on the labour market as an adolescent and adult? Investing money on interventions promoting and sustaining breastfeeding might lead to more human capital and be an economic gain in the long-run. Breastfeeding has many health-related benefits for both mother and child, nevertheless breast milk all too often gets substituted for infant formula. This study compares long-run outcomes within education and the labour market of individuals that were breastfed to their peers that were not breastfed, using propensity score matching on American longitudinal data. Having been breastfed has a positive impact on some educational outcomes but the benefits do not extend on to the labour market.

Presterar barn som blivit ammade bättre inom utbildning och arbetsmarknad som ungdomar och vuxna? Investeringar i insatser som främjar och stödjer amning kan leda till mer humankapital på lång sikt. Amning har många hälsorelaterade fördelar för både mamma och barn, trots detta byts bröstmjölk allt för ofta ut mot modersmjölksersättning. Denna studie jämför långsiktiga prestationer inom utbildning och arbetsmarknad av individer som blev ammade med jämlika som inte blev ammade genom propensity score matchning på amerikanska paneldata. Att ha blivit ammad har positiva effekter på vissa moment inom utbildning men fördelarna sträcker sig inte så långt som till arbetsmarknaden.

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Introduction

Research has shown that being breastfed has many positive benefits for mother and child. Health-related benefits of breastfeeding are vastly explored. The link between breastfeeding and health outcomes is simple to see, since nutrition and what we consume has a direct relationship with our physical and mental health. However, a growing literature is also looking at educational and economic benefits from having been breastfed. Our physical and mental health affects our possibilities and our choices, hence nutrition and what we consume can have an indirect relationship to our success within education and the labour market. This study explores how having been breastfed relates to various outcomes of education and the labour market later in life using American data.

The United States Department of Health and Human Services has, in three decade long periods, set goals intending to improve the health of all people in the United States. The healthy people 2020 agenda includes goals related to breastfeeding. The breastfeeding targets include breastfeeding initiation and duration, there are also policy targets concerning lactation sites and hospital care for lactating mothers. Lastly there is a target to reduce formula supplementation. In most states, the initiation targets were already met in 2016. What seems to be difficult, is to meet the duration and exclusivity goals. Many women initiate breastfeeding but do not follow through with it over time (National Center for Chronic Disease Prevention and Health Promotion, 2016).

The reason agencies are trying to raise breastfeeding levels are due to the positive health benefits to both mother and child that stem from breastfeeding. Paediatricians Dr. Lissauer and Dr. Clayden writes that *"There can be no doubt that breast milk is the best diet for babies"* (Lissauer and Clayden, 2012, p. 203). Other than providing well adapted nutrition to infants, breastfeeding protects against a variety of health conditions to both mother and child. There might also be an economic winning for governments to invest in breastfeeding interventions. Fletcher (2011) mentions in his paper the low return on investment on health and suggests that a possible solution could be to turn away from disease treating of the old to disease prevention from a young age. Disease treatment is a costly practice, but apart from the direct economic effects, there are also some evidence that a higher breastfeeding rate leads to greater human capital (Rollins et al., 2016). This paper explores the idea that breastfeeding could possibly lead to greater educational and labour market achievements.

Apart from the interest of government and policy makers, outcomes of infants who were breastfed are also in the interest of parents, as well as medical practitioners who give parents-to-be advice on feeding options. It is important to note already here that basing choices regarding breastfeeding *only* on possible future benefits in the area of education and work is not sensible, the choice should firstly be based on health-related facts.

Previous research tends to show a positive (see for example Rothstein (2013) or Quinn et al. (2001)) or no relationship (see for example Fletcher (2011)) between having been breastfed and future educational benefit. The only study, to my knowledge, focusing on long term earnings after having been breastfed is done by Cesur et al (2017) and shows no relationship between the two. This paper contributes to the literature by following the development of outcomes over time and not only focusing on long-term outcomes at one point in time, but several. The paper also extends the literature on long-term earnings.

The data used is longitudinal data on American individuals provided by National Longitudinal Study of Adolescent to Adult Health (ADD health). The data has been used by several researchers before who investigate similar questions, which makes it interesting to compare results. The data ranges between 1994 and 2008. The method used is a propensity score matching model where the treatment of having been breastfed is compared to the control of not having been breastfed. The rest of the paper is structured as follows: Section 1 explains the medical aspects of breastfeeding, discusses what factors determine breastfeeding and explains the mechanisms between breastfeeding and future outcomes. Section 2 presents the previous literature. Data and method is found in section 3 and 4 respectively. Results are presented in section 5. Section 6 offers a discussion including limitations. Section 7 concludes.

1. Background

1.1 Medical aspects of breastfeeding

There are a lot of health-related benefits associated with breastfeeding, the human breast milk is clearly the most suitable milk to the human infant and provides all the right nutrients for a newborn baby. Other than that, breast milk contain several types of antibodies that protect the infant from getting infections. Antibodies that are especially important for the infant to receive are those who destroy the bacteria causing dangerous diarrhoea. Breast milk also contain different types of white blood cells that handle bacteria that otherwise could cause fatal infections. All this is lost when feeding the baby with instant formula based on cow's milk,

since the agents in that milk typically do not survive in the environment of a human (Hall and Guyton, 2016, p. 1068-1069).

There are also health benefits lasting as far as adulthood for persons who were breastfed. Among the benefits is a reduced risk of obesity, which has been seen in many studies: Belfield and Kelly (2012) found that breastfeeding protects against obesity at the age of two and four and a half years old. Evenhouse and Reilly (2005) concluded that breastfed infants are less likely to be obese in their adolescence years, and Horta et al., (2007) found the same affect in person's adult years. The last-mentioned study was done for the World Health Organization (WHO) and showed that adults who had been breastfed as infants were not only protected against obesity, they also had lower blood pressure, lower cholesterol and were less likely to have type-2 diabetes.

1.2 Mechanisms between breastfeeding and long-term outcomes

Why would babies who were breastfed advance in education and labour market success as compared to their peers who were not breastfed? There are three different theories as to why this relationship can be stated. Firstly, breast milk contain long-chained polyunsaturated fatty acids docosahexaenoic (DHA) and arachidonic (AA), which are components in the structural lipids that build up neural cell membranes. In other words, the ingredients in breast milk are essential for brain development (Williatts and Forsyth, 2000). The acids accumulate most swiftly in the brain of the foetus towards the end of the pregnancy and the first month of the infant's life (Horta et al., 2007). Explained otherwise, it is crucial, for continued brain development after birth, that the infant gets fed a diet that contains these acids. Breast milk is a natural source to both DHA and AA but lately long-chained polyunsaturated fatty acids (LCPFA) has been supplemented to some infant formulas as well. However, many studies have been conducted comparing the cognitive outcomes of infants receiving formula with added LCPFAs to infants receiving formula without added LCPFAs. Qawasmi et al. (2012) did a meta-analysis researching the above comparison and found no significant difference in the early infant cognition between the two groups, suggesting that artificially adding LCPFA's to infant formula does not yield the same outcomes as naturally receiving the LCPFA's through breast milk.

Another theory is that the breastfeeding practice strengthens the mother-infant relationship and that a strong such relationship helps the baby develop better cognitive abilities

while growing. Two psychobiological phenomena happen while breastfeeding that could be an explanation to a more prosperous relationship between mother and baby. Firstly, mothers who breastfeed has an increased responsiveness to the different signals of her infant, which leads to a more harmonious interdependence between the two. Secondly, when the baby suckles the breast or when there is skin to skin contact between the two, a hormone called oxytocin is released in the mother that reduces stress, anxiety and even depression, which may play a role in the way the mother- infant relationship develops (Feldman and Eidelman, 2003).

Lastly, breastfeeding might have an indirect effect on the cognitive abilities of the baby through general health factors. As was reviewed previously, breastfeeding leads to a stronger immune system, hence just being spared from sickness could let the infant develop its cognitive abilities (Cesur et al., 2017).

