ISSN 1471-0498

DEPARTMENT OF ECONOMICS

DISCUSSION PAPER SERIES

The Demand for Season of Birth

Damian Clarke, Sonia Oreffice

and Climent Quintana-Domeque

Number 792
April 2016

Manor Road Building, Oxford OX1 3UQ

The Demand for Season of Birth*

Damian Clarke
Universidad de Santiago de Chile

Sonia Oreffice
University of Surrey & IZA

Climent Quintana-Domeque
University of Oxford, IAE-CSIC & IZA

April 2016

Abstract

We study the determinants of season of birth of the first child, for White non-Hispanic married women aged 25-45 in the US, using birth certificate and Census data. The prevalence of good season (quarters 2 and 3) is significantly related to mother's age, education, and smoking status during pregnancy, as well as to receiving WIC food during pregnancy and to pre-pregnancy body mass index. Moreover, those who did *not* use assisted reproductive technology (ART) present a higher prevalence of good season births. The frequency of good season is also higher and more strongly related to mother's age in states where cold weather is more severe, and varies with mother's occupation, exhibiting a particularly strong positive association with working in "education, training, and library". Remarkably, this relationship between good season and weather disappears for mothers in "education, training, and library" occupations, revealing that season of birth is a matter of choice and preferences, not simply a biological mechanism. We estimate the compensating wage differential for *mothers* who work in jobs other than "education, training, and library", which allows us to provide an upper-bound to the life-time value of good season of birth of about USD 1,000,000. Finally, we present evidence that good season of birth is positively related to health at birth conditional on several maternal characteristics.

JEL Classification Codes: I10, J01, J13.
Keywords: quarter of birth, fertility timing, compensating wage differentials, birth outcomes.

*We thank seminar participants at Stockholm University (SOFI), University of Surrey, the Annual Royal Economic Society Conference 2016 (University of Sussex), the Family Economics Workshop (Barcelona Graduate School of Economics) 2015, the Alicante Health Economics Workshop 2015, and the Vienna LHEDC Workshop 2015 for helpful comments and suggestions. Any errors contained in the paper are our own.

1 Introduction

Motivation. While the relevance of season of birth has been acknowledged at least since Huntington's 1938 book "Season of Birth: Its Relation to Human Abilities", it was not until the seminal article by Angrist and Krueger (1991)—in which quarter of birth was shown to be related to education and earnings in the US—that season of birth became popular in economic research.[1] Recent work has unveiled a variety of channels, beyond school cutoff laws, through which season of birth may affect adult outcomes, for example, its potential effects on birth outcomes. Indeed, a clear and consistent pattern of "good" and "bad" seasons has emerged. In the US, winter months are associated with lower birth weight, education and earnings, while spring and summer are found to be "good" seasons (e.g., Buckles and Hungerman, 2013; Currie and Schwandt, 2013). However, most mechanisms postulated so far are consistent with both biology and preferences. Here we show that season of birth is a matter of choice and preferences above and beyond biological constraints.

This paper. We first present novel correlates of season of birth in the US, investigating women's decisions of when to have their first child in terms of season of birth, for White non-Hispanic married women aged 25-45. Using US Vital Statistics data from 2005 to 2013 on all first singleton births, we show that the prevalence of good season (quarters 2 and 3) is related to mother's age in a concave fashion, positively related to education and negatively related to smoking during pregnancy and receiving Women, Infants and Children federal assistance (WIC) during pregnancy. Maternal pre-pregnancy body mass index (BMI)[2] is related to good season in a concave way: both underweight (BMI < 18.5) and obese (BMI

[1] The validity of this approach has been questioned as quarter of birth is only weakly correlated with schooling. Even a weak correlation between quarter of birth and unobserved ability, for instance due to seasonal effects, might yield a large inconsistency in the IV estimates (Bound et al., 1995). These validity concerns appear to be unsettled. For instance, a recent study shows that "winter babies" are more likely to have unmarried mothers, teenage mothers or less educated mothers, and that maternal schooling peaks for mothers who give birth in the second quarter (Buckles and Hungerman, 2013).

[2] BMI is defined as the individual's body weight (in kg) divided by the square of his/her height (in m).

≥ 30) women are less likely to have their first birth in the good season. In addition, we find that women who did *not* use assisted reproductive technology (ART) are 3 percentage points more likely to give birth in the good season. This finding, which is robust to controlling for gestation length fixed effects, is consistent with season of birth being a choice outcome, if undergoing ART is associated with *no* longer being able to control conception timing and/or caring about season of birth. Moreover, if women undergoing ART do not choose season of birth, we should expect to find no seasonality gap, and we present supportive evidence of this prediction.

Using data from the American Community Survey for 2005-2014, we examine the interaction of a child's season of birth with his or her mother's occupation. Our findings reveal that in professions in which strong seasonality of work hours exists (such as teachers), mothers are additionally more likely to choose good season of birth. Moreover, this holds conditional on observed age, education, and state and year fixed effects. Using temperature data from the National Centers for Environmental Information, we show that the prevalence of first births occurring in the spring or summer is higher in states with more severe cold weather in winter. However, we unveil that among mothers in "education, training, and library" occupations weather does *not* play any role in explaining good season, whereas among occupations other than "education, training, and library" it does. These novel and different seasonal patterns by *occupation-age-weather* highlight the role of preferences and decision-making behavior above and beyond biological mechanisms.

We then attempt to quantify the value of good season of birth, using a standard compensating differential framework. We provide an *upper bound* to the present life-time value of good season of birth of about USD 1,000,000, based on the estimated earnings differential between *mothers* in occupations other than "education, training, and library" and *mothers* in "education, training, and library" occupations, controlling for age, age squared, a college indicator, usual weekly hours of work, and year and state fixed effects, and assuming a 5%

interest rate and a working life of 40 years.

Finally, we examine how birth outcomes, such as birth weight, prematurity (< 37 weeks of gestation) and APGAR scores, are related to season of birth, controlling or not for mother's characteristics. We find that being born in the good season is positively associated with better birth outcomes. Our correlational evidence (with and without controls) is consistent with good season of birth having a positive causal effect on birth outcomes, echoing the findings by Currie and Schwandt (2013) who focus on births to the same mother and show that the seasonal patterns in birth weight and gestation are not entirely driven by the fact that women with different characteristics tend to give births at different times.

Given the prominence of fertility planning in balancing people's work and family life (Jones and Tertilt, 2008) as well as the above findings, it is hard to believe that season of birth may simply be a matter of chance. In addition, far from assuming that the average woman is aware that both birth outcomes (such as birth weight) and child's long-term outcomes (such as future earnings) are affected by season of birth, it is sufficient to consider that the average woman has a sense that, on the one hand, winter months may be tougher birth months because of cold weather and higher disease prevalence,[3] and on the other, work commitments may make it much easier to take time off with a spring-summer birth.[4]

Related literature. Recent work by Barreca et al. (2015) suggests that individuals may make short-term shifts in conception month in response to very hot days, with resulting declines and rebounds in the following months. However, it is not clear how and why these

[3]According to the CDC (2014), from 1982-83 through 2013-14, the "peak month of flu activity" (the month with the highest percentage of respiratory specimens testing positive for influenza virus infection), has been February (14 seasons), followed by December (6 seasons) and January and March (5 seasons each): http://www.cdc.gov/flu/about/season/flu-season.htm

[4]The report on Fertility, Family Planning, and Women's Health (CDC, 1997) notes that some women do not take maternity leave due to the timing of birth relative to their job schedules. An online search on blogs of women planning pregnancies reported the following statements: "It is certainly not a bad time to give birth —less fear of germs getting your baby sick and plenty of sunshiney days for backyard birthday parties when they are older;" "Summer is a great season for your maternity leave to fall on . . . ".

short-term shifts would impact the seasonal distribution of births between April-September and October-March. Currie and Schwandt (2013) explain the first quarter of birth disadvantage through the negative impact of the disease environment on birth weight and gestational weeks in cold months, whereas Buckles and Hungerman (2013) emphasize the role of maternal characteristics in shaping the later socioeconomic disadvantage of winter-born individuals, showing that the mothers of these children are significantly less educated, less likely to be married or white, and more likely to be teenagers.[5]

Although prior work on birth seasonality has also focused on sperm motility, hormone production, male and female fecundability, and behavioral changes in the type of riskiness of sexual activity, Currie and Schwandt (2013) show that influenza at birth drives seasonality in gestational length, while Buckles and Hungerman (2013) show that expected weather at birth drives month of conception, and emphasize that "one's birth date is in part the result of a choice made by one's parents". Indeed, using data from the National Survey of Family Growth, they show that seasonality appears to be driven by wanted births — there is no seasonality in maternal characteristics among unwanted births. In France, Régnier-Loilier (2010) shows that birth seasonality is related to occupation, claiming that "the primary school teachers' April peak is almost entirely due to seasonal birth strategies."[6]

Régnier-Loilier (2010) in France and Buckles and Hungerman (2013) in the US are the only socioeconomic analyses consistent with season of birth being a choice variable. The data used by Régnier-Loilier (2010), the French registry of live births, do not report mother's occupation for 40% of the births, while the analysis in Buckles and Hungerman (2013) focuses on a very *heterogeneous* group of mothers. However, none of these studies disentangles choice or preferences (e.g. occupational choice) from biological mechanisms (e.g. weather or influenza). Here, we focus on a *homogeneous* group of mothers, White Non-

[5] Alba and Cáceres-Delpiano (2014) describe similar findings for Chile and Spain.

[6] The idea is to time maternity leave so that it runs into the summer holidays. However, the data used by Régnier-Loilier (2010), the registry of live births, do not report mother's occupation for 40% of the births.

Hispanic married women aged 25-45, and document that season of birth is a choice variable, encompassing novel characteristics, including *occupation* and *ART* use. We analyze the determinants of season of birth by *occupation-age-weather* in an attempt to disentangle behavioral from biological responses, and estimate the value of season of birth and its relationship with birth outcomes. We show that the realization of season of birth is not simply biology (e.g. weather, influenza): older women or ART users exhibit *no* seasonality, while other women respond to incentives, with preferences tilted towards the realization of good season births. In states with cold winter weather women show a more acute sense of the costs of winter births, and they behave *differently* by occupation: young women in "Education, Training and Library" do not respond to weather conditions, whereas those in other occupations do. We believe our results highlight that there is indeed a demand for season of birth.

There is also a literature on "exact" birth timing that analyzes the joint decision of parents and physicians to alter the delivery of an already existing pregnancy (in response to non-medical incentives). Shigeoka (2015), focusing on the distribution of births between December and January, finds that in Japan many births are shifted one week forward around the school entry cutoff date. In the US, instead, birth timing does not happen systematically before school-eligibility cutoff dates (Dickert-Conlin and Elder, 2010). Dickert-Conlin and Chandra (1999) and LaLumia et al. (2015) report that in the US parents may move expected January births backwards to December to gain tax benefits, while Gans and Leigh (2009) estimate that parents moved forward June deliveries to become eligible for a newly introduced "baby bonus" in Australia. Fewer births are documented on holidays (Rindfuss et al., 1979) and weekends (Gould et al., 2003), medical professional meeting dates (Gans et al., 2007), and less auspicious dates (Almond et al., 2015).

Although this body of evidence clearly shows that parents may be willing and able to manipulate birth timing, it represents a choice made well *after* conception occurs. Our analysis is about a choice made *before* conception occurs. To the best of our knowledge ours is the first study to clearly document the planning of season of birth, with our analysis by occupation, age and weather providing the first attempt to estimate the value of good season of birth.

Structure of the paper. Section 2 describes the data sources. Section 3 presents the analysis of the correlates of season of birth. Section 4 provides a simple framework to estimate an *upper-bound* to the life-time value of good season of birth. Section 5 shows how birth outcomes correlate with season of birth controlling or not for mothers' characteristics. Section 6 contains robustness checks. Section 7 offers a discussion of our findings. Section 8 concludes the paper.

2 Data Sources and Descriptive Statistics

2.1 Birth Certificate Data

Data on all births occurring each year in the US are collected from birth certificate records, and are publicly released as the National Vital Statistics System (NVSS) by the National Center of Health Statistics. These data are available for all years between 1968 and 2013, with all registered births in all states and the District of Columbia reported from 1984 onwards.[7] In total, more than 99% of births occurring in the country are registered (Martin et al., 2015). The birth certificate data record important information on births and their mothers. For the mother, this includes age, race, ethnicity, marital status, education, smoking status during pregnancy, and, since 2009, assisted reproductive technology (ART) use, whether the mother received WIC food benefits during pregnancy, height and pre-

[7]Prior to 1984, a 50% sample was released for those states that did not submit their birth records on electronic, machine readable tape (Martin et al., 2015).

pregnancy weight.[8] We use height and pre-pregnancy weight to construct pre-pregnancy BMI and the standard BMI categories: Underweight (BMI < 18.5), Normal Weight ($18.5 \leq$ BMI < 25), Overweight ($25 \leq$ BMI < 30) and Obese (BMI ≥ 30).[9] For the newborn, in addition to place and time of birth, measures include birth parity, singleton or multiple births status, gestational length (in weeks), birth weight, and one- and five-minute APGAR scores.[10]

Our estimation sample consists of the years 2005-2013, and we retain all singleton first-births to White, non-Hispanic married mothers aged 25-45 who are issued an updated birth certificate with available education and smoking status.[11] We focus on first births, given that higher-order births also involve the additional decision of birth spacing and the role of experience, possibly underestimating the determinants of the choice of season of birth if planning improves with higher-order pregnancies.[12] We also restrict our main sample only to singleton births.[13] This results in a sample of 2,260,745 births, 2,259,553 of which have gestation length recorded, that is, for whom conception month is known. Season of birth is defined as the *expected* (intended) season of birth, which we compute combining information on the month of birth and gestational length. In practice, and following Currie and Schwandt (2013), month of conception is calculated by subtracting the rounded number of gestation months (gestation in weeks $\times$ 7/30.5) from month of birth. Hence, we focus on the *planning* of season of birth, i.e., the decision to conceive.[14]

[8]The question on WIC benefits is: "Did you receive WIC (Women, Infants & Children) food for yourself because you were pregnant with this child?"

[9]When using pre-pregnancy BMI, we restrict our sample to mothers with a BMI between 16 and 40. Hence, we exclude the severely underweight ($<$16) and obese class III ($\geq$40), following the BMI classification from the WHO.

[10]Birth certificates have gone through two important revisions in the variables reported: one in 1989 and the other in 2003. These revisions (described fully in NCHS, 2000) were implemented by states at different points in time. Prior to 2005, all states had fully incorporated the 1989 revision. In the most recent wave of birth certificate data (2013), 41 states, containing 90.2% of all births, had switched to the more recent 2003 revision. Importantly, the revised data include a different measure of education, a wider range of birth outcomes, and do not include the mother's smoking status.

[11]The analysis is replicated including unmarried women in the online appendix.

[12]The analysis including second-births is provided in the online appendix.

[13]The analysis including twins (and for twins only) is provided in the online appendix.

[14]Using *actual* or *expected* season of birth is immaterial for our findings.