1.3 Breastfeeding determinants

The determinants of breastfeeding are visible at many dimensions; individual, family, societal and cultural. The discussion of breastfeeding determinants is important because it lays the foundation of variables that must be taken into consideration in the empirical work. There are many individual level factors that matter; characteristics such as socioeconomic status, education, age and race has shown to differ between breastfeeding and non-breastfeeding mothers (Belfield and Kelly 2012; Chapman and Pérez-Escamilla, 2009).

The work situation of the woman plays a crucial role. Having to return to work shortly after having a child can cut the breastfeeding practice short or inhibit the initiation of breastfeeding all together. Paid maternity leave for at least 12 weeks increases the probabilities of initiated breastfeeding (Mirkovic et al., 2016). Other policies such as lactation rooms and break guarantees at the work place are effective in increasing breastfeeding rates by allowing breastfeeding women to pump breast milk during the work day, helping them maintain their milk production (Rollins et al., 2016).

Surrounding family, friends and network can be an affecting factor. Mothers are sometimes alone given the responsibility of making sure the infant gets breastfed, which might not be too incomprehensible because of the biological facts. Nevertheless, breastfeeding sometimes requires a lot of support and help from others, especially the support of the partner (Brown and Peuchaud, 2008). Active support from families before and after the childbirth is effective in increasing initiated and continued breastfeeding (Rollins et al., 2016).

Another influential aspect comes from the society and the culture. As long as corporations with an economical interest are allowed to produce, market and sell a substitute to breast milk, breastfeeding will continue to be replaced with that substitute in many cases. The industry of instant formula has incentives to portray infant formula as a superior alternative to breast milk in their advertisement. As Rollins et al. (2016) explains; the industries in question are large and do not too seldom sponsor health professional associations leading to conflicts of interests. Instant formula marketing causes confusion and reduces women's confidence in their own ability to successfully breastfeed, this is especially true when medical practitioners advocates the products (Parry et al., 2013).

The ADD health dataset unfortunately does not include variables such as the work situation of the mother or how extensively the father or partner was involved in the breastfeeding, neither is there any information of how influential the media and advertisement of infant formula was to the mother. These factors are unobserved and could possibly bias the results if they effect the future outcomes of the child. One could for example imagine that being surrounded by a supportive partner/father and family would affect both the mother's breastfeeding success and the educational outcomes of the child in a positive way.

The empirical work in this study can be considered trustworthy without above mentioned variables, the analysis of the empirical method shows that is reliable. The observed characteristics of the breastfeeding mothers in this study will be presented under data. Nevertheless, the factors discussed above are all relevant and should be kept in mind throughout the reading and perhaps implemented in other studies if possible.

2. Previous Literature

The number one main issue authors have had when it comes to estimating the outcomes of infants who were breastfed is selection bias. Selection bias is directly related to what was discussed in the previous section; mothers who breastfeed are different from mothers who do not breastfeed in many ways. To then simply compare the outcome of these different women's children is certainly going to give misleading results. Researchers have tackled this endogeneity issue in different ways that will be discussed momentarily. Evenhouse and Reilly (2005), Rees and Sabia (2009), Fletcher (2011) and Cesur et al. (2017) are authors that have used the same

dataset as this study is based on, this is interesting to keep in mind throughout the reading for a comparison purpose.

In Australia, Quinn et al. (2001) found that at age five, children who had been breastfed scored higher on the Peabody Picture Vocabulary Test – Revised (PPVT-R)[1] than those who were never breastfed. They also found that a longer breastfeeding duration was significantly associated with higher test scores. Their intervals of breastfeeding ended at "still breastfeeding at six months". The authors came to this conclusion using an analysis of variance (ANOVA) technique, which simply explained compares the means of two groups with a null hypothesis that they are equal. This method can be considered insufficient in this setting since there is such a substantial problem of selection present. More reliable results were found by Rothstein (2013), who examined cognitive math and reading test scores of American children at the ages of five to six. The author used both a propensity score matching model and a "mother fixed effects" model. The former can be explained as a more accurate comparison-of-means-test since the treated and untreated individuals are matched by different characteristics before compared. The latter model reduces much of the bias by comparing siblings, with different breastfeeding patterns, to each other. It is a desirable method since siblings are normally very similar and share many characteristics, making the comparison more accurate. What the author finds is that the propensity score matching estimates show quite a small but significant advantage for children who were breastfed. When applying the "mother-fixed-effects" model however, no estimates are significant. It is uncertain whether this is due to a reduction in sample size or not.

The "mother-fixed-effects" model was also used by Der et al. (2006) on American data. The outcomes the authors tested were the overall Peabody individual achievement test (PIAT)[2] and the individual sub scores in in mathematics, reading comprehension and recognition, of children aged between five and fourteen. In the sibling analysis, the authors found no significant estimates. It is again difficult to say whether this is due to the sample size since sibling data is scarce. Jiang et al. (2011) studied cognitive outcomes of American children of ages between five and eighteen. The outcomes the authors looked at were Woodcock Johnson Psycho-Educational Battery-Revised (WJ-R)[3] test scores and Wechsler Intelligence Scale for Children-

[1] "The PPVT-R is a standardized test of receptive language, which has been extensively validated against other standardized tests of intelligence in children and is indicative of verbal intelligence." (Quinn et al., 2001, p. 466)

[2] The PIAT includes scores in mathematics, reading recognition, reading comprehension, spelling and general information (Cps.nova.edu1., 2017)

[3] The WJ-R includes tests for letter word, passage comprehension, applied problem and broad reading (Jiang et al., 2011).

Revised (WISC-R)[4] and the method used was a propensity score matching model. The results of the study showed modest but significant estimates with a positive effect for individuals having been breastfed at three out of four scores of the WJ-R test (letter word, applied problem and broad reading, but not passage comprehension). No significant estimates for the WISC-R test were found.

For American individuals aged yet a little older, between 11 and 21, Evenhouse and Reilly (2005) compared outcomes from breastfed and non-breastfed groups. Several outcomes were analysed, among those relating to cognition were grade point average in math, science, social studies and language arts, PPVT scores, whether the individual had had to retake a grade and whether the individual reported as being highly likely to go to college. The analysis was done on a sibling set of the data to get around the problem of endogeneity and the results showed only significant positive effects from having been breastfed on the PPVT score. Once again, the effect was modest. Rees and Sabia (2009) use the same dataset as the previously mentioned study by Evenhouse and Reilly, the data is longitudinal which means that the same individuals were questioned at several points in time. Rees and Sabia look at outcomes from a later point in time when the individuals were aged between 18 and 28. The outcomes studiet were whether the individual had received a high school diploma, whether the individual was attending college and the individual's cumulative high school grade point average. The authors also exploit the sibling subset of the data for their analysis and, interestingly enough, get positive significant estimates on grade point average for those who were breastfed compared to those who were not, as well as all analysed breastfed durations (between 1-6 months, 6-12 months and more than 12 months) compared to those who were not breastfed. Having been breastfeed between 6-12 months and more than 12 months is also positively associated with attending college. The same setting as just mentioned (dataset, point in time and sibling sub sample) is also used by Fletcher (2011). The outcomes the author looks at differ a bit however, he estimates differences in years of schooling, high school dropout, college enrolment, PPVT scores and learning disabilities. When applying the "mother-fixed-effects" model to the data, positive yet insignificant estimates are shown for PPVT scores, college enrolment and years of schooling. However, after adjusting for "no parental favouritism" (a measure derived from questions asked to the siblings of parental treatment) all positive differences were eliminated.

Lastly, being to my knowledge (and the authors') the only study to date that looks at

[4] The WISC-R test is a general intelligence test which has two larger sub sections, one being "verbal" and the other "performance" (Cps.nova.edu2., 2017)

breastfeeding and its impact on adult earnings written by Cesur et al. (2017). The authors look at American individuals' earnings at ages between 24 and 32. They compare those who were breastfed with those who were not breastfed using first a propensity score matching model and secondly a "mother-fixed-effects" model. Neither model rendered any significant estimates after including all relevant controls.

Previous results of the question at hand are diverse and differ between being positive and showing no difference between individuals that were breastfeed and their peers that were not breastfed. As far as my knowledge goes, no study has found a negative impact of having been breastfed on these matters. This paper adds to the existing literature firstly by providing more knowledge to what already exists, which is important since no clear relationship between breastfeeding and educational outcomes exists. Secondly, this paper measures educational outcomes at four different points in time as well as labour market related outcomes at two different points in time. In the previous literature, the results seem to differ between studies using the same data but different time periods or models, by measuring outcomes at different points in time within the same study, hopefully a clearer pattern will emerge. Lastly it adds to the scarce literature on effects on labour market outcomes from having been breastfed by estimating variables regarding job-holding and earnings at two different points in time.

3. Data

The data used is the public use sample of the ADD health data. The data is of survey type and longitudinal. Surveys include questions regarding adolescent's health and various outcomes as young adults, making the data perfect for the research question at hand. Surveys were administered in four waves; wave one was collected in 1995, wave two in 1996, wave three in 2001-2002 and finally wave four was collected in 2008-2009. The data includes an in-school survey, in-home survey and a parent questionnaire (which was an additional questionnaire for the respondent's parent that was given at the first wave). The total span of the interviews is 14 years, starting when respondents were at youngest 11, but the parent questionnaire provides useful information about the respondents as newborns, such as birthweight and whether he/she was breastfed (Harris et al., 2009).

The public-use dataset is a smaller and more limited sample than the full restricted-use dataset which is accessible only to those with a contract. All the data from the in-home surveys are included in the public-use dataset but as a smaller sample. What is not included in the public-

use dataset is ID numbers that enable the researcher to link individuals that are siblings, friends or romantic partners. Further the public-use sample lacks information about Obesity, Neighbourhood Environment, genetics, disposition, political context and alcohol density.

4.1 Treatment

The treatment variable in this study is "breastfed", which is a binary variable taking the value of one if an individual was breastfed as an infant, this information is usually provided by the mother (a few observations has a male parent representative in the parental questionnaire). Additional analysis is made by categorizing the breastfed variable into different durations of breastfeeding, hence a second separate treatment is "breastfed less than 6 months", a third is "breastfed between 6-12 months" and lastly a forth is "breastfed more than 12 months". The data initially included more intervals, but the loss of observations made it necessary to restrict them to the above mentioned. Even so, the treatment groups for the sub-categories are quite small. Table 1 shows the number of observations of the control group and the treatment group "breastfed", which is 3030 and 2494 respectively, a decent balance between the groups. Table A1-A3 in the appendix similarly shows the number of observations for the three additional sub-categories. The treatment group "breastfed between 6-12 months" has 1356 observations, the treatment group "breastfed between 6-12 months" has 734 observations and the treatment group "breastfed more than 12 months" has 404 observations. The data reflects that many women initiate breastfeeding but not as many breastfeed their babies throughout the first year and beyond that.

4.2 Outcomes

The outcome variables are within the topics of education and labour market. Table 1 shows the means and standard deviations by treatment. F-tests and p-values have been included to show potential differences in means between the treatment and control group. The outcome variables differ from wave to wave and are chosen to match what is supposed to be "natural" to having achieved at the different ages. The outcome measured at the first wave, when individuals are between 11.5-21 years, is whether he/she has had to retake a grade. At ages 12.5-22 (wave 2) this study looks at grades in; English or language arts, mathematics, history or social studies and science. The grades are measured at a scale of 4, with 4 being the highest grade and 1 being

the lowest or below pass. At wave 3, when individuals are aged 18-28 years, the outcome variable measured is whether the individual has completed high school. Lastly at ages 24-34 (wave 4) the outcome measured is whether the individual has completed college.

The outcomes regarding the success on the labour market are not measured until the third wave, when individuals are between 18-28 years. At this point, the first outcome is whether individuals have ever had a job, excluding military and jobs in the sort of babysitting or lawn mowing, unless done for a business. The second outcome is whether the person has worked at a paying job for nine weeks or more that was at least 10 hours a week. The last outcome is earnings. The earnings variable was constructed from two questions in the survey. In general, it reflects the annual earnings a person claimed to have. If the person answered, "I don't know" they were asked to guess their earnings within intervals. Not to lose observations, the individuals that provided their earnings within intervals have been given the average point of the chosen interval to be their annual earnings. This counts for only a small proportion of the observations and should not alter the results in any significant way. The same applies to the outcome for the fourth wave as well; yearly earnings when individuals were aged 25.5-34 years.

The descriptive statistics in table 1 provide a first raw overview of the differences in means between the treatment and control group. The treatment group has, on average, less individuals that ever retook a class (16% to 24%), higher grades in all four subjects, more individuals that has finished high school (90% to 83%) and more individuals who have finished college (41% to 24%). The magnitude of the differences for the four grades are not major, nevertheless significant, the same is true for high school completion. Panel B shows that the treatment group has just a slightly higher share of individuals that ever had a job (98% to 96%) and ever had a job for nine weeks or more that was at least 10 hours a week (98% to 97%). Interestingly enough, the control group has higher earnings on average in wave 3, but the treatment group claims the highest average earnings in wave 4. A possible explanation to this could be that the individuals who were breastfed had started college in wave 3 and did not have any earnings. The pattern looks similar for the three sub-categories of treatments that are found in table A1-A3 in the appendix, with some slight differences in the magnitudes.

Table 1. Outcomes - Means - Treatment: Breastfed, Control: Never breastfed						
	Mean		Standard Error		F-value	P-value
Variable	Never breastfed	Breastfed	Never breastfed	Breastfed		
PANEL A: Education						
Retake (W1)	0,240	0,155	0,013	0,012	33,451	0,000
History grade (W2)	2,872	3,028	0,034	0,033	16,534	0,000
English grade (W2)	2,796	2,931	0,039	0,037	13,479	0,000
Mathematics grade (W2)	2,631	2,817	0,039	0,033	20,508	0,000
Science grade (W2)	2,780	2,943	0,035	0,035	14,245	0,000
High school (W3)	0,828	0,899	0,015	0,010	31,931	0,000
College (W4)	0,242	0,406	0,018	0,022	78,834	0,000
PANEL B: Labour market						
Ever worked (W3)	0,961	0,979	0,007	0,004	11,540	0,001
Ever worked2 (W3)	0,965	0,981	0,007	0,003	6,373	0,013
Earnings (W3)	12712,650	11064,445	537,879	462,861	11,496	0,001
Earnings (W4)	31838,924	36690,281	1321,477	1238,714	11,255	0,001
Observations	3030	2494				
Wald test of the null hypothesis that the means of the treatment and control group are equal. Earnings are measured in US dollars.						

4.3 Covariates

The covariates in this study are used to create the propensity score that individuals are then matched with. All covariates used in this paper have been partly or fully used in the papers discussed under previous literature that applied propensity score matching to their similar research question (see Cesur et al., 2017; Jiang et al., 2011; Rothstein, 2013). The covariates are divided into mother/household characteristics and child characteristics. Table 2 provides means and standard deviations for the covariates, (Table A4-A6 in the appendix shows the descriptive statistics for the different sub-categories of treatments). Household earnings was measured at wave one and refers to year 1994, ideally this would be measured at the time of the birth of the child. Age at birth is the age of the mother at the birth of her child. High school and college refers to the educational attainment of the mother, the former is a dummy for whether the mother has completed high-school or not, the latter a dummy for whether she has attended college or not. Self-rated health is measured on a scale from 1 to 5 and applies to the mother, 1 being excellent health and 5 being poor health. White is a dummy that takes the value of one if the child is white and zero otherwise. The data does however provide a more detailed record of ethnicity and consists of around 60% white individuals, around 25 black/African Americans, 11% Hispanics and the rest Asian, Indian or other, but this is disregarded in the analysis and a distinction only occurs between “white” and “other”.