2.2 Occupation Data

The US birth certificate data do *not* contain information on mother's occupation. In order to investigate the role of mother's occupation in explaining season of birth we supplement our analysis of NVSS data with the American Community Survey (ACS) conducted by the United States Census Bureau on a representative 1% of the US population every year (Ruggles et al., 2015). Along with demographic and socioeconomic characteristics of women, we observe their labor market outcomes, and specifically occupation which is coded using the standard Census occupation codes and defined as the individual's primary occupation for those who had worked within the previous five years. We use data from 2005 to 2014, the most recent available survey, and focus on White non-Hispanic married women aged 25-45 who are either the head of the household or spouse of the head of the household, and have a first singleton child who is *at most* one year old.[15] Given that Census data do not provide gestational length, season of birth is defined as the *actual* quarter of birth, not the *expected* one.

We use the ACS data in two instances: the first to study the relationship between season of birth of first-born and occupation; the second to study the relationship between earnings and job type, and their different relationship for mothers and non-mothers. For the former analysis, we retain only women who had worked within the previous five years in non-military occupations where each occupation must have at least 500 women over the entire range of survey years, while for the latter, we *add* to our previous sample women without children and women with more than one child.[16]

[15] We exclude women who are in the military, in a farm household, or currently in school.

[16] The small number of observations of households containing two women have been excluded.

2.3 Temperature Data

Temperature data are provided by the National Centers for Environmental Information from 1895 onwards, updated monthly. We collate measures of monthly means, maxima and minima for each state, year and month over our time period of analysis, as described in Vose et al. (2014). These are available for all states with the exception of Hawaii and the District of Columbia (DC). We assign births that take place in DC the temperature data from Maryland, a contiguous state. Measures of temperature are calculated at the year by month and state level, and are merged by conception (not birth) month.

2.4 Descriptive Statistics

Table 1 presents summary statistics of all births in our sample. The first panel of the table shows that first-time mothers are on average 30 years old, and 97% are aged below 40 at the time of their first birth ("younger").[17] For those birth certificates with available mother's education and smoking information, 77% have at least some college education; for those with non-missing smoking information, 3% reported having smoked during pregnancy. Finally, for the five most recent years in our sample (2009-2013), we have information on the use of ART procedures, WIC assistance, and pre-pregnancy BMI: 1% of these first-births were achieved through ART; 8% of these births are born to mothers who received WIC food during pregnancy; and 42% of first-time mothers have a non-normal pre-pregnancy weight (3% are underweight, and 39% are overweight or obese).

In the second panel, we present detailed information on birth outcomes. 52% of babies to first-time, married mothers are born in the good season, defined as quarters 2 and 3; taking into account gestational length, a similar proportion (52%) of the newborns were planned for the good season. It is noteworthy that in the US none of the public holidays falls close

[17]Figure 1A in the online appendix displays the histogram of mother's age at first birth.

Table 1: Descriptive Statistics (NVSS 2005-2013)

	N	Mean	Std. Dev.	Min.	Max.
Panel A: Mother					
Mother's Age	2260745	30.28	3.92	25	45
Young (aged 25-39)	2260745	0.97	0.16	0	1
Aged 25-27	2260745	0.28	0.45	0	1
Aged 28-31	2260745	0.39	0.49	0	1
Aged 32-39	2260745	0.30	0.46	0	1
Aged 40-45	2260745	0.03	0.16	0	1
Some College +	2260745	0.77	0.42	0	1
Years of education	2260745	15.59	1.59	4	17
Smoked during Pregnancy	2260745	0.03	0.18	0	1
Used ART[a]	1572674	0.01	0.11	0	1
Received WIC food in Pregnancy[a]	1561541	0.08	0.26	0	1
Pre-pregnancy BMI[a]	1490036	24.86	4.79	16	40
Pre-pregnancy Underweight (BMI $<$ 18.5)[a]	1490036	0.03	0.17	0	1
Pre-pregnancy Normal Weight (18.5 $\leq$ BMI $<$ 25)[a]	1490036	0.58	0.49	0	1
Pre-pregnancy Overweight (25 $\leq$ BMI $<$ 30)[a]	1490036	0.24	0.43	0	1
Pre-pregnancy Obese (BMI $\geq$ 30)[a]	1490036	0.15	0.36	0	1
Panel B: Child					
Good season of birth (birth date)	2260745	0.52	0.50	0	1
Good season of birth (due date)	2259553	0.52	0.50	0	1
Female	2260745	0.49	0.50	0	1
Birthweight (grams)	2255282	3352.85	535.94	500	5000
Low Birth Weight ($<$2500 g)	2255282	0.05	0.22	0	1
Weeks of Gestation	2259553	39.02	2.17	17	47
Premature ($<$ 37 weeks)	2259553	0.08	0.27	0	1
APGAR (1-10)	2248425	8.78	0.82	0	10

NOTES: Sample consists of all first-born, singleton children born to White, Non-Hispanic married mothers aged 25-45 for whom education and smoking during pregnancy are available. Good season refers to birth quarters 2 and 3 (Apr-Jun and Jul-Sept). Bad season refers to quarters 1 and 4 (Jan-Mar and Oct-Dec). ART refers to the proportion of women who undertook assisted reproductive technologies that resulted in these births. [a] Only available from 2009.

to the frontiers between the good and bad seasons defined above.[18] Regarding gender, 49% are girls. Finally, we have information on birth "quality" measures, including birth weight, prematurity (< 37 weeks of gestation) and APGAR score. The averages of these measures (3,353 grams, 8%, and 8.8 respectively) are consistent with those from previous studies.

While not reported in the table, since we are focusing on singleton first-births, we note that 35% of first-births achieved through ART are twins, whereas 65% are singletons. Among those not achieved through ART, less than 3% are twins and more than 97% are singletons. In addition, among ART users, 96% of women have at least some college education, and 0.7% smoked during pregnancy.

3 Season of Birth Correlates

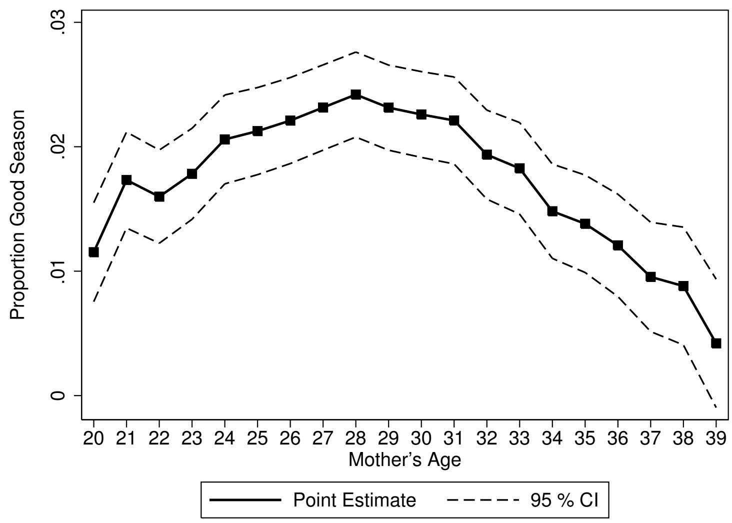
3.1 Mother's Age and ART usage

Figure 1 highlights the seasonality gap by age group in the US: it plots the frequency of good season of singleton first births for each age from 20 to 39, compared to the omitted base group of 40-45 year olds. Two novel features are worth mentioning. First, there is a decreasing gap in age from 28 to 45. In particular, the relative prevalence of good season is highest (almost 2.5 pp higher) for mothers aged 28, while it is essentially zero for mothers aged 39. Second, the relationship between the proportion of good season births (relative to 40-45 year olds) and age is non-monotonic, and in particular, concave: the gap increases as women approach the age of 28, is approximately flat up until the age of 31, and then follows a downward trajectory for women aged 32-39. While the former feature is consistent with biological constraints whereby younger women can better control their fertility and

[18]Nationally Observed Public Holidays are: New Year's Day, Martin Luther King Jr. Day, Presidents' Day, Memorial Day, July 4, Labor Day, Columbus Day, Veteran's Day, Thanksgiving, and Christmas Day.

optimally time their births, the latter suggests that the prevalence of good season of birth cannot be entirely accounted for by the higher biological ability of younger mothers to engage in optimal planning.

Figure 1: Prevalence of Good Season by Age



NOTES TO FIGURE 1: Coefficients and standard errors are estimated by regressing "good season" on dummies of maternal age. Age groups 40-45 are omitted as the base group. The full sample consists of White Non-Hispanic married mothers aged 20-45. For the omitted group, proportion good season (and standard error) is 0.499 (0.002).

The patterns in Figure 1 are summarized in Table 2, which contains information on the percent of births by good season, but also on prematurity and use of assisted reproductive technology (ART). These percentages are examined by age and education groups. Good season is non-monotonically related to age: 51.59% of all births among very young women (aged 20-24) occur in the good season, and this value increases to 52.23% among women aged 28-31, before decreasing to 50.11% among older women (aged 40-45). This non-monotonic relationship can reflect two opposing effects: a *selection* effect—very young mothers tend to be negatively selected—and a *biological* effect—older mothers have less control over their fertility timing than younger ones. The positive relationship between good season and age from 20 to 28 could capture a (positive) net selection effect, while the negative relationship between good season and age from 28 to 45 could capture a (negative) net biological effect.

Table 2: Percent of Births

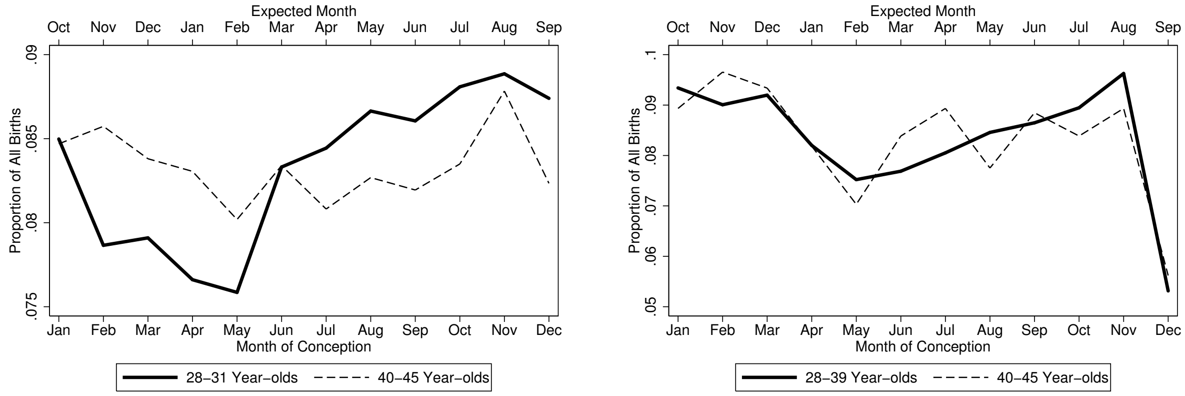
	Seasons				Characteristics	
	Bad Season	Good Season	Diff.	Ratio	<37 Gestation Weeks	ART
Panel A: By Age						
20-24 Years Old	48.41	51.59	3.18	1.07	0.08	0.00
25-27 Years Old	47.94	52.06	4.12	1.09	0.08	0.00
28-31 Years Old	47.77	52.23	4.46	1.09	0.08	0.01
32-39 Years Old	48.69	51.31	2.62	1.05	0.09	0.02
40-45 Years Old	49.89	50.11	0.22	1.00	0.12	0.08
Panel B: By Education						
No College	49.07	50.93	1.86	1.04	0.10	0.00
Some College +	48.07	51.93	3.86	1.08	0.08	0.01

Notes: Main estimation sample augmented with mothers aged 20-24.

With regards to education, more educated women are more likely to choose good season births. Looking at the percent of premature newborns (born within 37 weeks of gestation) and those from women undertaking ART, we find that prematurity increases with age, from 8% among 20-24 years old to 12% for women aged 40-45, as does ART, from 1% among 28-31 years old to 8% among women aged 40-45. Newborns of women without a college degree are more likely to be premature than those of their college-educated counterparts (10% vs. 8%), and among highly-educated women the percent of ART newborns is higher than among their less educated counterparts (1% vs. 0%).

We now examine the birth prevalence by month for two age groups of younger and older first time mothers (28-31 vs. 40-45 year-olds). Figure 2a shows that the gap between the two groups is positive precisely in the months representing the "good" season (April to September) and negative in the "bad" season (October to March). This finding is consistent with "younger" mothers being less biologically constrained than "older" mothers when making their fertility decision, *ceteris paribus*.

Figure 2: Birth Prevalence by Month, Age Group, and ART Usage



(a) Proportion of Conceptions in Each Month

(b) Proportion of Conceptions (ART Only)

Notes to figure 2: Month of conception is calculated by subtracting the rounded number of gestation months (gestation in weeks $\times$ 7/30.5) from month of birth. Each line presents the proportion of all births conceived in each month for the relevant age group.

If women undergoing ART to achieve their first birth cannot and do *not* choose season of birth, we should expect to find no seasonality gap in their births: that is exactly what the patterns in Figure 2b show.[19] Moreover, when examining the distribution of ART births over the year, the entire difference in the proportion of good season births appears to be driven by a large reduction of ART conceptions occurring in December.[20] This is in line with the seasonality of treatment availability in ART clinics, which in many cases do not offer complex fertility treatments such as IVF (in vitro fertilization) or embryo transfers in December due to Christmas closure and the daily attention and last minute changes that these treatments require.[21] Therefore, when the choice of season of birth is not in women's hands or they do not care about it any longer, we observe no seasonality at all.[22]

[19]Note that the fraction of ART babies for women aged 28-31 is 1%, while for mothers younger than 28 the percentage decreases to 0%.

[20]Figure 2A in the online appendix displays the birth prevalence by month for women of all ages undergoing ART.

[21]This is supported by anecdotal evidence on fertility clinics operations.

[22]Buckles and Hungerman (2013), using data from the National Survey of Family Growth, show that seasonality appears to be driven by wanted births — there is no seasonality in maternal characteristics among unwanted births.

Table 3: Season of Birth Correlates

	(1) Good Season	(2) Good Season	(3) Good Season	(4) Good Season	(5) Good Season
Mother's Age (years)	0.007***	0.005***	0.004***	0.005***	0.004***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Mother's Age^2 / 100	-0.012***	-0.011***	-0.009***	-0.010***	-0.008***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Some College +			0.009***	0.007***	0.005***
			[0.001]	[0.002]	[0.002]
Smoked in Pregnancy			-0.012***	-0.013***	-0.011***
			[0.002]	[0.002]	[0.003]
Received WIC food in Pregnancy					-0.008***
					[0.002]
Pre-pregnancy Underweight (BMI $<$ 18.5)					-0.007***
					[0.002]
Pre-pregnancy Overweight (25 $\leq$ BMI $<$ 30)					0.001
					[0.001]
Pre-pregnancy Obese (BMI $\geq$ 30)					-0.004***
					[0.001]
Did not undergo ART					0.028***
					[0.004]
Observations	2259553	2259553	2259553	1459040	1459040
F-test of Age Variables	0.000	0.000	0.000	0.000	0.000
Optimal Age	27.04	25.59	24.28	24.55	23.33
State and Year FE		Y	Y	Y	Y
Gestation FE			Y	Y	Y
2009-2013 Only				Y	Y

NOTES: F-test of age variables refers to the p-value on the test that the coefficients on mother's age and age squared are jointly equal to zero. Optimal age calculates the turning point of the mother's age quadratic. Heteroscedasticity robust standard errors are reported in parentheses. ***p-value<0.01, **p-value<0.05, *p-value<0.1.