Table 2. Covariates - Difference in means - Treatment: Breastfed, Control: Never breastfed						
	Mean		Standard Error		F-value	P-value
Variable	Never Breastfed	Breastfed	Never Breastfed	Breastfed		
PANEL A: Mother/Household						
Married	0,691	0,751	0,015	0,015	15,305	0,000
Age at birth	25,339	25,995	0,174	0,175	10,391	0,002
Self-rated health	2,506	2,234	0,027	0,040	52,407	0,000
Completed high school	0,804	0,894	0,018	0,013	27,118	0,000
Attended college	0,304	0,546	0,017	0,022	158,925	0,000
Household earnings	41,032	52,446	1,523	2,861	23,358	0,000
Household members	4,361	4,475	0,050	0,044	3,979	0,048
PANEL B: Child						
Age (wave 1)	15,964	15,646	0,127	0,119	12,701	0,001
Age (wave 2)	16,528	16,273	0,117	0,109	9,871	0,002
Age (wave 3)	22,171	21,800	0,131	0,124	14,115	0,000
Age (wave 4)	28,947	28,584	0,129	0,121	14,622	0,000
Sex	0,501	0,478	0,012	0,013	2,381	0,125
Birth order	2,038	1,934	0,030	0,033	8,155	0,005
Birth weight (ounces)	117,444	121,164	0,453	0,481	32,676	0,000
White	0,669	0,736	0,033	0,028	7,977	0,005
Observations	3030	2494				
Wald test of the null hypothesis that the means of the treatment and control group are equal. Household earnings are measured in thousands (US dollars) in 1994.						

The key issue in this paper is the potential selection between the treatment and control groups that functions as a prevention to make confident claims about benefits from breastfeeding from a simple comparison between treated and untreated. As have been previously mentioned, mothers who breastfeed their children are likely to differ in characteristics from women who does not breastfeed their children. In turn, this might cause some of the children's characteristics to differ between the two groups. Table 2 provides a raw overview of the differences in means of the characteristics of the mother and child, and might reveal some insight into what determines breastfeeding. A first glance at Table 2 shows that breastfeeding mothers are indeed different from non-breastfeeding mothers. In this dataset, a larger percentage of the women who breastfeed their children are married, 75% to 69%. The average breastfeeding woman is slightly older and on average their self-rated health is somewhat higher. A slightly larger percentage of the breastfeeding women have finished high-school (89% to 80%) and a considerably larger percentage have attended college (55% to 30%). The annual household earnings of the breastfeeding women are about $10 000 higher than the household earnings of the non-breastfeeding women. The average number of household members is just a tiny bit different between the "never breastfed"-families and the "breastfed"-families, with the latter being larger in numbers. The general picture these means give is that women who

breastfeed are slightly older, married, they have acquired more education and live in households with higher earnings, and perhaps most interesting, from a health perspective, is that they consider themselves healthier.

This simple descriptive analysis will not tell us whether these characteristics are determinants to breastfeeding or not. It is merely an overview of the association between variables in the data. It is probably safe to claim that breastfeeding must be related to these characteristics, but the relationship might as well be going in the other direction. One should rule out some other factor that determines these characteristics as well as breastfeeding. This relationship does not lie within the scope of this study, but is nonetheless interesting.

There is no difference in gender proportions between the treated and untreated children. Birth order differs a little bit between the two groups, it seems that babies that get breastfed are born before their siblings in order, compared to those who do not get breastfed. A possible explanation is that mothers initiate breastfeeding with their first child/children, but those who do not have positive breastfeeding experiences might dismiss the practise with the later born children. The birthweight is larger of the children who gets breastfed (121 ounces to 117 ounces). This probably goes together with the fact that breastfeeding women are healthier. The decomposition of white and non-white children differs a bit (74% to 67%).

All baby-mother relations are unique and ultimately there is no right or wrong breastfeeding duration. There are however mostly positive aspects of continuing the breastfeeding if possible, both for mother and baby. Initiating breastfeeding but quitting might be a choice by the mother or family. The mother can also suffer from inability to continue the practice because of imbalance that suppresses the hormone (oxytocin) that releases the milk from the breast, and with this the production of milk will decrease and eventually cease all together (Kylberg et al., 2014, p50-61). Reasons for different breastfeeding durations are therefore complex and individual, it is nevertheless interesting to look at the characteristics of mothers who have different breastfeeding durations and analyse if the baby benefits differently from being breastfed for a shorter or longer period. Table A4 in the appendix shows descriptive statistics for treatment group “breastfed between 0-6 months”. The pattern looks the same as discussed above, yet there seem to be no real difference in the average ages of the mothers at the time of the birth, household sizes are also on average the same between the groups. Mothers babies that were “breastfed between 6 and 12 months” are older at the birth of their child than those who do not breastfeed (Table A5 in the appendix). The largest differences in means are seen between the mothers to the children that were “breastfed more than 12 months” and the control group (Table A6 in the appendix). In conclusion, mothers who initiate breastfeeding but

cease the practice within six months are different in characteristics as compared to those who do not breastfeed their children. Women who have even longer breastfeeding durations differ even more in these same characteristics compared to the mothers that do not breastfeed their children, this is not an unexpected phenomenon. The interesting part of this analysis is that there is an actual threshold in the characteristics between the non-breastfeeding mothers and the breastfeeding mothers regardless of duration. It seems there are characteristics that are special for the mothers that breastfeed, the case is not that all women try but only some continue the practice, yet again, the determinants for breastfeeding lies outside the scope of this study.

4. Method

A propensity score method is applied to the data to assess what impact having been breastfed has on the educational and economical outcomes in later life. As discussed previously, a causal relationship is difficult to state with confidence by simply comparing means of the treated and control group. To address this issue, a propensity score method is used. The basic idea with propensity score matching, or matching in general is to match treated individuals with untreated individuals to assure that as many characteristics as possible (ideally everything), except the treatment status, are the same. One can then, with some more confidence draw causal conclusions.

Matching techniques rests on an assumption that says that the potential outcomes, for example having finished high school, are independent of the treatment, having been breastfed, given the characteristics that are controlled for. Otherwise written as;

$$[Y(0), Y(1)] \perp T|X. \tag{1}$$

where Y(0) is the potential outcome of the control and Y(1) the potential outcome of the treated. T is treatment and can either be present (as for the treatment group) or not present (as for the control group). X refers to all the observable characteristics. Having been breastfed depends on a whole lot of things, such as the covariates that are described above. If one can manage to control for all those things, then the variation that is left is supposedly random, allowing one to compare the means without including any bias (Caliendo and Kopeing, 2008). The other assumption, which is not as difficult to fulfil is the overlap assumption. This merely states that

not all observations are treated or untreated, the probability of being treated should lie between 0 and 1, otherwise written as;

$$0 < P(T = 1|X) < 1. \quad (2)$$

where P is the probability, T the treatment (in this case present since it is equal to one), X is again the observable characteristics. In the context of this paper, equation (2) says that the probability of having been breastfed, given the covariates controlled for, lies between 0 and 1. Figure 2a-2d shows the fulfilment of the overlap assumption. The graphs show the density of the estimated propensity scores by treatment and control group. The graphs in figure 2a-2c show large similarities in densities between the groups. The graphs in figure 2d show less similar, yet still reliable densities. The importance is that there is a large enough overlap. To correct for the small differences in the densities, the propensity score matching is run, allowing for replacement, meaning that a control can be matched with more than one time. Common support is also applied, making sure that "outliers" – treated observations that lie above or below the maximum or minimum of the controls – are dropped from the estimation. The balance analysis in in section 6.1 shows us that the matching was done successfully.

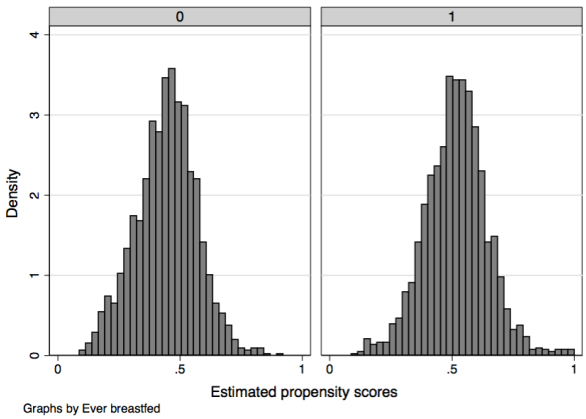

Figure 2a

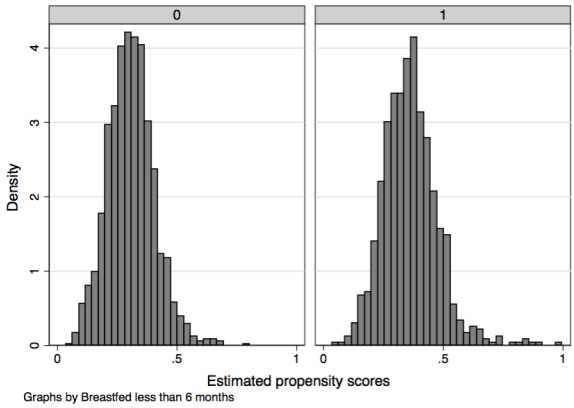

Figure 2b

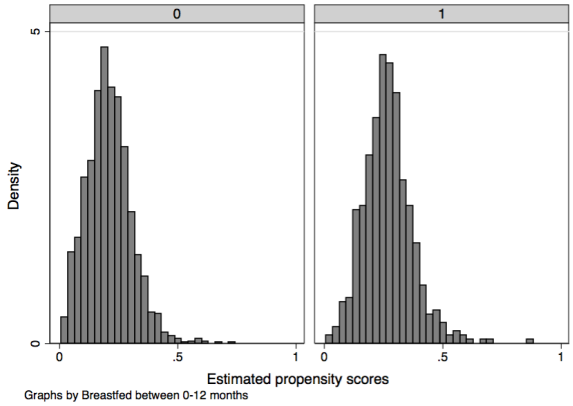

Figure 2c

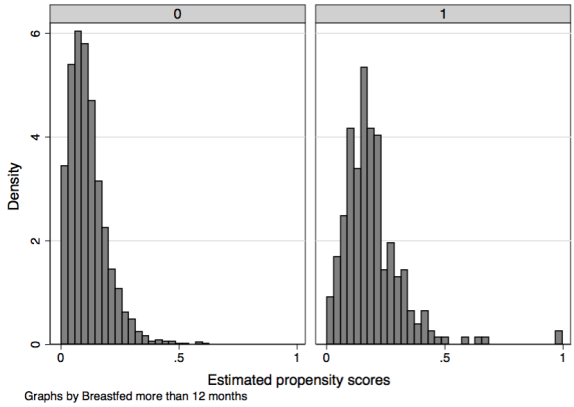

Figure 2d

Figure 2. Density of estimated propensity scores, by treatment.
2a (0=Never breastfed, 1=Breastfed)
2b (0=Never breastfed, 1=Breastfed between 0-6 months)
2c (0=Never breastfed, 1=Breastfed between 6-12 months)
2d (0=Never breastfed, 1=Breastfed more than 12 months)

The actual model used to produce the propensity scores is a probit function;

$$P(BF=1) = \Phi(\alpha + \beta'_1 C_i + \beta'_2 M_i + \varepsilon_i) \quad (3)$$

where P is the propensity score, or the probability of being assigned to the treatment, which in this case is having been breastfed (BF=1). Phi (Φ) symbolizes the standard normal cumulative distribution function. The probability of having been breastfed is estimated by a function including a vector of child characteristics (C_i) and a vector of mother/household characteristics (M_i) and an error term (ε_i). Alpha (α) is the intercept. The estimated propensity scores are used

in the matching process. Individuals are matched within a radius of 0.05.

The standard effect that the propensity score method estimates is the average treatment effect on the treated (ATET). The ideal treatment effect would be obtained by comparing the outcome of someone who was breastfed to the potential outcome of the same person if he or she was not breastfed. This effect exists only in theory, since it is impossible for one person to simultaneously be treated and not treated. Therefore, the effect that is estimated is the average treatment effect of having been breastfed for those who were breastfed.

Stuart and Rubin (2008) emphasise the importance of analysing the matching process to assess whether it did a good job. This is commonly done by checking the balance properties of the resulting matches. The balance analysis will estimate the mean bias, which – if low – tells us that the matching managed to reduce the initial bias. Rubin's B and Rubin's R are additional measures of the balance analysis. The former is the number of standard deviations between the propensity score means of the treated and control group. The latter is the ratio of the propensity score variance of the treated to the propensity score variance of the controls. Rubin suggests, to be able to call the matching reliable, that B is less than 25 and that R lies between 0.5 and 2 (Rubin, 2001).

5. Results

6.1 Balance analysis

Table 5 and 6 show the mean bias, Rubin's B and Rubin's R. The different panels represent the different subgroups analysed and the columns represent the outcomes.

The mean bias stays acceptably low with the largest being 2.63%. Suggesting that most of the initial bias has been removed. Rubin's B is at largest 10.9, far below 25 which is the recommended uppermost acceptable value. Rubin's R are clustered around 1, except for a few that lie closer to the boundaries but still within.

Table 5. Balance analysis – education							
	(1) Retake W1	(2) English Grade W2	(3) History Grade W2	(4) Mathematics Grade W2	(5) Science Grade W2	(6) High School W3	(7) College W4
PANEL A: Breastfeeding							
Mean Bias (%)	1,685	2,598	2,398	2,626	1,951	2,108	1,796
Rubin's B	8,043	10,175	10,019	10,425	8,236	10,081	7,649
Rubin's R	1,186	1,232	1,224	1,244	1,123	1,194	1,242
PANEL B: Breastfed less than 6 months							
Mean Bias (%)	1,617	1,995	1,960	1,953	2,231	1,483	1,378
Rubin's B	7,222	9,501	9,071	9,229	9,811	7,916	5,394
Rubin's R	1,070	1,075	1,064	1,046	0,995	1,113	0,984
PANEL C: Breastfed between 6 and 12 months							
Mean Bias (%)	1,658	2,307	1,908	2,006	1,816	2,473	2,117
Rubin's B	7,333	8,840	8,106	8,065	6,525	9,962	8,809
Rubin's R	1,101	1,063	1,114	1,106	1,062	1,025	1,096
PANEL D: Breastfed more than 12 months							
Mean Bias (%)	2,124	2,202	2,143	2,570	2,209	2,470	2,563
Rubin's B	8,758	8,836	8,678	8,769	8,886	10,874	9,914
Rubin's R	1,070	1,101	1,029	0,879	0,898	1,007	1,643

Table 6 shows the balance analysis for the labour market outcome models, the mean bias is again very low, with the largest percentage being 2,5. Rubin's B lies well below 25 with the largest value being 10,63. Rubin's R lies within the interval recommended and is clustered around 1. Overall, the balance properties are reliable and the matching seem to have been well conducted.

Table 6. Balance analysis – labour market				
	(1) Ever Worked W3	(2) Ever Worked2 W3	(3) Earnings W3	(4) Earnings W4
PANEL A: Breastfeeding				
Mean Bias (%)	2,108	2,122	1,985	1,787
B	10,087	10,298	10,564	8,392
R	1,195	1,178	1,076	1,183
PANEL B: Breastfed less than 6 months				
Mean Bias (%)	1,502	1,539	1,999	1,257
B	7,954	8,119	10,012	5,669
R	1,115	1,098	0,884	1,085
PANEL C: Breastfed between 6 and 12 months				
Mean Bias (%)	2,478	2,494	2,505	2,089
B	9,884	9,839	10,452	9,297
R	1,040	1,020	1,056	1,094
PANEL D: Breastfed more than 12 months				
Mean Bias (%)	2,410	2,321	2,109	2,309
B	10,634	10,433	9,142	10,287
R	1,012	0,913	1,079	1,117

6.2 Results from propensity score matching

The results from the propensity score matching are presented in table 3 and 4. The different panels show the different subgroups analysed, in panel A the treatment is having been breastfed and the control group are those that were not breastfed. Panel B shows results where treatment is having been breastfed less than 6 months, the control group stays the same throughout the analysis. In panel C the treatment is having been breastfed between 6 and 12 months and in panel D it is having been breastfed more than a year. The columns are numbered 1-7 and represent the different outcome variables that have been analysed. To keep track of when in time these outcomes were measured (which wave) a W followed with the number of the wave is specified in each column.