In Table 3 we investigate the determinants of good season of birth. In column 1 we find a concave relationship between good season of birth and age, mimicking the graphical pattern described in Figure 1, and mirroring the descriptive statistics in Table 2. Note that the "optimal" age of 27.04 is close to the peak of 28 described in Figure 1. The non-monotonic relationship is robust to controlling for state and year fixed effects, education (an indicator for having some college or above), and (an indicator for) smoking during pregnancy (columns 2-3). In addition, highly-educated women are between 0.5 and 0.9 percentage points more likely to have their first-born child in the good season than their counterparts. Women who smoked during pregnancy are between 1.1 and 1.3 percentage points less likely to choose the good season. Finally, in column 5, we make use of the additional information contained in the live birth certificates since 2009 and add the following controls: an indicator of whether the mother received WIC food during pregnancy, pre-pregnancy BMI indicators, and a non-ART indicator (1 if the birth did not happen through an ART procedure, 0 otherwise). Since this information is available only from 2009 to 2013, we replicate column 3 with this restricted sample in column 4, finding the same results. Column 5 shows that women who received WIC food during pregnancy are 0.8 pp less likely to give birth in the good season. In addition, we find a non-monotonic relationship between pre-pregnancy BMI and good season: women who are underweight before the pregnancy are 0.7 pp less likely to give birth in the good season and women who are obese are 0.4 pp less likely to deliver in the good season. Finally, women who did not undergo ART are about 3 pp more likely to give birth in the good season. This last finding is consistent with season of birth being a choice variable, if undergoing ART is associated with no longer being able to control conception timing.

The "optimal" age for good season of birth computed in Table 3 describes an interesting pattern: it decreases as we include additional socioeconomic controls, going from 27.04 in column 1 to 23.33 in column 5. This pattern is consistent with young women being *biologically* more able to plan good season of birth, once the *negative selection* of young

Table 4: Season of Birth Correlates (Including Fetal Deaths)

	(1) Good Season	(2) Good Season	(3) Good Season	(4) Good Season
Mother's Age (years)	0.007***	0.005***	0.005***	0.005***
	[0.001]	[0.001]	[0.001]	[0.001]
Mother's Age^2 / 100	-0.012***	-0.011***	-0.010***	-0.010***
	[0.002]	[0.002]	[0.002]	[0.002]
Smoked in Pregnancy			-0.015***	-0.014***
			[0.002]	[0.002]
Observations	2269645	2269645	2269645	2269645
F-test of Age Variables	0.000	0.000	0.000	0.000
Optimal Age	27.03	25.6	25.33	25.13
State and Year FE		Y	Y	Y
Gestation FE				Y

NOTES: Main sample is augmented to include fetal deaths occurring between 25 and 44 weeks of gestation. Fetal death files include only a subset of the full set of variables included in the birth files, so education and ART controls are not available. F-test of age variables refers to the p-value on the test that the coefficients on mother's age and age squared are jointly equal to zero. Optimal age calculates the turning point of the mother's age quadratic. Heteroscedasticity robust standard errors are reported in parentheses. ***p-value<0.01, **p-value<0.05, *p-value<0.1.

women into motherhood (e.g., less educated, more likely to smoke, more likely to be on welfare) is accounted for.[23] Finally, Table 4 shows that including fetal deaths (deaths occurring between 25 and 44 weeks of gestation) does not affect our findings.[24]

Our estimated seasonality gaps, between 1.1 pp (smoking during pregnancy gap) and 3 pp (non-ART gap), are sizable. Buckles and Hungerman (2013) report a 1 pp difference in teenage mothers and a 2 pp difference in unmarried or Non-White mothers between January births and May births, and they interpret these gaps as "strikingly large" compared to the estimated effects of welfare benefits on non-marital childbearing (Rosenzweig, 1999) or unemployment on fertility (Dehejia and Lleras-Muney, 2004). More recently, Raute (2015) assesses the effects of changes in financial incentives on fertility arising from a reform in parental leave benefits in Germany, and she finds that a €1,000 increase in parental

[23]Note that smoking during pregnancy captures both the effect of low socioeconomic status on fertility decisions and the potential biological effects of smoking on conception.

[24]Accounting for fetal deaths is also a crude way to account for the influence of miscarriages, which we cannot observe.

benefits raises the probability to have a child in the four years post reform by (at least) 1.2%. Given that our seasonality gaps are obtained within a much more *homogeneous* group of mothers (White, Non-Hispanic, Married, Non-Teenage) and *not* in response to generous monetary benefits, our estimated gaps are definitely large. Moreover, these seasonality gaps may represent lower bounds of the actual relationship of mothers' characteristics and birth seasonality, if we take into account that women on average take a few (about 6) months to get pregnant after they stop contracepting. Indeed, birth seasonality has been found to be consistent with the seasonality at which women stop contracepting (Rodgers and Udry, 1988) but not with marriage seasonality timing (Lam et al., 1994).[25]

3.2 Age, Selection and Biology

We argued that the concave relationship between good season of birth and age can reflect the influence of two opposing effects: a *selection* effect—younger mothers tend to be negatively selected—and a *biological* effect—older mothers have less control over their fertility timing than younger mothers. In Table 5 we add very young women (aged 20-24) to our main sample and unveil several interesting findings. First, very young women are 0.3 percentage points *less* likely to have their first child in the good season, and women not using ART are 3 percentage points more likely to plan for the good season. Controlling for state and year fixed effects decreases the relationship with age but strengthens the correlation with non-ART usage, column 2. Interestingly, when controlling for mother's education and smoking during pregnancy, column 3, the negative relationship between being a very young mother and good season disappears, while the ART correlation is robust to such an adjustment: women who smoked during pregnancy are 1.1 percentage points less likely to have their first child in the good season, and women with some college (or above) are about 1 percentage point more likely to plan for the good season. Finally, in column 4, we control

[25]This last finding excludes honeymoon effects.

for an indicator of whether the mother received WIC food during pregnancy, pre-pregnancy BMI indicators, and a non-ART indicator: while the coefficient on non-ART remains the same, and the coefficients on education and smoking are very similar to those in column 3, now very young women are 3 pp *more* likely to give birth in the good season.

The findings in Table 5 reveal that the stylized fact that very young mothers are *less* likely to choose the good season captures negative selection: these mothers are less educated, more likely to smoke, more likely to be on welfare, and more likely to have a pre-pregnancy BMI falling in the non-normal categories. Once these negative factors are accounted for, younger mothers are indeed *more* likely to choose the good season. This shows that the relationship between season of birth and age is not solely governed by a biological mechanism. Moreover, we can see that the ART correlation reflects a biological mechanism, since its magnitude remains constant from column 2 to 5. It is worth noting that the fact that December is the most popular conception month in the US or that the sperm is better in winter and early spring (Levitas et al., 2013) cannot explain the observed seasonality.[26]

3.3 Temperature

If women choose season of birth at all, their willingness to give birth in the spring or summer may be higher in states with more severe cold weather in winter, as cold weather in winter is associated with higher disease prevalence (Currie and Schwandt, 2013) and limited time outside for mothers and their babies (Régnier-Loilier, 2010). In Figure 3 we plot the percentage of "younger" (28-31) women giving birth in the good season against the coldest monthly average by state. The pattern is spectacular. There is a strong linear negative association between these two variables (correlation coefficient $= -0.668$, p-value=0.000), whereas we do not find any such relationship for women aged 40-45 (correlation coefficient

[26] We also run our main regressions excluding September (December + 9 months) and find the same patterns of results. See Table 1A in the online appendix.

Table 5: Season of Birth Correlates: Very Young (20-24) and ART users

	(1) Good Season	(2) Good Season	(3) Good Season	(4) Good Season
Aged 20-24	-0.003***	-0.002*	0.001	0.003***
	[0.001]	[0.001]	[0.001]	[0.001]
Did not undergo ART	0.032***	0.035***	0.035***	0.035***
	[0.004]	[0.004]	[0.004]	[0.004]
Some College +			0.009***	0.007***
			[0.001]	[0.001]
Smoked in Pregnancy			-0.011***	-0.008***
			[0.002]	[0.002]
Received WIC food in Pregnancy				-0.008***
				[0.001]
Pre-pregnancy Underweight (BMI $<$ 18.5)				-0.006***
				[0.002]
Pre-pregnancy Overweight (25 $\leq$ BMI $<$ 30)				0.001
				[0.001]
Pre-pregnancy Obese (BMI $\geq$ 30)				-0.004***
				[0.001]
Observations	1808788	1808788	1808788	1808788
State and Year FE		Y	Y	Y

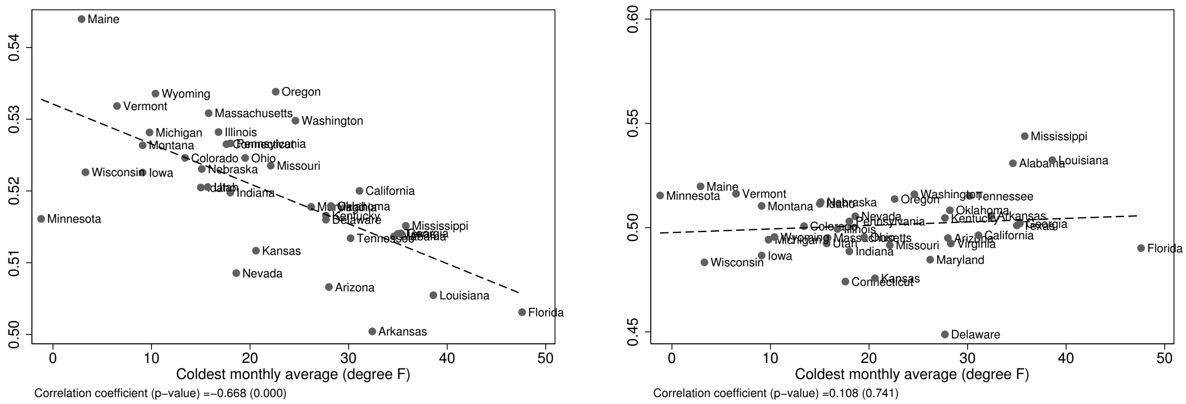
NOTES: Main sample is augmented to include women aged 20-24. Heteroscedasticity robust standard errors are reported. ***p-value<0.01, **p-value<0.05, *p-value<0.1.

= 0.108, p-value=0.741).[27]

This finding suggests that season of birth is not simply a biological mechanism due to weather or influenza, as women appear to respond to incentives: in states where winters are colder, women exhibit a more acute sense of the costs of winter births (Figure 3a) but *not* when they are older and *no* longer control conceptions, or care about season (Figure 3b). We further explore season of birth as a matter of choice and preferences beyond biological constraints or mechanisms in the following analysis by occupation.

[27] Buckles and Hungerman (2013) documented that expected weather at birth explains much of the seasonal patterns due to racial, marital, and teen pregnancy status, but did not run the analysis by age groups.

Figure 3: Prevalence of Good Season and Cold Temperatures by State and Age



(a) Younger Mothers (28-31)

(b) Older Mothers (40-45)

NOTES TO FIGURE 3: Each point represents a state average of the proportion of women giving birth in the good birth season between 2005 and 2013. The dotted line is a fitted regression line. Monthly temperature data is collected from the National Centers for Environmental Information.

3.4 Occupation

There is considerable evidence that labor market flexibility affects women's job choices as well as partially explains the pay gap (Goldin, 2014). If season of birth is a choice variable, then we may expect it to be also related to mother's occupation, if only because certain jobs allow more flexibility in taking time off work in certain seasons (Régnier-Loilier, 2010). This is particularly relevant in the US, given the very limited maternity leave available in this country. While the NVSS (2005-2013) has no information on occupation, we use the ACS data (2005-2014) to shed light on the relationship between good season of birth and occupation.[28]

Table 6 shows that occupation is a relevant determinant of season of birth. In the first column, we regress season of birth on age, age squared and education, year and state fixed effects, documenting the previously reported concave relationship between age and good season (p-value on the F-test for the coefficients on age variables being zero is 0.031).

[28] Tables 2A and 3A in the online appendix provide the descriptive statistics for the ACS data.

Table 6: Season of Birth Correlates: Occupation

	(1) Good Season	(2) Good Season	(3) Good Season
Mother's Age (years)	0.011	0.011*	0.011*
	[0.007]	[0.007]	[0.007]
Mother's Age^2 / 100	-0.019*	-0.019*	-0.019*
	[0.010]	[0.010]	[0.010]
Some College +	0.008	0.006	0.005
	[0.007]	[0.008]	[0.008]
Architecture and Engineering		0.015	
		[0.023]	
Business Operations Specialists		0.018	
		[0.016]	
Community and Social Services		0.022	
		[0.017]	
Computer and Mathematical		0.030	
		[0.020]	
Education, Training, and Library		0.036***	
		[0.013]	
Financial Specialists		0.015	
		[0.016]	
Food Preparation and Serving		0.035*	
		[0.019]	
Healthcare Practitioners and Technical		0.024*	
		[0.013]	
Healthcare Support		-0.005	
		[0.019]	
Legal		-0.000	
		[0.018]	
Life, Physical, and Social Science		0.011	
		[0.020]	
Management		0.025*	
		[0.014]	
Office and Administrative Support		0.023*	
		[0.013]	
Personal Care and Service		0.029*	
		[0.016]	
Production		0.008	
		[0.023]	
Sales		0.003	
		[0.014]	
Observations	74780	74780	74780
Occupation Codes (level)	-	2	3
F-test of Occupation dummy variables	-	.057	0.000
F-test of Age Variables	0.031	0.051	0.046
State and Year FE	Y	Y	Y

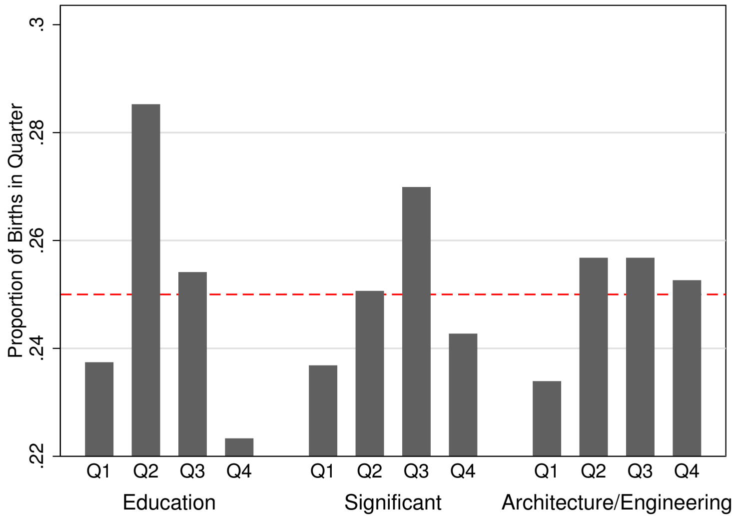
NOTES: Sample consists of all singleton first-born children in the US to white, non-hispanic married mothers aged 25-45 included in 2005-2014 ACS data where the mother is either the head of the household or the partner of the head of the household and works in an occupation with at least 500 workers in the sample. Occupation codes refer to the level of occupation codes (2 digit, or 3 digit). The omitted occupational category in column 2 is Arts, Design, Entertainment, Sports, and Media, as this occupation has good quarter= 0.500 (0.500). F-tests for occupation report p-values of joint significance of the dummies, and F-test of age variables refers to the p-value on the test that the coefficients on mother's age and age squared are jointly equal to zero. Heteroscedasticity robust standard errors are reported in parentheses. ***p-value<0.01, **p-value<0.05, *p-value<0.1.