At the first wave, when the individuals were at average around 15-16 years, the outcome measured is "retake class" (1), a variable that takes the value of one if the individual has indeed had to retake a class. The ATET is negative throughout all subgroup analyses indicating that the treated groups have on average less individuals retaking classes than the control group. The ATET is only significant for the overall sample (panel A) and for those breastfed between 6 and 12 months, the former is smaller in magnitude than the latter because it is offset a bit by the other subgroups. About a year later, when individuals were on average 16-17 years old, the outcome analysed are school grades (columns (2)-(5)). A positive ATET means higher grades on average for the treated. Only history or social studies show ATET's with negative signs in two panels, they are however not significant. English or language arts show no significant estimates at all, it is the case that the variable for the English or language arts has fewer observations than the other outcomes and this could increase the standard error, there is however a pattern of non-significance for most outcomes. Seeing to the rest of the grades, mathematics has highly significant ATET's within all panels but one. The largest ATET is in panel C where the treated were breastfed between 6 and 12 months. The last is also true for science grade, even the ATET in panel C for history is significant. The takeaway here is that there is a clear indication that having been breastfed has beneficial effects on individual's grades, but primarily mathematics and science. There are also very strong indications that having been breastfed between 6 and 12 months is the most beneficial in this sense.

Table 3. Output from propensity score matching - Education							
	(1) Retake Class W1	(2) English Grade W2	(3) History Grade W2	(4) Mathematics Grade W2	(5) Science Grade W2	(6) High School W3	(7) College W4
PANEL A: Breastfeeding							
ATET	-0,035**	0,050	0,010	0,135***	0,070	0,026*	0,060***
	(0,015)	(0,044)	(0,049)	(0,050)	(0,051)	(0,014)	(0,020)
PANEL B: Breastfed less than 6 months							
ATET	-0,025	0,028	-0,007	0,063	0,002	0,034**	0,013
	(0,017)	(0,050)	(0,055)	(0,058)	(0,057)	(0,015)	(0,023)
PANEL C: Breastfed between 6 and 12 months							
ATET	-0,072***	0,093	0,124*	0,221***	0,178***	0,023	0,124***
	(0,019)	(0,060)	(0,065)	(0,067)	(0,067)	(0,018)	(0,029)
PANEL D: Breastfed more than 12 months							
ATET	-0,005	0,014	-0,122	0,177**	0,090	0,014	0,014**
	(0,026)	(0,082)	(0,092)	(0,087)	(0,085)	(0,023)	(0,023)
. "English" refers to English or language arts, "History" refers to history or social studies. Standard errors in parentheses. *p<0.1 **p<0.05 ***p<0.01							

Jumping a few years in time to when the individuals average age was 21-22, the outcome analysed is the completion of high school. The variable takes the value of one for individuals that completed high school and zero otherwise, hence a positive ATET indicates that more individuals on average among the treated finishes high school. There are only small significant values in panel A and B, making it difficult to draw any clear conclusions. Going further to when individuals were on average 28-29, the outcome measured is having completed college and earned at least a bachelor's degree, the variable is coded the same as the high school variable. Here it is seen that treated individuals stand out a bit compared to the controls, the strongest ATET is again seen in panel C for those being breastfed between 6 and 12 months. All in all, the results from this part of the analysis shows that there are some benefits to collect education wise after having been breastfed. The duration of breastfeeding generating the highest benefits in this area is between 6 and 12 months. It is not at all unexpected, as discussed in the introduction, recommendations from various sources is to proceed with the breastfeeding for at least 6 months.

The other area of interest is outcomes in the labour market, labour market outcomes have only been measured in the third and fourth wave, since individuals were still primarily in school during the two fist waves. Table 4 gives the results for the labour market outcomes. The table is structured the same way as the previous table. At wave three, when individuals had a mean age of around 21-22, three different outcomes were measured, ever having had a job (1), ever having had a job for 9 weeks with an intensity of at least 10 weeks per hour (2) and annual earnings (3). Annual earnings were also measured at wave four when individuals had reached ages 28-29 on average (4).

Table 4. Output from propensity score matching - Labour market				
	(1) Ever Worked W3	(2) Ever Worked2 W3	(3) Earnings W3	(4) Earnings W4
PANEL A: Initiated Breastfeeding				
ATET	0,004 (0,007)	-0,001 (0,007)	-158,490 (647,226)	-1975,069 (2039,48)
PANEL B: Breastfed less than 6 months				
ATET	0,002 (0,008)	-0,003 (0,008)	-395,126 (665,643)	-95,556 (2270,673)
PANEL C: Breastfed between 6 and 12 months				
ATET	0,007 (0,008)	0,006 (0,008)	906,707 (1035,159)	-2779,870 (2228,701)
PANEL D: Breastfed more than 12 months				
ATET	0,007 (0,011)	-0,004 (0,012)	-965,943 (964,356)	-1495,927 (3392,374)
Standard errors in parentheses. *p<0.1 **p<0.05 ***p<0.01.				

The outcomes in (1) and (2) are binary variables meaning that a positive ATET is an indication on beneficial attributes for the treated group as compared to the control. The outcomes in (3) and (4) are continuous variables and a positive sign indicates that the treated individuals have higher annual earnings on average than the controls. First notice is that no ATET is significant. The values in (1) and (2) are so small that no conclusions should probably even be discussed here, from this analysis there are no signs that individuals that have been breastfed benefit in these two outcomes. The earning values, even though insignificant are more interesting, there are negative ATET's for all panels in (3) and (4) except panel C in (3). The values in (3) are too small to actually conclude much except for the one in panel D. That individuals that have been breastfed earn less on average than the controls is at first glance very unexpected, especially when they do get higher educations which should be associated with higher earnings. However, the explanation might be that because they have acquired more education than the controls, they might have, at the time of the interview, just started their carriers hence earn less.

6. Discussion

The fetal origins hypothesis is worth discussing in this setting, according to the theory, chronic health conditions can sometimes be traced back to the in-utero conditions. Economists has extended the research and analysed what effect in-utero conditions has on educational and labour market outcomes. Almond (2006) showed that individuals that were in the neonatal stage

during an influenza pandemic had lower socioeconomic status and income and did worse in their education than their comparison group whose mothers were not exposed to the pandemic.

This phenomenon is relevant to discuss here since it can be a source to a possible bias, much of the selection bias on the breastfeeding issue is reduced by different econometrical techniques. The breastfeeding mothers in this sample have reported better health, they have on average a higher education and have higher mean earnings, characteristics that create opportunities for prosperous in-utero conditions during pregnancy. Failing to correct for the in-utero condition can possibly bias the results upwards. Most likely, both the in-utero conditions and the breastfeeding matter for long term outcomes. From an economical perspective, if it is not possible to invest in interventions in both areas, researchers should try to establish which area yields higher benefits. Yet, disentangling the positive effects that stems from in-utero conditions from the effects that comes from breastfeeding is not an easy task.

The study suffers from some limitations that should be addressed. The public-use dataset of the ADD Health data is a smaller dataset than the restricted-use sample and lacks other features that would be very useful in this setting. The latter includes identification variables to link not only siblings but also twins. Applying the "mother-fixed-effect" model as a few of the authors have done earlier is a good technique to eliminate selection bias. Applying a "twin-fixed-effect" model would even eliminate biases arising due to genetic differences. Both models would be very interesting to add to a study such as this to get a fuller analysis. Nevertheless, the public use sample provides a large enough sample to get reliable estimates.

Another data related limitation present in this study is that there is no information on whether the infants that were breastfed were done so exclusively or if they were also fed infant formula. Having this information would strengthen the analysis further.

The subject matter has various angles and factors that all play its part in the breastfeeding jungle. For future research; if the data allows it, using information on what hospital the individual was born at could add important information to the analysis since different hospitals have different routines around breastfeeding. Another very interesting angle is the already mentioned effect advertisement of infant formula has on the breastfeeding decision.

7. Conclusion

This study uses a propensity score method to explore the impacts of ever having been breastfed on individual's educational attainment and performance and the labour market success. The results show that there is some indication on improved average grades for those that were breastfed compared to those who were not breastfed. There is also a weak argument that those treated with breastfeeding has a higher mean proportion of individuals completing college. When it comes to the effect on labour market success in terms of attaining a job and earnings there seem to be no support of any improvement amongst those having been breastfed. The literature on whether breastfeeding positively affects cognitive ability and educational attainment has been very split and needs to be researched further to reach a clear picture of the relationship. The one previous study investigating the effects of breastfeeding on labour market outcomes shows the same results as the ones concluded in this study and this relationship seems to be clearer.

A very important note is that these results do not at all mean mothers should choose not to breastfeed their infants with this argument as base. As described in the introduction, there already exists several widely agreed upon benefits for both the infant and the mother of breastfeeding. This is an extremely complicated relationship trying to make sense of and more research is inviting on several aspects.

References

Almond, D. (2006). Is the 1918 Influenza Pandemic Over? Long-Term Effects ofIn UteroInfluenza Exposure in the Post-1940 U.S. Population. *Journal of Political Economy*, 114(4), pp.672-712.

Belfield, C. and Kelly, I. (2012). The Benefits of Breast Feeding across the Early Years of Childhood. *Journal of Human Capital*, 6(3), pp.251-277.

Brown, J. and Peuchaud, S. (2008). Media and breastfeeding: Friend or foe?. *International Breastfeeding Journal*, 3(1).

Caliendo, M. and Kopeinig, S. (2008). Some Practical Guidance for the Implementation of Propensity Score Matching. *Journal of Economic Surveys*, 22(1), pp.31-72.

Cesur, R., Sabia, J., Kelly, I. and Yang, M. (2017). The effect of breastfeeding on young adult wages: new evidence from the add health. *Review of Economics of the Household*, 15(1), pp.25-51.

Chapman, D. and Pérez-Escamilla, R. (2009). US National Breastfeeding Monitoring and Surveillance: Current Status and Recommendations. *Journal of Human Lactation*, 25(2), pp.139-150.

Cps.nova.edu1. (2017). *Peabody Individual Achievement Test*. [online] Available at: http://www.cps.nova.edu/~cpphelp/PIAT.html [Accessed 24 Sep. 2017].

Cps.nova.edu2. (2017). *Wechsler Intelligence Scale for Children--Revised*. [online] Available at: http://www.cps.nova.edu/~cpphelp/WISC-R.html [Accessed 24 Sep. 2017].

Der, G., BATETy, G. and Deary, I. (2006). Effect of breast feeding on intelligence in children: prospective study, sibling pairs analysis, and meta-analysis. *BMJ*, 333(7575), pp.945-0.

Evenhouse, E. and Reilly, S. (2005). Improved Estimates of the Benefits of Breastfeeding Using Sibling Comparisons to Reduce Selection Bias. *Health Services Research*, 40(6p1), pp.1781-1802.

Feldman, R. and Eidelman, A. (2003). Direct and indirect effects of breast milk on the neurobehavioral and cognitive development of premature infants. *Developmental Psychobiology*, 43(2), pp.109-119.

Fletcher, J. (2011). Long-term effects of health investments and parental favoritism: the case of breastfeeding. *Health Economics*, 20(11), pp.1349-1361.

Hall, J. and Guyton, A. (2016). *Guyton and Hall textbook of medical physiology*. 1st ed. Philadelphia, PA: Elsevier.

Harris, K.M., C.T. Halpern, E. Whitsel, J. Hussey, J. Tabor, P. Entzel, and J.R. Udry. 2009. The National Longitudinal Study of Adolescent to Adult Health: Research Design [WWW document]. URL: http://www.cpc.unc.edu/projects/addhealth/design.

Horta, B., Bahl, R., Martines, J. and Victoria, C. (2007). *Evidence on the long-term effects of breastfeeding*. Geneva: World Health Organization.

Jiang, M., Foster, E. and Gibson-Davis, C. (2011). Breastfeeding and the Child Cognitive Outcomes: A Propensity Score Matching Approach. *Maternal and Child Health Journal*, 15(8), pp.1296-1307.

Kylberg, E., Westlund, A. and Zwedberg, S. (2014). *Amning i dag*. Stockholm: Gothia fortbildning.

Lissauer, T. and Clayden, G. (2012). *Illustrated Textbook of Paediatrics*. 4th ed. Edinburgh: Mosby/Elsevier, pp.203-206.

Mirkovic, K., Perrine, C. and Scanlon, K. (2016). Paid Maternity Leave and Breastfeeding Outcomes. *Birth*, 43(3), pp.233-239.

National Center for Chronic Disease Prevention and Health Promotion (2016). *Breastfeeding Report Card 2016*. Atlanta.

Parry, K., Taylor, E., Hall-Dardess, P., Walker, M. and Labbok, M. (2013). Understanding Women's Interpretations of Infant Formula Advertising. *Birth*, 40(2), pp.115-124.

Qawasmi, A., Landeros-Weisenberger, A., Leckman, J. and Bloch, M. (2012). Meta-analysis of Long-Chain Polyunsaturated FATETy Acid Supplementation of Formula and Infant Cognition. *PEDIATRICS*, 129(6), pp.1141-1149.

Quinn, P., O'Callaghan, M., Williams, G., Najman, J., Andersen, M. and Bor, W. (2001). The effect of breastfeeding on child development at 5 years: A cohort study. *Journal of Paediatrics and Child Health*, 37(5), pp.465-469.

Rees, D. and Sabia, J. (2009). The Effect of Breast Feeding on Educational ATETainment: Evidence from Sibling Data. *Journal of Human Capital*, 3(1), pp.43-72.

Rollins, N., Bhandari, N., Hajeebhoy, N., Horton, S., Lutter, C., Martines, J., Piwoz, E., Richter, L. and Victora, C. (2016). Why invest, and what it will take to improve breastfeeding practices?. *The Lancet*, 387(10017), pp.491-504.

Rothstein, D. (2013). Breastfeeding and Children's Early Cognitive Outcomes. *Review of Economics and Statistics*, 95(3), pp.919-931.

Rubin, D. (2001). Using Propensity Scores to Help Design Observational Studies: Application to the Tobacco Litigation. *Health Services & Outcomes Research Methodology 2*, pp.169-188.

Stuart, E. and Rubin, D. (2008). Matching Methods for Causal Inference. In: J. Osborne, ed., *BEST PRACTICES IN QUASI- EXPERIMENTAL DESIGNS*, 1st ed. Thousand Oaks: SAGE Publications Inc.

WillATETs, P. and Forsyth, J. (2000). The role of long-chain polyunsaturated fATETy acids in infant cognitive development. *Prostaglandins, Leukotrienes and Essential FATETy Acids (PLEFA)*, 63(1-2), pp.95-100.

Appendix

Descriptive statistics of outcomes

Table A1. Outcomes - Difference in means - Treatment: Breastfed 0-6 months, Control: Never breastfed						
	Mean		Standard Error		F-value	P-value
Variable	Never breastfed	Breastfed	Never breastfed	Breastfed		
PANEL A: Education						
Retake (W1)	0,240	0,181	0,013	0,016	11,482	0,001
History grade (W2)	2,872	3,003	0,034	0,043	7,893	0,006
English grade (W2)	2,796	2,883	0,039	0,045	4,099	0,045
Mathematics grade (W2)	2,631	2,747	0,039	0,043	5,059	0,026
Science grade (W2)	2,780	2,872	0,035	0,044	3,751	0,055
High school (W3)	0,828	0,889	0,015	0,014	20,313	0,000
College (W4)	0,242	0,349	0,018	0,024	29,923	0,000
PANEL B: Labour market						
Ever worked (W3)	0,961	0,973	0,007	0,007	4,877	0,029
Ever worked2 (W3)	0,965	0,974	0,007	0,005	1,990	0,161
Earnings (W3)	12712,650	10699,607	537,879	509,723	11,901	0,001
Earnings (W4)	31838,924	35230,445	1321,477	1302,477	3,933	0,049
Observations	3030	1356				
Wald test of the null hypothesis that the means of the treatment and control group are equal. Earnings are measured in US dollars.						