In column 2, we include the 2-digit occupational dummy variables from the Census classification.[29] From the 16 occupational indicators, the coefficient that has both the largest magnitude and highest statistical significance is the one corresponding to "Education, Training, and Library": women in these types of jobs are 3.6 percentage points more likely to plan their birth in the good season (with respect to those working in "Arts, Design, Entertainment, Sports and Media"), and such a sizable gap is statistically significant at the 1% level. In addition, we reject at the 10% level the hypothesis that occupation is irrelevant in explaining season of birth: the p-value associated to the F-test for the coefficients on all occupation indicators being zero is 0.057. Finally, column 3 repeats the same exercise replacing 2-digit occupational dummy variables with 3-digit occupational indicators. If anything, this indicates the relevance of occupation as a predictor of good season of birth: the p-value associated to the corresponding F-test is now 0.000.

One of the key messages from this table is that being employed in "Education, Training, and Library" occupations makes it easier to target the good season. In Figure 4 we examine birth timing and occupation class by quarter of birth. Teachers are much more likely to time their births in the spring to align the end of the maternity leave with the beginning of their summer break, and thus maximize their time home with their baby while fully paid, which is consistent with the explanation given by Régnier-Loilier (2010) in France. Other "significant" occupations (those whose coefficient is statistically significant in Table 6) are more likely to target quarter 3.

[29] All occupation codes refer to IPUMS `occ2010` codes, which are available at: https://usa.ipums.org/usa/volii/acs_occtooccsoc.shtml

Figure 4: Birth Prevalence by Quarter and Occupation



Notes to figure 4: Groups are defined as: (1) Education, Training, Library; (2) Occupations with statistically significant coefficients in Table 6 (Education, Training, Library; Food Preparation and Serving; Healthcare Practitioners and Technical; Management, Office and Administrative Support; Personal Care and Service); (3) the occupation with the least seasonality (Architecture and Engineering).

This evidence clearly suggests that there is a decision-making process behind season of birth: "Education, Training, and Library" is not a high-salary occupation or one with only very young women, so that the strong positive significant correlation with good season of birth cannot simply be explained by a biological mechanism or a budget constraint channel (income) but rather with the implementation of a choice. We now present further evidence to support this claim.

In Table 7, we compare the good season of birth prevalence between women in Teacher related jobs ("Education, Training, and Library") and those in Non-Teacher related jobs (all the remaining occupations), controlling or not for age and education, finding that "Teachers" are 2 pp more likely to achieve the good season. We then reexamine our finding on cold winters by these occupation categories. We first replicate Figure 3 with ACS data, confirming in Figures 5 and 6 that there is a seasonality due to states with cold winters among 28-31 year-old mothers but *not* among 40-45 year-olds. In Figures 7 and 8, we perform this analysis by "teacher" and "non-teacher" occupations. Interestingly, for younger "teachers" there is *no* seasonality pattern due to weather (Figure 7a) while there is among younger “non-teachers” (Figure 7b). For “older” women, the pattern is *not* there, *regardless* of their occupational status (Figures 8a, 8b). This finding reinforces our contention that season of birth represents the implementation of a choice above and beyond biological mechanisms.

Table 7: Season of Birth Correlates: “Teachers” vs. “Non-Teachers”

	(1) Good Season	(2) Good Season	(3) Good Season	(4) Good Season	(5) Good Season
Teacher	0.019***	0.019***		0.019***	0.018***
	[0.006]	[0.006]		[0.006]	[0.006]
Mother’s Age (years)					0.011
					[0.007]
Mother’s Age^2 / 100					-0.018*
					[0.010]
Some College +			0.009	0.006	0.006
			[0.007]	[0.007]	[0.007]
Observations	74780	74780	74780	74780	74780
F-test of Age Variables					0.044
State and Year FE		Y	Y	Y	Y

NOTES: Main ACS estimation sample is used. Teacher refers to individuals employed in “Education, Training and Library” occupation (occupation codes 2200-2550). The omitted occupational category is all non-educational occupations. F-test of age variables refers to the p-value on the test that the coefficients on mother’s age and age squared are jointly equal to zero. Heteroscedasticity robust standard errors are reported in parentheses. ***p-value<0.01, **p-value<0.05, *p-value<0.1.

Figure 5: Temperature and Good Season (28-31)

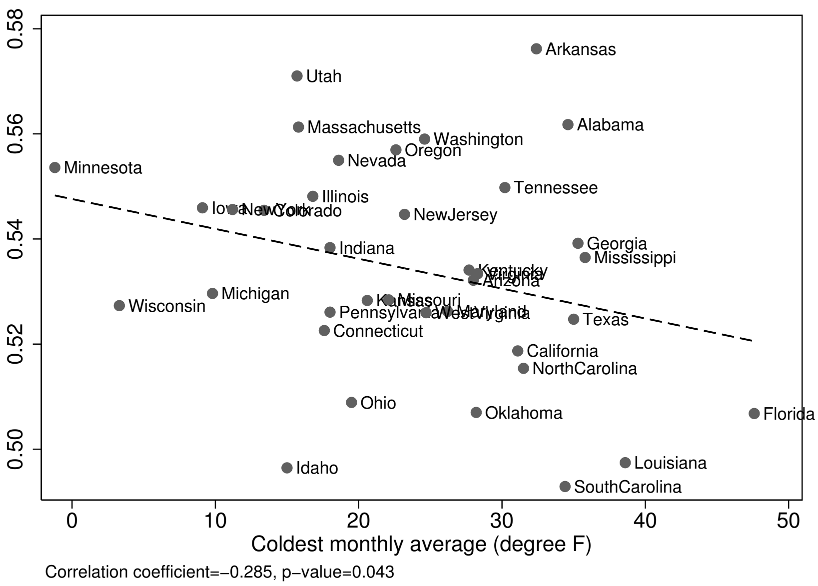


Figure 6: Temperature and Good Season (40-45)

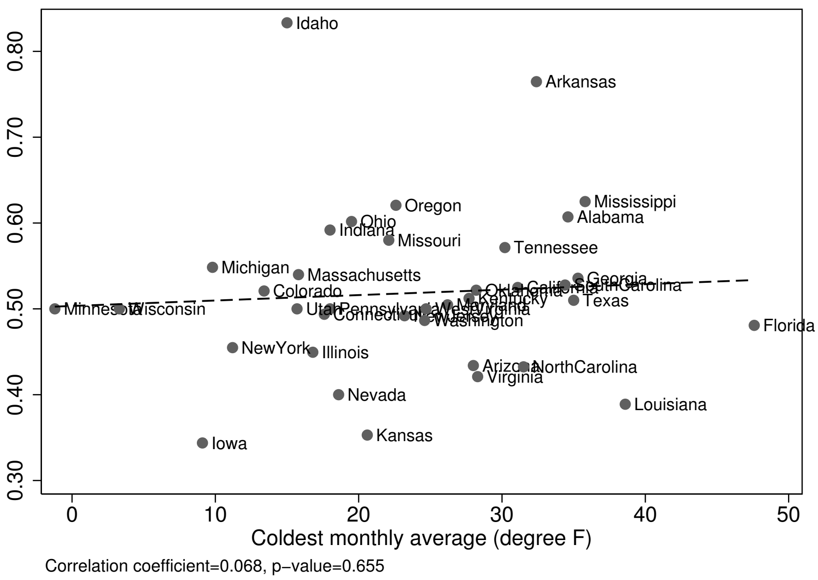
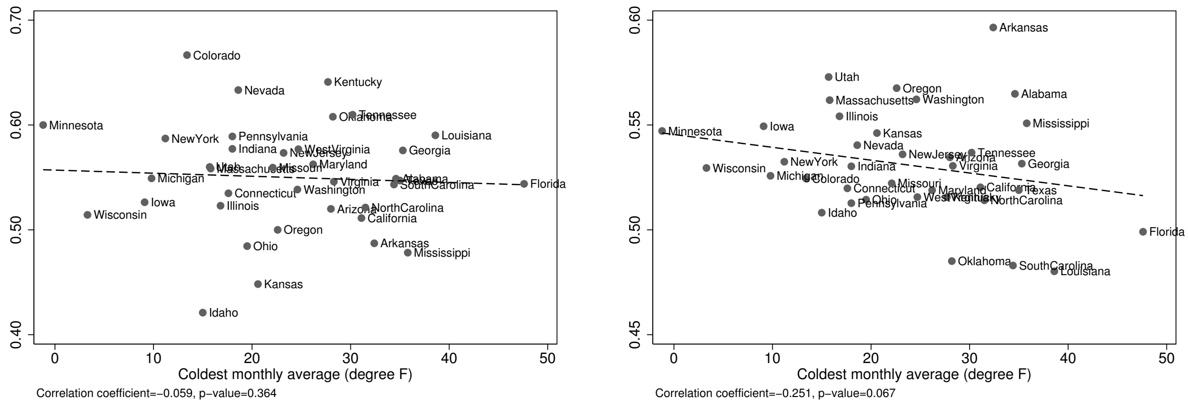


Figure 7: Temperature and Good Season (28-31 “Teachers” vs “Non-Teachers”)

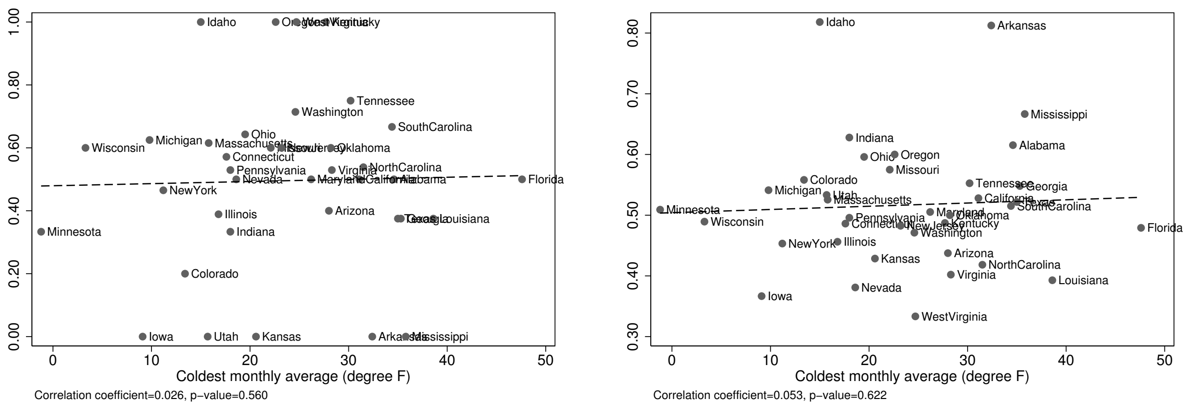


(a) “Teachers”

(b) “Non-Teachers”

Notes to figure: State averages of good season are plotted against the coldest average monthly temperature in the state. Panel A includes all workers who are in “Education, Training and Library”, while Panel B includes all other workers.

Figure 8: Temperature and Good Season (40-45 “Teachers” vs “Non-Teachers”)



(a) “Teachers”

(b) “Non-Teachers”

NOTES TO FIGURE: State averages of good season are plotted against the coldest average monthly temperature in the state. Panel A includes all workers who are in “Education, Training and Library”, while Panel B includes all other workers.

We now take this reasoning one step further, and claim that if mothers value good season of birth, then mothers in jobs other than “Education, Training, and Library” should receive a compensating wage differential, *ceteris paribus*. We investigate whether this is the case in the next section.

4 The Value of Season of Birth

4.1 Rosen’s model of equalizing differences

We borrow from Rosen’s (1986) model of equalizing differences to investigate whether mothers in jobs different from “Education, Training, and Library” (“non-teachers”) are paid a compensating wage differential, *ceteris paribus*. Suppose a woman can choose between two types of jobs: teacher $D = 0$ or non-teacher $D = 1$. Non-teachers are paid w_1, and teachers w_0. Assume her preferences can be represented by the following utility function

$$U(C, D).$$

We assume that, *ceteris paribus*, a teacher job is preferred to a non-teacher job

$$U(C, 0) \geq U(C, 1).$$

How much income (or consumption) must the woman be compensated with to undertake the less preferred job?

Let C_0 be the consumption when $D = 0$, and define $\widetilde{C}$ as the consumption level required to achieve the same utility in a non-teacher job

$$U(\widetilde{C}, 1) = U(C_0, 0)$$

Hence, $\widetilde{C} \geq C_0$.

Let $\Delta w = w_1 - w_0$ be the market equalizing difference: the non-teacher job offers Δw units of consumption for worse "working" conditions: *the implicit price of all the amenities of a teacher job.*

The woman chooses the non-teacher job ($D = 1$) if and only if

$$U(\Delta w + C_0, 1) > U(C_0, 0) = u(\widetilde{C}, 1) = u(C_0 + z, 1)$$

where $z = \widetilde{C} - C_0$ is the compensating variation.

Thus, she chooses the non-teacher job if and only if

$$\Delta w > z.$$

In practice, we can estimate

$$w = \alpha + \beta D + \gamma X + \epsilon \quad (1)$$

where X is a vector of control variables (age, education, year and state fixed effects), and β is *the average implicit price of all the amenities of a teacher job for all women*, those who are mothers and those who are not. However, if being able to plan season of birth is valuable, the implicit price of the amenities of a teacher job will be *higher* for mothers than for non-mothers. This price can be recovered estimating

$$w = \alpha + \beta D + \pi M + \delta(D \times M) + \gamma X + \epsilon \quad (2)$$

where $M = 1$ if the woman is a mother (= 0 otherwise), so that δ is *the average implicit price of all the amenities of a teacher job for mothers*: the price *mothers* are willing to pay for having the amenities of a teacher job, including the possibility to fully enjoy the good season of birth.

4.2 Estimating the Value of Season of Birth

In Table 8 we estimate equation (2) using the ACS data (2005-2014) by regressing annual log(earnings) or annual earnings on a mother indicator (whether the woman has at least one child), a non-"Education, Training, and Library" (non-teacher) occupation indicator, and the interaction between these two variables, which should measure the (average) compensating wage differential, controlling for age, age squared, a college indicator, usual weekly hours of work, and year and state fixed effects.[30] The results confirm the well-known motherhood earnings penalty in the labor market (e.g., Waldfogel, 1998), which we estimate

[30] Since 2008 it is no longer possible to properly compute the hourly wage in the ACS data, given that the variable number of weeks worked is no longer available (only a bracketed version of it). We believe that annual earnings is the most appropriate measure here.

to be around 16% of annual earnings for women aged 25-45 or 14% for women aged 35-45. In addition, we find a "non-teacher" occupation earnings premium of about 12% for women aged 25-45 or 13% for women aged 35-45. However, the most interesting and novel finding is that *mothers* who are in *non-teacher* occupations earn about 12%-16% higher annual earnings (or USD 1,300-1,600 per year), which captures the compensating wage differential for *all* the bundle of disamenities that characterize a "non-teacher" occupation from a mother's point of view.

Table 8: Earnings regressions

	All		≥ 35 Years	
	(1) log(Earnings)	(2) Earnings	(3) log(Earnings)	(4) Earnings
Mother	-0.163***	-1304.978***	-0.137***	-289.992
	[0.005]	[132.143]	[0.009]	[251.257]
Non-Teacher	0.115***	9018.024***	0.125***	10821.904***
	[0.005]	[140.907]	[0.009]	[279.209]
Non-Teacher × Mother	0.119***	1322.979***	0.158***	1584.232***
	[0.006]	[159.051]	[0.009]	[291.897]
Age (years)	0.111***	4424.368***	0.031***	3069.843***
	[0.002]	[78.239]	[0.011]	[469.351]
Age^2 / 100	-0.132***	-5167.795***	-0.031**	-3505.082***
	[0.003]	[112.028]	[0.014]	[585.976]
Some College +	0.487***	18107.290***	0.484***	20506.050***
	[0.002]	[68.220]	[0.003]	[93.932]
Observations	1249620	1249620	779581	779581
State and Year FE	Y	Y	Y	Y

NOTES: Main ACS estimation sample is used augmented with non-mothers and with mothers of more than one child (or older children). Teacher refers to occupational codes 2250-2500 (teachers, librarians and educational occupations). Earnings refer to earned income in the past 12 months, and are measured in dollars per year. Usual weekly hours of work are included as a control variable. Heteroscedasticity robust standard errors are reported in parentheses. ***p-value<0.01, **p-value<0.05, *p-value<0.1.

What is then the value of "good season" of birth? If mothers care *only* about season of birth when making their occupational choice, USD 1,322.79 per year provides an estimate of the annual value of the possibility to fully enjoy the good season of birth. If a woman works for 40 years, and future annual earnings are discounted at 5%, the present value of the possibility to fully enjoy the good season of birth ($PVSOB$) is

$$PVSOB = 1322.979 \times \frac{(1-(1+0.05)^{-40})}{0.05} = 22,701.111 \quad (3)$$

However, becoming a teacher does not guarantee that the woman will achieve the good season of birth with certainty, it only increases the likelihood by 2 percentage points (pp). Hence, a back-of-the-envelope calculation suggests that the present life-time value of the good season of birth is about USD 1 million (USD 22,701.111/0.02 = 1,135,055.55). Of course, if mothers care about *other* job amenities (not just season of birth), our estimate provides an *upper bound* to the value of season of birth.[31] Finally, if season of birth does not have any value, and the other amenities are certain, the value of those amenities is simply USD 22,701.111. However, there are reasons to believe that good season of birth is valuable, if only because of its potential positive effects on birth outcomes.

5 Season of Birth and Birth Outcomes

In this section, we assess some of the *direct* benefits of good season of birth, namely, its effects on birth outcomes. Panel A of Table 9 shows that babies born in the "good season" tend to have better outcomes at birth: they are 10.3 grams heavier, 0.2 percentage points less likely to be low birth weight (<2500 g), 0.1 percentage points less likely to be very low birth weight (<1500 g), they have 0.029 additional weeks of gestation and they are 0.1 percentage points less likely to be premature.[32]

Of course, such a naive comparison of average birth outcomes by season of birth is unlikely to reveal the average causal effect of good season of birth on birth outcomes.

[31]If women choosing "teacher" jobs are those with a higher preference for the "teacher" amenities, our estimate will be also an upper bound.

[32]We use *expected* rather than *actual* season of birth, but results are virtually the same using both definitions. Results available upon request.

Table 9: Birth Outcomes and Season of Birth

	(1) Birthweight	(2) LBW	(3) VLBW	(4) Gestation	(5) Premature	(6) APGAR
Panel A: without controls						
Good Season	10.285***	-0.002***	-0.001***	0.029***	-0.001***	0.001
	[0.873]	[0.000]	[0.000]	[0.004]	[0.000]	[0.001]
Constant	3348.640***	0.053***	0.008***	39.001***	0.082***	8.773***
	[1.261]	[0.001]	[0.000]	[0.005]	[0.001]	[0.002]
Panel B: with controls						
Good Season	9.122***	-0.002***	-0.001***	0.024***	-0.001	-0.000
	[0.868]	[0.000]	[0.000]	[0.003]	[0.000]	[0.001]
Mother's Age (years)	10.640***	-0.003***	-0.001***	0.071***	-0.006***	0.009***
	[1.501]	[0.001]	[0.000]	[0.006]	[0.001]	[0.002]
Mother's Age^2 / 100	-26.481***	0.009***	0.002***	-0.161***	0.013***	-0.020***
	[2.360]	[0.001]	[0.000]	[0.010]	[0.001]	[0.004]
Some College +	48.028***	-0.015***	-0.004***	0.159***	-0.015***	0.029***
	[1.746]	[0.001]	[0.000]	[0.007]	[0.001]	[0.003]
Smoked in Pregnancy	-175.899***	0.047***	0.006***	-0.202***	0.024***	-0.019***
	[2.869]	[0.001]	[0.001]	[0.013]	[0.002]	[0.005]
Received WIC food in Pregnancy	-39.248***	0.011***	0.001***	-0.053***	0.010***	-0.031***
	[1.808]	[0.001]	[0.000]	[0.008]	[0.001]	[0.003]
Pre-pregnancy Underweight (BMI $<$ 18.5)	-120.732***	0.020***	0.001***	-0.133***	0.009***	0.011***
	[2.478]	[0.001]	[0.000]	[0.011]	[0.001]	[0.004]
Pre-pregnancy Overweight (25 $\leq$ BMI $<$ 30)	63.700***	-0.000	0.002***	-0.061***	0.006***	-0.025***
	[1.065]	[0.000]	[0.000]	[0.004]	[0.001]	[0.002]
Pre-pregnancy Obese (BMI $\geq$ 30)	65.131***	0.011***	0.006***	-0.196***	0.022***	-0.066***
	[1.370]	[0.001]	[0.000]	[0.006]	[0.001]	[0.002]
ART	-66.307***	0.028***	0.007***	-0.430***	0.049***	-0.029***
	[4.353]	[0.002]	[0.001]	[0.019]	[0.002]	[0.006]
Observations	1456384	1456384	1456384	1459040	1459040	1453117
State and Year FE	Y	Y	Y	Y	Y	Y

NOTES: Main estimation sample is used. Heteroscedasticity robust standard errors are reported in parentheses. ***p-value<0.01, **p-value<0.05, *p-value<0.1.

Formally, if we compare the average birth outcome Y of first-born babies born in the good season ($D = 1$) with those born in the bad season ($D = 0$), and using the potential outcomes framework notation, we obtain

$$\begin{aligned} &E[Y|D=1] - E[Y|D=0] = E[Y(1)|D=1] - E[Y(0)|D=0] = \\ &\underbrace{E[Y(1)|D=1] - E[Y(0)|D=1]}_{\text{ATT}} + \underbrace{E[Y(0)|D=1] - E[Y(0)|D=0]}_{\text{SB}} \end{aligned} \tag{4}$$

where $Y(1)$ ($Y(0)$) is the potential birth outcome if the baby is born in the good (bad) season of birth; ATT is the *average treatment effect on the treated*—the average causal effect of good season of birth on birth outcomes of those born in the good season—and SB is the *selection bias*—the selection effect due to the fact that mothers who choose the good season of birth are likely to be *positively* selected (more educated, less likely to smoke during pregnancy, less likely to be on welfare, more likely to have a normal BMI).

Controlling for X (mother's age, education, smoking during pregnancy, received WIC food during pregnancy, pre-pregnancy BMI indicators and ART usage),

$$\begin{aligned} &E[Y|X,D=1] - E[Y|X,D=0] = E[Y(1)|X,D=1] - E[Y(0)|X,D=0] = \\ &\underbrace{E[Y(1)|X,D=1] - E[Y(0)|X,D=1]}_{\text{ATT(X)}} + \underbrace{E[Y(0)|X,D=1] - E[Y(0)|X,D=0]}_{\text{SB(X)}} \end{aligned} \tag{5}$$

should reduce the selection bias, so that $SB(X) \in [0, SB]$. Panel B in Table 9 shows that, controlling for a bundle of maternal characteristics, we can explain 11% of the good season advantage in average BW (the coefficient decreases from 10.285 in Panel A to 9.122 in Panel B) and 17% of that in average gestational length (the coefficient decreases from 0.029 to 0.024). Our results are consistent with the findings in Currie and Schwandt (2013), who show that—focusing on births occurring to the *same* mother—the seasonal patterns in birth weight and gestation are not entirely driven by the fact that women with different characteristics tend to give births at different times. In addition, our control variables exhibit the same features as in previous work. Highly-educated women tend to have babies with better outcomes at birth (Currie and Moretti, 2003). Moreover, women who smoke in pregnancy have babies who are 176 grams lighter, consistent with the findings in Lien and Evans (2005), who use an instrumental variable approach and find that maternal smoking reduces mean birth weight by 182 grams. Finally, the positive relationship between pre-pregnancy BMI and birth weight echoes the recent results by Yan (2015). It is worth noting that the good season of birth advantage in terms of average birth weight is substantial: Almond et al. (2011) estimate the impact of the Food Stamp Program in the US on participants' birth weight to be between 15 and 20 grams for whites.

6 Robustness checks

In the online appendix we examine a number of alternative specifications and samples to test the robustness of "good season" as a choice variable. The inclusion of state specific linear trends and unemployment rate at season of conception leads to essentially no changes in the estimated coefficients (see Table 4A in the online appendix).[33] Considering the additional sample of second births (see Table 5A in the online appendix) or including twins (see Table 6A in the online appendix) and running our main regressions of good season of birth on maternal characteristics, we find the same pattern of results and significance.

Considering only twin births (see Table 7A in the online appendix) leads to no seasonality patterns, only those born to mothers who were underweight before the pregnancy or those who used ART are less likely to be born in the good season. Controlling for household income (see Table 8A in the online appendix) or using wage income instead of earned income (see Table 9A in the online appendix) does not qualitatively affect our findings

[33]Unemployment data at the level of the state, year and month is created from the Bureau of Labor Statistics' (BLS) online monthly time series data. Full records are available at http://download.bls.gov/pub/time.series/la. These data come from the Local Area Unemployment Statistics (LAUS) Series, and are available for all states plus DC for the entire time period of interest.

by occupation and of value of good season. Finally, replicating our analysis by including unmarried mothers does not alter our seasonality patterns of results (all the main tables of the paper are replicated including unmarried women in section B of the online appendix).

7 Discussion

It is difficult to reconcile the above patterns with a story in which seasonality of births is only driven by "infectious disease" or any other correlate of it, since (a) influenza and infectious disease are prevalent throughout the entire US (`https://flunearyou.org`), while we document a very sharp gradient by temperature in season of birth, and (b) influenza affects mothers of all ages, and if anything will affect older mothers more severely, whereas we estimate that the prevalence of good season is correlated with weather only among "younger" mothers, not among "older" mothers. It seems that—beyond mothers' characteristics differing by season of birth (Buckles and Hungerman, 2013)—mothers who can respond, do respond to incentives: mothers in cold states have a much more acute sense of the cost of winter births, so are more likely to have summer births (if they can, i.e., *only* younger mothers).

Similarly, women who have labor market incentives time their birth: mothers in "education, training, and library" occupations are more likely to give birth in the good season of birth (Régnier-Loilier, 2010). What is even more remarkable, however, is the fact that the relationship between good season and weather *disappears* for babies born to mothers in "education, training, and library" occupations. This reveals that season of birth is a matter of choice and preferences, and not simply governed by biological mechanisms.

8 Conclusion

The role of season of birth on newborn and adult socioeconomic outcomes has been widely documented across disciplines, where a clear and consistent pattern of "good" and "bad" seasons has emerged. We document a series of novel stylized facts in the US which are consistent with season of birth being a choice variable above and beyond biological channels.

First, the prevalence of good season is non-monotonically (concavely) related to mother's age, positively related to her education, negatively to her smoking during pregnancy, the receipt of WIC food during pregnancy, and to being underweight or obese pre-pregnancy. Second, we find that women who did *not* use ART are 3 percentage points more likely to give birth in the good season. Third, we document that the prevalence of first births born in the spring or summer is higher in states with more severe cold weather in winter, but only among younger women. Fourth, in professions in which strong seasonality of work hours exists (such as teachers), mothers are more likely to choose good season of birth, whereas they do *not* respond to cold weather incentives. This last finding highlights the role of behavior and preferences above and beyond biological mechanisms.

We estimate an upper-bound to the life-time value of good season of birth of about USD 1,000,000. Finally, we show that those babies born in the good season tend to have better birth outcomes, controlling or not for mothers' characteristics, suggesting that good season of birth has a positive causal effect on birth outcomes. All in all, our evidence points to the fact that the *seasonal* timing of birth is a *valuable* choice with *health* benefits.

References

Alba, A. and J. Cáceres-Delpiano (2014): "Season of birth and mother and child characteristics : evidence from Spain and Chile," Economics Working Papers we1423, Universidad Carlos III, Departamento de Economía.

Almond, D., C. P. Chee, M. Sviatschi, and N. Zhong (2015): "Auspicious birth dates among Chinese in California," *Economics & Human Biology*, 18, 153–159.

Almond, D., H. W. Hoynes, and D. W. Schanzenbach (2011): "Inside the War on Poverty: The Impact of Food Stamps on Birth Outcomes," *Review of Economics and Statistics*, 93, 387–403.

Angrist, J. D. and A. B. Krueger (1991): "Does Compulsory School Attendance Affect Schooling and Earnings?" *Quarterly Journal of Economics*, 106, 979–1014.

Barreca, A., O. Deschenes, and M. Guldi (2015): "Maybe Next Month? Temperature Shocks, Climate Change, and Dynamic Adjustments in Birth Rates," NBER Working Papers 21681, National Bureau of Economic Research, Inc.

Bound, J., D. A. Jaeger, and R. M. Baker (1995): "Problems with instrumental variables estimation when the correlation between the instruments and the endogenous explanatory variable is weak," *Journal of the American Statistical Association*, 90, 443–450.

Buckles, K. S. and D. M. Hungerman (2013): "Season of Birth and Later Outcomes: Old Questions, New Answers," *Review of Economics & Statistics*, 95, 711–724.

CDC (1997): "Fertility, Family Planning, and Women's Health: New Data from the 1995 National Survey of Family Growth," Vital and Health Statistics Series 23, No 19, Centers for Disease Control and Prevention.

——— (2014): "The Flu Season," Last accessed: September 15, 2015.

Currie, J. and E. Moretti (2003): "Mother's Education and the Intergenerational Transmission of Human Capital: Evidence from College Openings," *Quarterly Journal of Economics*, 118, 1495–1532.

Currie, J. and H. Schwandt (2013): "Within-mother analysis of seasonal patterns in health at birth," *Proceedings of the National Academy of Sciences*, 110, 12265–12270.

Dehejia, R. and A. Lleras-Muney (2004): "Booms, Busts and Babies' Health," *Quarterly Journal of Economics*, 119, 1091–1130.

Dickert-Conlin, S. and A. Chandra (1999): "Taxes and the Timing of Birth," *Journal of Political Economy*, 107, 161–177.

Dickert-Conlin, S. and T. Elder (2010): "Suburban legend: School cutoff dates and the timing of births," *Economics of Education Review*, 29, 826–841.

Gans, J. S. and A. Leigh (2009): "Born on the first of July: An (un)natural experiment in birth timing," *Journal of Public Economics*, 93, 246–263.

Gans, J. S., A. Leigh, and E. Varganova (2007): "Minding the shop: The case of obstetrics conferences," *Social Science & Medicine*, 65, 1458–1465.

Goldin, C. (2014): "A Grand Gender Convergence: Its Last Chapter," *American Economic Review*, 104, 1091–1119.

Gould, J. B., C. Qin, A. R. Marks, and G. Chavez (2003): "Neonatal Mortality in Weekend vs Weekday Births," *Journal of the American Medical Association*, 289, 2958–62.