Table A2. Outcomes - Difference in means - Treatment: Breastfed 6-12 months, Control: Never breastfed						
	Mean		Standard Error		F-value	P-value
Variable	Never breastfed	Breastfed	Never breastfed	Breastfed		
PANEL A: Education						
Retake (W1)	0,240	0,108	0,013	0,014	58,923	0,000
History grade (W2)	2,872	3,146	0,034	0,051	25,403	0,000
English grade (W2)	2,796	3,019	0,039	0,054	19,126	0,000
Mathematics grade (W2)	2,631	2,928	0,039	0,059	22,237	0,000
Science grade (W2)	2,780	3,057	0,035	0,053	22,298	0,000
High school (W3)	0,828	0,907	0,015	0,016	17,926	0,000
College (W4)	0,242	0,478	0,018	0,030	63,424	0,000
PANEL B: Labour market						
Ever worked (W3)	0,961	0,990	0,007	0,004	13,911	0,000
Ever worked2 (W3)	0,965	0,990	0,007	0,004	10,870	0,001
Earnings (W3)	12712,650	11907,380	537,879	818,909	1,215	0,272
Earnings (W4)	31838,924	37824,789	1321,477	2346,929	5,887	0,017
Observations	3030	734				
Wald test of the null hypothesis that the means of the treatment and control group are equal. Earnings are measured in US dollars.						

Table A3. Outcomes - Difference in means - Treatment: Breastfed more than 12 months, Control: Never breastfed						
	Mean		Standard Error		F-value	P-value
Variable	Never breastfed	Breastfed	Never breastfed	Breastfed		
PANEL A: Education						
Retake (W1)	0,240	0,152	0,013	0,023	15,187	0,000
History grade (W2)	2,872	2,902	0,034	0,081	0,124	0,725
English grade (W2)	2,796	2,934	0,039	0,074	3,012	0,085
Mathematics grade (W2)	2,631	2,859	0,039	0,088	6,815	0,010
Science grade (W2)	2,780	2,943	0,035	0,035	14,245	0,000
High school (W3)	0,828	0,917	0,015	0,017	18,002	0,000
College (W4)	0,242	0,471	0,018	0,039	40,391	0,000
PANEL B: Labour market						
Ever worked (W3)	0,961	0,980	0,007	0,009	3,130	0,079
Ever worked2 (W3)	0,965	0,985	0,007	0,009	3,398	0,068
Earnings (W3)	12712,650	10738,783	537,879	667,026	6,947	0,009
Earnings (W4)	31838,924	39605,035	1321,477	3187,870	7,172	0,008
Observations	3030	404				
Wald test of the null hypothesis that the means of the treatment and control group are equal. Earnings are measured in US dollars.						

Descriptive statistics of covariates

Table A4. Covariates - Difference in means - Treatment: Breastfed 0-6 months, Control: Never breastfed						
	Mean		Standard Error		F-value	P-value
Variable	Never Breastfed	Breastfed 0-6 months	Never Breastfed	Breastfed 0-6 months		
PANEL A: Mother/Household						
Married	0,691	0,739	0,015	0,020	6,383	0,013
Age at birth	25,339	25,711	0,174	0,213	2,579	0,111
Self-rated health	2,506	2,314	0,027	0,041	22,338	0,000
Completed high school	0,804	0,888	0,018	0,013	22,396	0,000
Attended college	0,304	0,497	0,017	0,022	83,587	0,000
Household earnings	41,032	50,544	1,523	2,809	17,504	0,000
Household members	4,361	4,376	0,050	0,051	0,074	0,786
PANEL B: Child						
Age (wave 1)	15,964	15,606	0,127	0,121	16,673	0,000
Age (wave 2)	16,528	16,268	0,117	0,111	10,201	0,002
Age (wave 3)	22,171	21,763	0,131	0,126	17,044	0,000
Age (wave 4)	28,947	28,537	0,129	0,127	18,139	0,000
Sex	0,501	0,473	0,012	0,016	2,424	0,122
Birth order	2,038	1,872	0,030	0,041	13,990	0,000
Birth weight (ounces)	117,444	120,594	0,453	0,755	13,143	0,000
White	0,669	0,728	0,033	0,030	5,796	0,017
Observations	3030	1356				
Wald test of the null hypothesis that the means of the treatment and control group are equal. Household earnings are measured in thousands (US dollars) in 1994.						

Table A5. Covariates - Difference in means - Treatment: Breastfed 6-12 months, Control: Never breastfed						
	Mean		Standard Error		F-value	P-value
Variable	Never Breastfed	Breastfed 6-12 months	Never Breastfed	Breastfed 6-12 months		
PANEL A: Mother/Household						
Married	0,691	0,761	0,015	0,017	12,808	0,000
Age at birth	25,339	26,125	0,174	0,226	9,960	0,002
Self-rated health	2,506	2,176	0,027	0,057	37,887	0,000
Completed high school	0,804	0,919	0,018	0,016	31,360	0,000
Attended college	0,304	0,593	0,017	0,031	107,715	0,000
Household earnings	41,032	52,799	1,523	2,860	23,554	0,000
Household members	4,361	4,533	0,050	0,074	3,644	0,058
PANEL B: Child						
Age (wave 1)	15,964	15,694	0,127	0,146	5,054	0,026
Age (wave 2)	16,528	16,289	0,117	0,137	4,687	0,032
Age (wave 3)	22,171	21,860	0,131	0,160	5,014	0,027
Age (wave 4)	28,947	28,634	0,129	0,148	6,155	0,014
Sex	0,501	0,485	0,012	0,020	0,521	0,472
Birth order	2,038	1,919	0,030	0,059	3,985	0,048
Birth weight (ounces)	117,444	121,754	0,453	0,921	17,877	0,000
White	0,669	0,760	0,033	0,029	10,632	0,001
Observations	3030	734				
Wald test of the null hypothesis that the means of the treatment and control group are equal. Household earnings are measured in thousands (US dollars) in 1994.						

Table A6. Covariates - Difference in means - Treatment: Breastfed more than 12 months, Control: Never breastfed						
	Mean		Standard Error		F-value	P-value
Variable	Never Breastfed	Breastfed more than 12 months	Never Breastfed	Breastfed more than 12 months		
PANEL A: Mother/Household						
Married	0,691	0,775	0,015	0,024	10,627	0,001
Age at birth	25,339	26,754	0,174	0,338	14,708	0,000
Self-rated health	2,506	2,061	0,027	0,066	43,063	0,000
Completed high school	0,804	0,871	0,018	0,027	6,344	0,013
Attended college	0,304	0,629	0,017	0,037	87,680	0,000
Household earnings	41,032	58,551	1,523	5,481	11,110	0,001
Household members	4,361	4,711	0,050	0,099	10,818	0,001
PANEL B: Child						
Age (wave 1)	15,964	15,696	0,127	0,147	3,812	0,053
Age (wave 2)	16,528	16,258	0,117	0,133	4,539	0,035
Age (wave 3)	22,171	21,811	0,131	0,166	5,147	0,025
Age (wave 4)	28,947	28,649	0,129	0,159	3,716	0,056
Sex	0,501	0,484	0,012	0,028	0,378	0,540
Birth order	2,038	2,157	0,030	0,087	1,746	0,189
Birth weight (ounces)	117,444	122,106	0,453	1,087	15,519	0,000
White	0,669	0,721	0,033	0,041	1,866	0,174
Observations	3030	404				
Wald test of the null hypothesis that the means of the treatment and control group are equal. Household earnings are measured in thousands (US dollars) in 1994.						