Huntington, E. (1938): *Season of Birth: Its Relation to Human Abilities*, New York: John Wiley & Sons, Inc.

Jones, L. E. and M. Tertilt (2008): "An Economic History of Fertility in the U.S.: 1826-1960," in *Frontiers of Family Economics*, ed. by P. Rupert, Emerald Press, vol. 1 of *Frontiers of Family Economics*, chap. 5.

LaLumia, S., J. M. Sallee, and N. Turner (2015): "New Evidence on Taxes and the Timing of Birth," *American Economic Journal: Economic Policy*, 7, 258–93.

Lam, D. A., J. Miron, and A. Riley (1994): "Modeling seasonality in fecundability, conceptions, and births," *Demography*, 31, 321–346.

Levitas, E., E. Lunenfeld, N. Weisz, M. Friger, and I. Har-Vardi (2013): "Seasonal variations of human sperm cells among 6455 semen samples: a plausible explanation of a seasonal birth pattern," *American Journal of Obstetrics and Gynecology*, 208, 406.e1–406.e6.

Lien, D. S. and W. N. Evans (2005): "Estimating the Impact of Large Cigarette Tax Hikes: The Case of Maternal Smoking and Infant Birth Weight," *Journal of Human Resources*, 40, 373–392.

Martin, J. A., B. E. Hamilton, M. J. Osterman, S. C. Curtin, and T. Mathews (2015): "Births: Final Data for 2013," National Vital Statistics Report Vol 64, No 1, National Vital Statistics, Division of Vital Statistics.

NCHS (2000): "Report of the Panel to Evaluate the U.S. Standard Certificates," Tech. rep., Division of Vital Statistics National Center for Health Statistics.

Raute, A. (2015): "Can financial incentives reduce the baby gap?- Evidence from a reform in maternity leave benefits," *University of Mannheim, mimeo.*

Régnier-Loilier, A. (2010): "La planification des naissances dans l'année : une réalité peu visible en France," *Population*, 65, 191–206.

Rindfuss, R., J. Ladinsky, E. Coppock, V. Marshall, and A. Macpherson (1979): "Convenience and the occurrence of births: induction of labor in the United States and Canada," *International Journal of Health Services*, 9, 439–460.

Rodgers, J. L. and J. Udry (1988): "The season-of-birth paradox," *Social Biology*, 35, 171–185.

Rosen, S. (1986): "The theory of equalizing differences," in *Handbook of Labor Economics*, ed. by O. Ashenfelter and R. Layard, Elsevier, vol. 1 of *Handbook of Labor Economics*, chap. 12, 641–692.

Rosenzweig, M. R. (1999): "Welfare, Marital Prospects, and Nonmarital Childbearing," *Journal of Political Economy*, 107, S3–S32.

Ruggles, S., K. Genadek, R. Goeken, J. Grover, and M. Sobek (2015): *Integrated Public Use Microdata Series: Version 6.0 [Machine-readable database]*, Minneapolis: University of Minnesota.

Shigeoka, H. (2015): "School Entry Cutoff Date and the Timing of Births," NBER Working Papers 21402, National Bureau of Economic Research, Inc.

Vose, R. S., S. Applequist, M. Squires, I. Durre, M. J. Menne, C. N. Williams, Jr., C. Feinmore, K. Gleason, and D. Arndt (2014): "Improved Historical Temperature and Precipitation Time Series for U.S. Climate Divisions," *Journal of Applied Meteorology & Climatology*, 53, 1232–1251.

Waldfogel, J. (1998): "Understanding the "Family Gap" in Pay for Women with Children," *Journal of Economic Perspectives*, 12, 137–156.

Yan, J. (2015): "Maternal pre-pregnancy BMI, gestational weight gain, and infant birth weight: A within-family analysis in the United States," *Economics & Human Biology*, 18, 1–12.

ONLINE APPENDIX

For the paper:

The Demand for Season of Birth

Damian Clarke, Sonia Oreffice and Climent Quintana-Domeque

Contents

A Robustness and Supplementary Results

A.1 Figures

Figure 1A: Mother's Age at First Birth

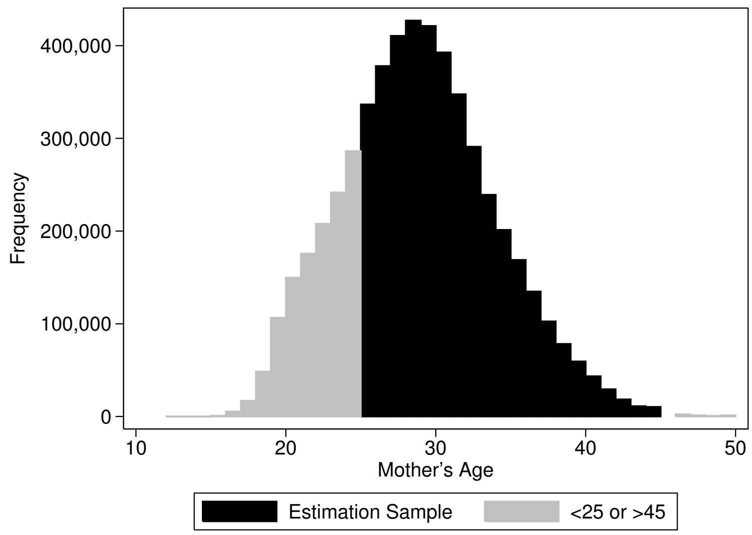
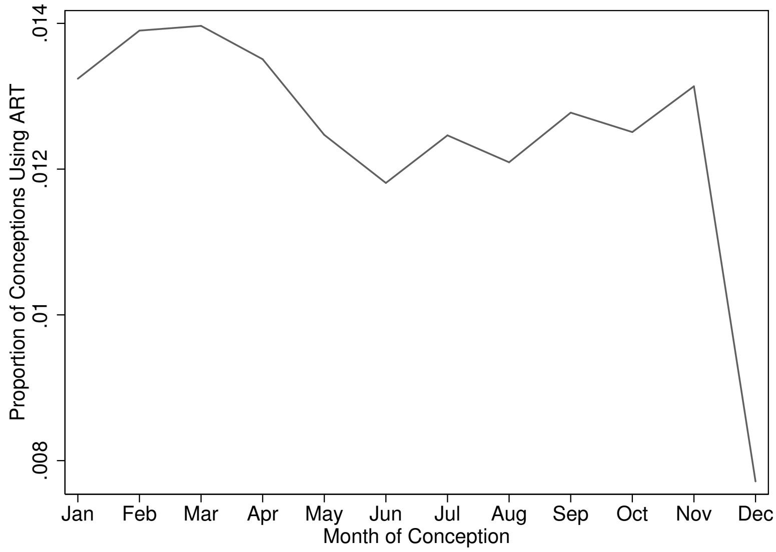


Figure 2A: ART Conceptions by Month



Notes to figure 2A: Proportion of ART births are calculated using data from 2009-2013 for our main sample. The proportion is calculated as: (ART conceptions)/(Non-ART Conceptions + ART Conceptions).

A.2 Tables

Table 1A: Season of Birth Correlates (excluding babies conceived in September)

	(1) Good Season	(2) Good Season	(3) Good Season	(4) Good Season	(5) Good Season
Mother's Age (years)	0.005***	0.004***	0.004***	0.004***	0.004**
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Mother's Age^2 / 100	-0.010***	-0.008***	-0.008***	-0.009***	-0.008***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Some College +			0.009***	0.008***	0.006***
			[0.001]	[0.002]	[0.002]
Smoked in Pregnancy			-0.012***	-0.013***	-0.010***
			[0.002]	[0.003]	[0.003]
Received WIC food in Pregnancy					-0.010***
					[0.002]
Pre-pregnancy Underweight (BMI $<$ 18.5)					-0.009***
					[0.003]
Pre-pregnancy Overweight (25 $\leq$ BMI $<$ 30)					0.000
					[0.001]
Pre-pregnancy Obese (BMI $\geq$ 30)					-0.004***
					[0.001]
Did not undergo ART					0.011***
					[0.004]
Observations	2063308	2063308	2063308	1331619	1331619
F-test of Age Variables	0.000	0.000	0.000	0.000	0.000
Optimal Age	27.68	26.06	24.22	24.42	23.22
State and Year FE		Y	Y	Y	Y
Gestation FE			Y	Y	Y
2009-2013 Only				Y	Y

NOTES: See Table 3 in the main text.

Table 2A: Descriptive Statistics (ACS 2005-2014)

	N	Mean	Std. Dev.	Min.	Max.
Mother's Age	77875	31.12	4.20	25	45
Married	77875	1.00	0.00	1	1
Young (aged 25-39)	77875	0.96	0.21	0	1
Aged 25-27	77875	0.22	0.41	0	1
Aged 28-31	77875	0.38	0.48	0	1
Aged 32-39	77875	0.37	0.48	0	1
Aged 40-45	77875	0.04	0.21	0	1
Some College +	77875	0.87	0.34	0	1
Years of education	77875	14.53	1.47	0	16
Good Season of Birth	77875	0.52	0.50	0	1

NOTES: We focus on White non-Hispanic married women aged 25-45 who are either head of the household or spouse of the head of the household, and have a first singleton child who is *at most* one year old. We exclude women who are in the military, in a farm household, or currently in school. We retain only women who had worked within the previous five years where each occupation must have at least 500 women over the entire range of survey years. Good season refers to children born in birth quarters 2 and 3 (Apr-Jun and Jul-Sept).

Table 3A: Percent of Births (ACS 2005-2014)

	Bad Season	Good Season	Diff.	Ratio
PANEL A: BY AGE				
20-24 Years Old	49.65	50.35	0.70	1.01
25-27 Years Old	48.26	51.74	3.48	1.07
28-31 Years Old	47.16	52.84	5.68	1.12
32-39 Years Old	48.07	51.93	3.86	1.08
40-45 Years Old	49.38	50.62	1.24	1.03
PANEL B: BY EDUCATION				
No College	48.98	51.02	2.04	1.04
Some College +	48.46	51.54	3.08	1.06

NOTES: Good season refers to birth quarters 2 and 3 (Apr-Jun and Jul-Sept). Bad season refers to quarters 1 and 4 (Jan-Mar and Oct-Dec).

Table 4A: Season of Birth Correlates (controlling for state-specific trends and unemployment rate)

	(1) Good Season	(2) Good Season	(3) Good Season	(4) Good Season	(5) Good Season	(6) Good Season
Mother's Age (years)	0.004***	0.004***	0.004***	0.004***	0.003**	0.003**
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Mother's Age^2 / 100	-0.009***	-0.009***	-0.009***	-0.009***	-0.007***	-0.007***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Some College +	0.008***	0.009***	0.009***	0.007***	0.005***	0.006***
	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]	[0.002]
Smoked in Pregnancy	-0.012***	-0.012***	-0.012***	-0.012***	-0.010***	-0.011***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Unemployment Rate		-0.009***	-0.009***	-0.150***	-0.150***	-0.178***
		[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Received WIC food in Pregnancy					-0.009***	-0.007***
					[0.002]	[0.002]
Pre-pregnancy Underweight (BMI $<$ 18.5)					-0.007***	-0.007***
					[0.002]	[0.002]
Pre-pregnancy Overweight ($25 \leq$ BMI $<$ 30)					0.000	0.001
					[0.001]	[0.001]
Pre-pregnancy Obese (BMI $\geq$ 30)					-0.004***	-0.004***
					[0.001]	[0.001]
Did not undergo ART					0.026***	0.026***
					[0.004]	[0.004]
Observations	2259553	2259553	2259553	1459040	1459040	1459040
F-test of Age Variables	0.000	0.000	0.000	0.000	0.000	0.000
Optimal Age	24.34	24.22	24.3	23.83	22.23	21.83
State and Year FE	Y	Y	Y	Y	Y	Y
Gestation FE	Y	Y	Y	Y	Y	Y
State Specific Linear Trends	Y		Y			Y
2009-2013 Only				Y	Y	Y

NOTES: See Table 3 in the main text.

Table 5A: Season of Birth Correlates (including second births)

	(1) Good Season	(2) Good Season	(3) Good Season	(4) Good Season	(5) Good Season
Mother's Age (years)	0.017***	0.016***	0.014***	0.013***	0.012***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Mother's Age^2 / 100	-0.027***	-0.026***	-0.023***	-0.022***	-0.020***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Some College +			0.009***	0.009***	0.006***
			[0.001]	[0.001]	[0.001]
Smoked in Pregnancy			-0.011***	-0.011***	-0.008***
			[0.002]	[0.002]	[0.002]
Received WIC food in Pregnancy					-0.011***
					[0.001]
Pre-pregnancy Underweight (BMI $<$ 18.5)					-0.009***
					[0.002]
Pre-pregnancy Overweight (25 $\leq$ BMI $<$ 30)					0.000
					[0.001]
Pre-pregnancy Obese (BMI $\geq$ 30)					-0.007***
					[0.001]
Did not undergo ART					0.023***
					[0.006]
Observations	2300265	2300265	2300265	1461963	1461963
F-test of Age Variables	0.000	0.000	0.000	0.000	0.000
Optimal Age	30.75	30.44	29.86	29.72	29.21
State and Year FE		Y	Y	Y	Y
Gestation FE			Y	Y	Y
2009-2013 Only				Y	Y

NOTES: See Table 3 in the main text.

Table 6A: Season of Birth Correlates (including twins)

	(1) Good Season	(2) Good Season	(3) Good Season	(4) Good Season	(5) Good Season
Mother's Age (years)	0.006***	0.005***	0.004***	0.004***	0.003**
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Mother's Age^2 / 100	-0.012***	-0.010***	-0.008***	-0.009***	-0.007***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Some College +			0.008***	0.007***	0.005***
			[0.001]	[0.002]	[0.002]
Smoked in Pregnancy			-0.011***	-0.012***	-0.010***
			[0.002]	[0.002]	[0.002]
Received WIC food in Pregnancy					-0.008***
					[0.002]
Pre-pregnancy Underweight (BMI $<$ 18.5)					-0.008***
					[0.002]
Pre-pregnancy Overweight (25 $\leq$ BMI $<$ 30)					0.001
					[0.001]
Pre-pregnancy Obese (BMI $\geq$ 30)					-0.004***
					[0.001]
Did not undergo ART					0.030***
					[0.003]
Observations	2341357	2341357	2341357	1509067	1509067
F-test of Age Variables	0.000	0.000	0.000	0.000	0.000
Optimal Age	26.47	24.9	23.53	23.94	22.35
State and Year FE		Y	Y	Y	Y
Gestation FE			Y	Y	Y
2009-2013 Only				Y	Y

NOTES: See Table 3 in the main text.

Table 7A: Season of Birth Correlates (only twins)

	(1) Good Season	(2) Good Season	(3) Good Season	(4) Good Season	(5) Good Season
Mother's Age (years)	-0.006	-0.006	-0.006	-0.006	-0.007
	[0.005]	[0.005]	[0.005]	[0.006]	[0.006]
Mother's Age^2 / 100	0.006	0.006	0.006	0.006	0.007
	[0.007]	[0.007]	[0.007]	[0.009]	[0.009]
Some College +			-0.003	0.008	0.005
			[0.007]	[0.009]	[0.009]
Smoked in Pregnancy			-0.000	-0.000	0.002
			[0.013]	[0.018]	[0.019]
Received WIC food in Pregnancy					-0.014
					[0.010]
Pre-pregnancy Underweight (BMI $<$ 18.5)					-0.046***
					[0.014]
Pre-pregnancy Overweight (25 $\leq$ BMI $<$ 30)					-0.004
					[0.005]
Pre-pregnancy Obese (BMI $\geq$ 30)					-0.008
					[0.006]
Did not undergo ART					0.023***
					[0.006]
Observations	81804	81804	81804	50027	50027
F-test of Age Variables	0.000	0.000	0.000	.001	.005
Optimal Age	47.68	47.32	46.79	48.77	44.71
State and Year FE		Y	Y	Y	Y
Gestation FE			Y	Y	Y
2009-2013 Only				Y	Y

NOTES: See Table 3 in the main text.

Table 8A: Season of Birth Correlates: Occupation (Income/Education Controls)

	(1) Good Season	(2) Good Season	(3) Good Season
Mother's Age	0.011*	0.011	0.012*
	[0.007]	[0.007]	[0.007]
Mother's Age^2 / 100	-0.019*	-0.019*	-0.019*
	[0.010]	[0.010]	[0.010]
log(household income)	-0.000	0.000	-0.000
	[0.004]	[0.004]	[0.004]
Some College +	0.008	0.005	0.005
	[0.007]	[0.008]	[0.008]
Architecture and Engineering		0.015	
		[0.023]	
Business Operations Specialists		0.018	
		[0.016]	
Community and Social Services		0.022	
		[0.017]	
Computer and Mathematical		0.029	
		[0.020]	
Education, Training, and Library		0.036***	
		[0.013]	
Financial Specialists		0.015	
		[0.016]	
Food Preparation and Serving		0.034*	
		[0.019]	
Healthcare Practitioners and Technical		0.024*	
		[0.013]	
Healthcare Support		-0.005	
		[0.019]	
Legal		0.000	
		[0.018]	
Life, Physical, and Social Science		0.012	
		[0.020]	
Management		0.025*	
		[0.014]	
Office and Administrative Support		0.023*	
		[0.013]	
Personal Care and Service		0.029*	
		[0.016]	
Production		0.008	
		[0.023]	
Sales		0.003	
		[0.014]	
Observations	74730	74730	74730
Occupation Codes (level)	-	2	3
F-test of Occupation Dummies	-	.054	0.000
F-test of Age Variables	0.033	0.05	0.048
State and Year FE	Y	Y	Y

NOTES: See Table 6 in the main text.

Table 9A: Earnings Regressions (Wage Income)

	All		$\geq$ 35 Years	
	(1) log(Wage Inc)	(2) Wage Income	(3) log(Wage Inc)	(4) Wage Income
Mother	-0.155***	-1164.001***	-0.129***	-120.955
	[0.005]	[131.983]	[0.009]	[251.037]
Non-Teacher	0.131***	9164.393***	0.146***	10989.129***
	[0.005]	[140.814]	[0.009]	[279.386]
Non-Teacher × Mother	0.127***	1491.639***	0.160***	1676.657***
	[0.006]	[158.873]	[0.009]	[292.040]
Age	0.113***	4455.884***	0.021*	2835.331***
	[0.002]	[78.330]	[0.011]	[471.218]
Age^2 / 100	-0.136***	-5217.164***	-0.020	-3225.813***
	[0.003]	[112.136]	[0.014]	[588.064]
Some College +	0.484***	18104.351***	0.478***	20435.844***
	[0.002]	[67.451]	[0.003]	[93.125]
Observations	1183287	1183287	733796	733796
State and Year FE	Y	Y	Y	Y

NOTES: Main ACS estimation sample is used augmented with non-mothers and with mothers of more than one child (or older children). Teacher refers to occupational codes 2250-2500 (teachers, librarians and educational occupations). Earnings refer to wage and salary income, and are measured in dollars per year. Usual weekly hours of work are included as a control variable. Heteroscedasticity robust standard errors are reported in parentheses. ***p-value$<$0.01, **p-value$<$0.05, *p-value$<$0.1.

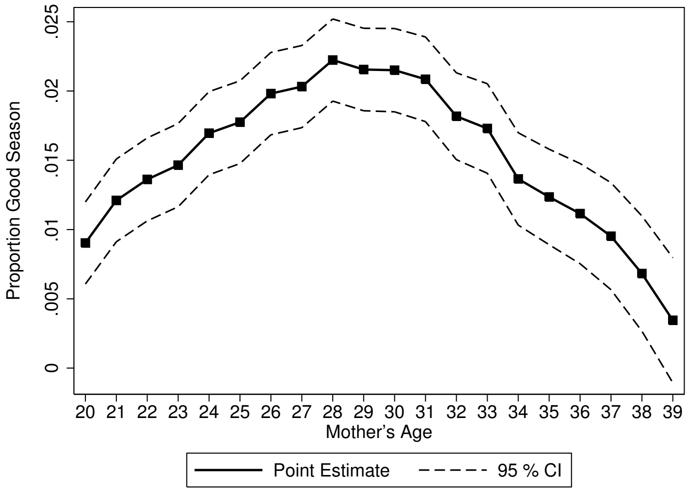
B Replicating Results Including Unmarried Women

Table 1B: Descriptive Statistics (NVSS 2005-2013)

	N	Mean	Std. Dev.	Min.	Max.
Panel A: Mother					
Mother's Age	2708385	30.14	4.00	25	45
Married	2708385	0.83	0.37	0	1
Young (aged 25-39)	2708385	0.97	0.16	0	1
Aged 25-27	2708385	0.30	0.46	0	1
Aged 28-31	2708385	0.38	0.48	0	1
Aged 32-39	2708385	0.29	0.45	0	1
Some College +	2708385	0.71	0.45	0	1
Years of education	2708385	15.35	1.75	4	17
Smoked during Pregnancy	2708385	0.07	0.25	0	1
Used ART[a]	1902841	0.01	0.11	0	1
Received WIC food in Pregnancy[a]	1887535	0.14	0.34	0	1
Pre-pregnancy BMI[a]	1793247	24.99	4.89	16	40
Pre-pregnancy Underweight (BMI < 18.5)[a]	1793247	0.03	0.17	0	1
Pre-pregnancy Normal Weight ($18.5 \leq$ BMI < 25)[a]	1793247	0.57	0.50	0	1
Pre-pregnancy Overweight ($25 \leq$ BMI < 30)[a]	1793247	0.24	0.43	0	1
Pre-pregnancy Obese (BMI ≥ 30)[a]	1793247	0.16	0.37	0	1
Panel B: Child					
Good season of birth (birth date)	2708385	0.52	0.50	0	1
Good season of birth (due date)	2706668	0.52	0.50	0	1
Female	2708385	0.49	0.50	0	1
Birthweight (grams)	2701381	3340.00	544.33	500	5000
Low Birth Weight (<2500 g)	2701381	0.06	0.23	0	1
Weeks of Gestation	2706668	38.99	2.24	17	47
Premature (< 37 weeks)	2706668	0.09	0.28	0	1
APGAR (1-10)	2693737	8.77	0.83	0	10

NOTES: Sample consists of all first-born, singleton children born to White, Non-Hispanic mothers aged 25-45 for whom education and smoking during pregnancy are available. Good season refers to birth quarters 2 and 3 (Apr-Jun and Jul-Sept). Bad season refers to quarters 1 and 4 (Jan-Mar and Oct-Dec). ART refers to the proportion of women who undertook assisted reproductive technologies that resulted in these births. [a] Only available from 2009.

Figure 1B: Prevalance of Good Season by Age



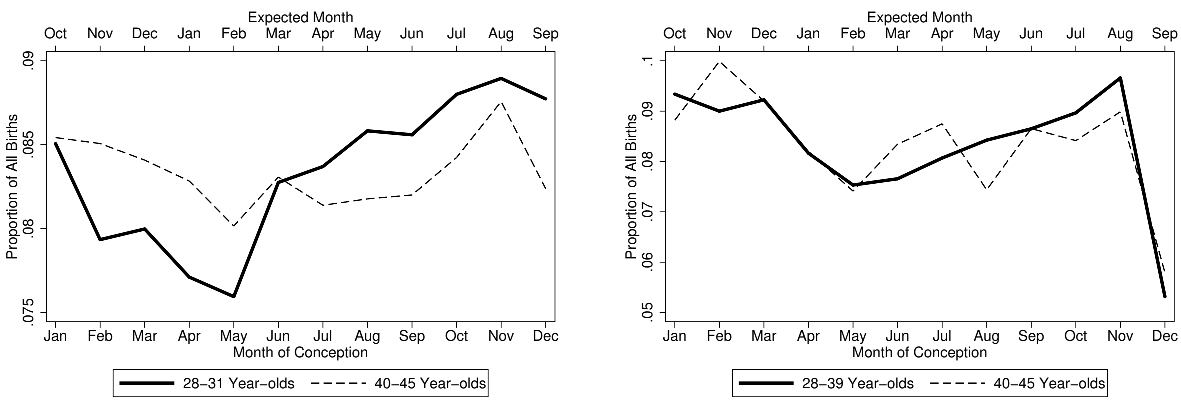
NOTES TO FIGURE 1B: Coefficients and standard errors are estimated by regressing "good season" on dummies of maternal age. Age groups 40-45 are omitted as the base group. The full sample consists of mothers aged 20-45. For the omitted group, proportion good season (and standard error) is 0.499(0.001).

Table 2B: Percent of Births

	Seasons				Characteristics	
	Bad Season	Good Season	Diff.	Ratio	<37 Gestation Weeks	ART
PANEL A: BY AGE						
20-24 Years Old	48.88	51.12	2.24	1.05	0.09	0.00
25-27 Years Old	48.27	51.73	3.46	1.07	0.08	0.00
28-31 Years Old	47.93	52.07	4.14	1.09	0.08	0.01
32-39 Years Old	48.78	51.22	2.44	1.05	0.10	0.02
40-45 Years Old	49.92	50.08	0.16	1.00	0.13	0.07
PANEL B: BY EDUCATION						
No College	49.35	50.65	1.30	1.03	0.10	0.00
Some College +	48.31	51.69	3.38	1.07	0.08	0.01

NOTES: Main estimation sample augmented with mothers aged 20-24.

Figure 2B: Birth Prevalence by Month, Age Group, and ART Usage



(a) Proportion of Conceptions in Each Month

(b) Proportion of Conceptions (ART Only)

Notes to figure 2B: Month of conception is calculated by subtracting the rounded number of gestation months (gestation in weeks $\times$ 7/30.5) from month of birth. Each line presents the proportion of all births conceived in each month for the relevant age group.

Table 3B: Season of Birth Correlates

	(1) Good Season	(2) Good Season	(3) Good Season	(4) Good Season	(5) Good Season
Mother's Age (years)	0.008***	0.007***	0.005***	0.006***	0.005***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Mother's Age^2 / 100	-0.014***	-0.013***	-0.009***	-0.011***	-0.009***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Some College +			0.007***	0.006***	0.005***
			[0.001]	[0.001]	[0.001]
Smoked in Pregnancy			-0.009***	-0.008***	-0.007***
			[0.001]	[0.002]	[0.002]
Married			0.008***	0.010***	0.009***
			[0.001]	[0.001]	[0.001]
Received WIC food in Pregnancy					-0.005***
					[0.001]
Pre-pregnancy Underweight (BMI $<$ 18.5)					-0.006***
					[0.002]
Pre-pregnancy Overweight (25 $\leq$ BMI $<$ 30)					0.000
					[0.001]
Pre-pregnancy Obese (BMI $\geq$ 30)					-0.004***
					[0.001]
Did not undergo ART					0.027***
					[0.004]
Observations	2706668	2706668	2706668	1756513	1756513
F-test of Age Variables	0.000	0.000	0.000	0.000	0.000
Optimal Age	28.67	27.96	25.58	26.16	25.54
State and Year FE		Y	Y	Y	Y
Gestation FE			Y	Y	Y
2009-2013 Only				Y	Y

NOTES: See Table 3 in the main text.

Table 4B: Season of Birth Correlates (Including Fetal Deaths)

	(1) Good Season	(2) Good Season	(3) Good Season	(4) Good Season
Mother's Age (years)	0.008***	0.007***	0.005***	0.005***
	[0.001]	[0.001]	[0.001]	[0.001]
Mother's Age^2 / 100	-0.014***	-0.013***	-0.010***	-0.010***
	[0.002]	[0.002]	[0.002]	[0.002]
Smoked in Pregnancy			-0.011***	-0.011***
			[0.001]	[0.001]
Married			0.010***	0.009***
			[0.001]	[0.001]
Observations	2719869	2719869	2719869	2719869
F-test of Age Variables	0.000	0.000	0.000	0.000
Optimal Age	28.64	27.93	26.3	26.23
State and Year FE		Y	Y	Y
Gestation FE				Y

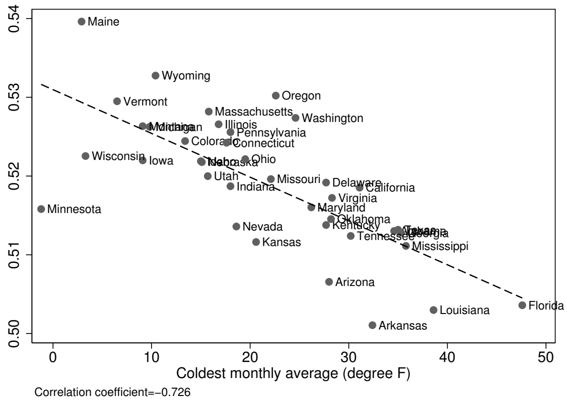
NOTES: See Table 4 in the main text.

Table 5B: Season of Birth Correlates: Very Young (20-24) and ART users

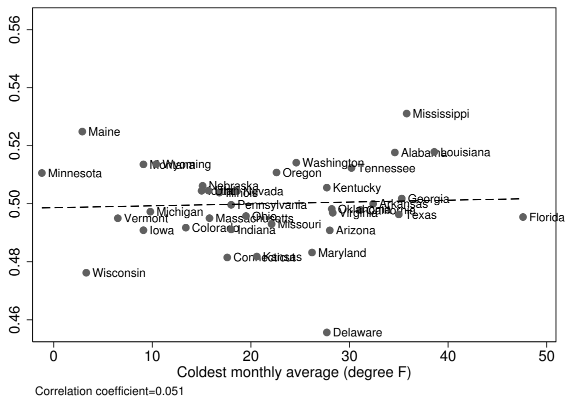
	(1) Good Season	(2) Good Season	(3) Good Season	(4) Good Season
Aged 20-24	-0.006***	-0.005***	-0.001*	0.003***
	[0.001]	[0.001]	[0.001]	[0.001]
Did not undergo ART	0.030***	0.032***	0.033***	0.034***
	[0.003]	[0.003]	[0.003]	[0.003]
Some College +			0.007***	0.005***
			[0.001]	[0.001]
Smoked in Pregnancy			-0.010***	-0.006***
			[0.001]	[0.001]
Received WIC food in Pregnancy				-0.005***
				[0.001]
Pre-pregnancy Underweight (BMI $<$ 18.5)				-0.005***
				[0.002]
Pre-pregnancy Overweight (25 $\leq$ BMI $<$ 30)				0.001
				[0.001]
Pre-pregnancy Obese (BMI $\geq$ 30)				-0.003***
				[0.001]
Married				0.008***
				[0.001]
Observations	2569651	2569651	2569651	2569651
State and Year FE		Y	Y	Y

NOTES: See Table 5 in the main text.

Figure 3B: Prevalence of Good Season and Cold Temperatures by State and Age



(a) Younger Mothers (28-31)



(b) Older Mothers (40-45)

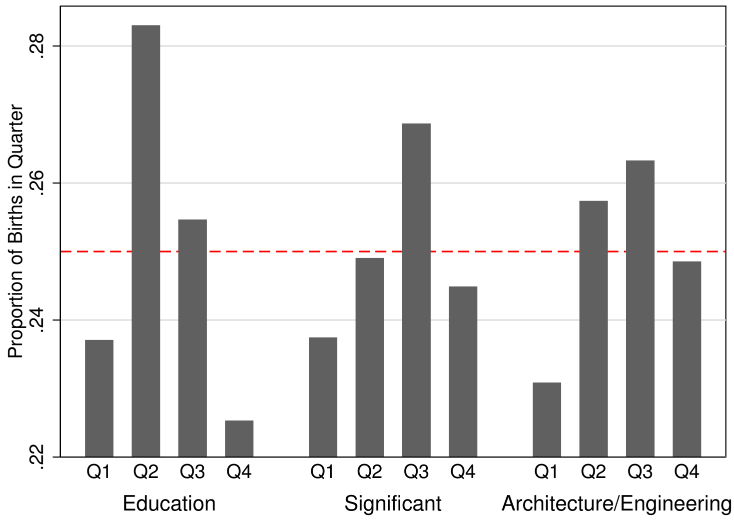
Notes to figure 3B: Each point represents a state average of the proportion of women giving birth in the good birth season between 2005 and 2013. The dotted line is a fitted regression line. Monthly temperature data is collected from the National Centers for Environmental Information.

Table 6B: Season of Birth Correlates: Occupation

	(1) Good Season	(2) Good Season	(3) Good Season
Mother's Age	0.009	0.009	0.009
	[0.006]	[0.006]	[0.006]
Mother's Age^2 / 100	-0.015	-0.015	-0.015
	[0.010]	[0.010]	[0.010]
Some College +	0.012*	0.008	0.008
	[0.006]	[0.007]	[0.007]
Architecture and Engineering		0.019	
		[0.022]	
Building and Grounds Cleaning and Maintenance		-0.008	
		[0.029]	
Business Operations Specialists		0.018	
		[0.015]	
Community and Social Services		0.016	
		[0.016]	
Computer and Mathematical		0.029	
		[0.019]	
Education, Training, and Library		0.032**	
		[0.013]	
Financial Specialists		0.011	
		[0.016]	
Food Preparation and Serving		0.023	
		[0.018]	
Healthcare Practitioners and Technical		0.020	
		[0.013]	
Healthcare Support		-0.000	
		[0.018]	
Legal		0.000	
		[0.017]	
Life, Physical, and Social Science		0.006	
		[0.019]	
Management		0.016	
		[0.013]	
Office and Administrative Support		0.021*	
		[0.013]	
Personal Care and Service		0.022	
		[0.016]	
Production		-0.002	
		[0.021]	
Protective Service		0.026	
		[0.030]	
Sales		0.005	
		[0.013]	
Transportation and Material Moving		-0.016	
		[0.028]	
Observations	83215	83215	83215
Occupation Codes (level)	-	2	3
F-test of Occupation Dummies	-	.259	0.000
F-test of Age Variables	0.038	0.071	0.085
State and Year FE	Y	Y	Y

NOTES: See Table 6 in the main text.

Figure 4B: Birth Prevalence by Quarter and Occupation



NOTES TO FIGURE 4B: Groups are defined as: (1) Education, Training, Library; (2) Occupations with statistically significant coefficients in Table 6B (Education, Training, Library; Food Preparation and Serving; Healthcare Practitioners and Technical; Management, Office and Administrative Support; Personal Care and Service); (3) the occupation with the least seasonality (Architecture and Engineering).

Table 7B: Season of Birth Correlates: "Teachers" vs. "Non-Teachers"

	(1) Good Season	(2) Good Season	(3) Good Season	(4) Good Season	(5) Good Season
Teacher	0.019***	0.019***		0.018***	0.017***
	[0.006]	[0.006]		[0.006]	[0.006]
Some College +			0.011**	0.008	0.008
			[0.005]	[0.005]	[0.005]
Mother's Age					0.010
					[0.007]
Mother's Age^2 / 100					-0.016
					[0.012]
Observations	83215	83215	83215	83215	83215
F-test of Age Variables					0.182
Optimal Age					30.02
State and Year FE		Y	Y	Y	Y

NOTES: See Table 7 in the main text.

Figure 5B: Temperature and Good Season (28-31)

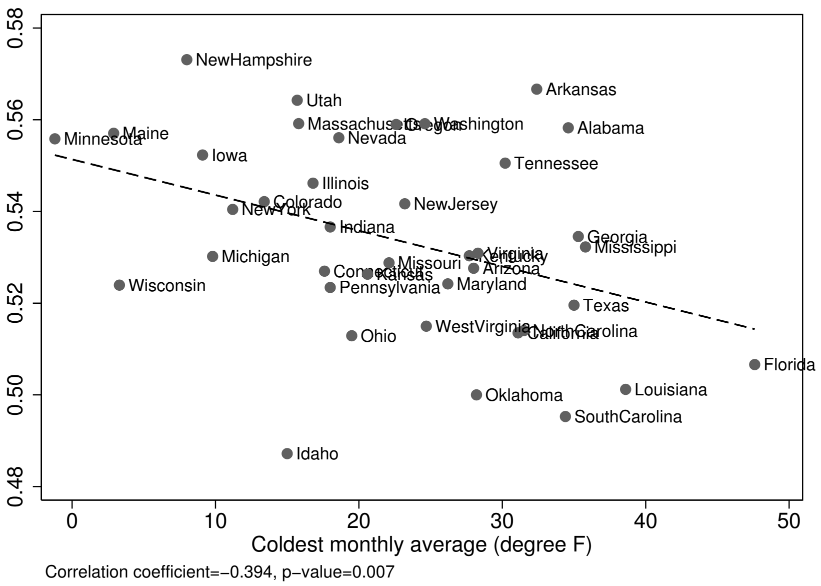


Figure 6B: Temperature and Good Season (40-45)

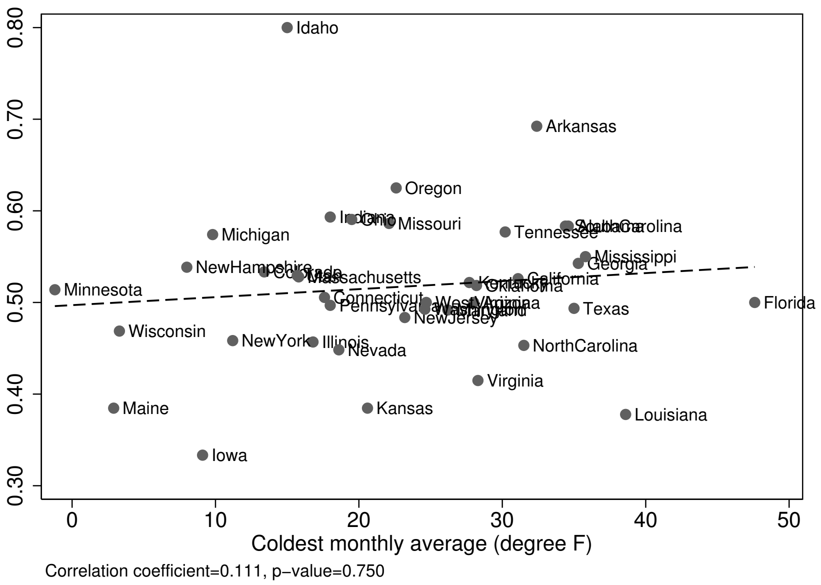
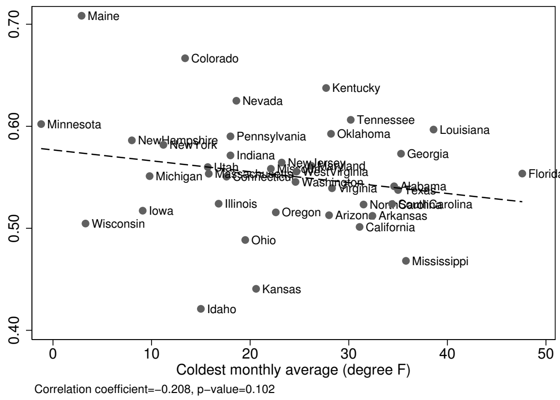
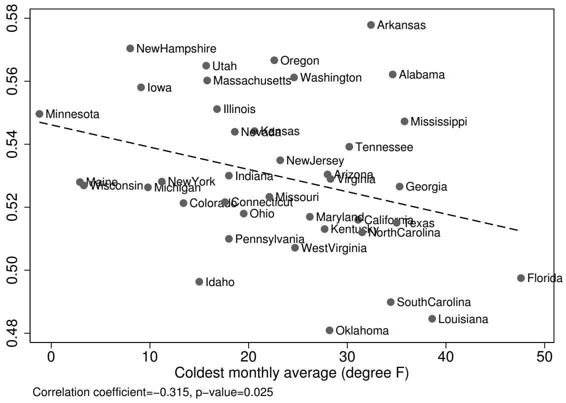


Figure 7B: Temperature and Good Season (28-31 "Teachers" vs "Non-Teachers")



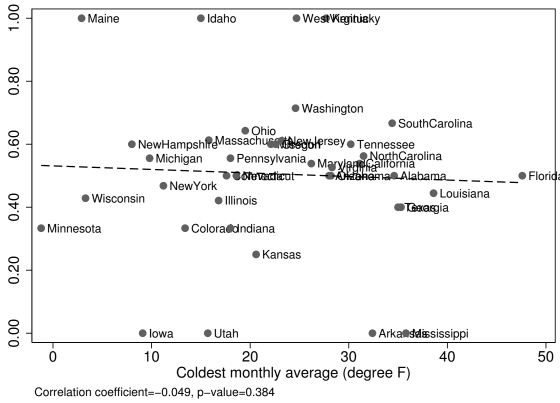
(a) "Teachers"



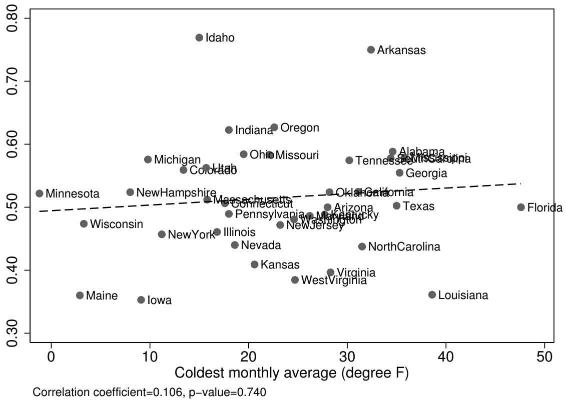
(b) "Non-Teachers"

Notes to figure: State averages of good season are plotted against the coldest average monthly temperature in the state. Panel A includes all workers who are in "Education, Training and Library Occupations", while Panel B includes all other workers.

Figure 8B: Temperature and Good Season (40-45 "Teachers" vs "Non-Teachers")



(a) "Teachers"



(b) "Non-Teachers"

Notes to figure: State averages of good season are plotted against the coldest average monthly temperature in the state. Panel A includes all workers who are in "Education, Training and Library Occupations", while Panel B includes all other workers.

Table 8B: Earnings regressions

	All		≥ 35 Years	
	(1) log(Earnings)	(2) Earnings	(3) log(Earnings)	(4) Earnings
Mother	-0.172***	-1926.469***	-0.169***	-1450.205***
	[0.004]	[108.887]	[0.006]	[210.959]
Non-Teacher	0.086***	8198.192***	0.076***	9836.166***
	[0.003]	[106.564]	[0.006]	[224.886]
Non-Teacher × Mother	0.115***	845.596***	0.175***	1289.676***
	[0.004]	[125.742]	[0.007]	[238.493]
Age	0.108***	4394.408***	0.027***	2536.997***
	[0.002]	[62.512]	[0.010]	[397.020]
Age^2 / 100	-0.127***	-5063.472***	-0.025**	-2771.692***
	[0.003]	[89.983]	[0.012]	[495.626]
Some College +	0.483***	17531.117***	0.485***	20279.217***
	[0.002]	[54.608]	[0.002]	[78.332]
Observations	1828498	1828498	1080326	1080326
State and Year Fixed Effects	Y	Y	Y	Y

NOTES: See Table 8 in the main text.

Table 9B: Birth Outcomes and Season of Birth

	(1) Birthweight	(2) LBW	(3) VLBW	(4) Gestation	(5) Premature	(6) APGAR
Panel A: without controls						
Good Season	10.025***	-0.002***	-0.001***	0.034***	-0.002***	0.002*
	[0.807]	[0.000]	[0.000]	[0.003]	[0.000]	[0.001]
Constant	3337.003***	0.057***	0.008***	38.976***	0.086***	8.767***
	[1.170]	[0.001]	[0.000]	[0.005]	[0.001]	[0.002]
Panel B: with controls						
Good Season	8.282***	-0.002***	-0.001***	0.028***	-0.001***	0.001
	[0.800]	[0.000]	[0.000]	[0.003]	[0.000]	[0.001]
Mother's Age (years)	8.666***	-0.002***	-0.001***	0.058***	-0.004***	0.007***
	[1.355]	[0.001]	[0.000]	[0.006]	[0.001]	[0.002]
Mother's Age^2 / 100	-23.897***	0.007***	0.002***	-0.142***	0.012***	-0.017***
	[2.130]	[0.001]	[0.000]	[0.009]	[0.001]	[0.003]
Some College +	54.284***	-0.017***	-0.004***	0.164***	-0.017***	0.031***
	[1.426]	[0.001]	[0.000]	[0.006]	[0.001]	[0.002]
Smoked in Pregnancy	-178.956***	0.049***	0.005***	-0.195***	0.025***	-0.016***
	[1.967]	[0.001]	[0.000]	[0.009]	[0.001]	[0.003]
Received WIC food in Pregnancy	-34.770***	0.009***	-0.000	-0.005	0.005***	-0.020***
	[1.398]	[0.001]	[0.000]	[0.006]	[0.001]	[0.002]
Pre-pregnancy Underweight (BMI $<$ 18.5)	-121.878***	0.024***	0.001***	-0.140***	0.010***	0.007**
	[2.239]	[0.001]	[0.000]	[0.010]	[0.001]	[0.004]
Pre-pregnancy Overweight ($25 \leq$ BMI < 30)	62.616***	-0.001**	0.002***	-0.062***	0.006***	-0.026***
	[0.980]	[0.000]	[0.000]	[0.004]	[0.000]	[0.001]
Pre-pregnancy Obese (BMI $\geq$ 30)	67.004***	0.009***	0.006***	-0.191***	0.020***	-0.067***
	[1.234]	[0.001]	[0.000]	[0.005]	[0.001]	[0.002]
ART	-59.020***	0.025***	0.006***	-0.399***	0.046***	-0.024***
	[4.196]	[0.002]	[0.001]	[0.019]	[0.002]	[0.006]
Married	30.076***	-0.010***	-0.003***	0.101***	-0.014***	0.019***
	[1.249]	[0.001]	[0.000]	[0.005]	[0.001]	[0.002]
Observations	1753083	1753083	1753083	1756513	1756513	1749459
State and Year FE	Y	Y	Y	Y	Y	Y

NOTES: See Table 8 in the main text.