NBER WORKING PAPER SERIES

SEASON OF BIRTH AND LATER OUTCOMES: OLD QUESTIONS, NEW ANSWERS

Kasey Buckles
Daniel M. Hungerman

Working Paper 14573
http://www.nber.org/papers/w14573

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
December 2008

Thanks to Doug Almond, Josh Angrist, Amitabh Chandra, Bill Evans, Alan Krueger, Joanna Lahey, Joe Price, David Ribar, and David Shapiro, and to audiences at the Bureau of Labor Statistics, Drexel University, Indiana University Purdue University Indianapolis, Notre Dame, the University of Chicago Graduate School of Business, the University of Wisconsin-Milwaukee, the University of Western Michigan, the Southern Economic Association, the Midwest Economic Association, and the Population Association of America. Kevin Baker and Ann Walter provided terrific research assistance. Contact the authors at kbuckles@nd.edu and dhungerm@nd.edu. The views expressed herein are those of the author(s) and do not necessarily reflect the views of the National Bureau of Economic Research.

Season of Birth and Later Outcomes: Old Questions, New Answers
Kasey Buckles and Daniel M. Hungerman
NBER Working Paper No. 14573
December 2008
JEL No. C10,J11,J13

ABSTRACT

Research has found that season of birth is associated with later health and professional outcomes; what drives this association remains unclear. In this paper we consider a new explanation: that children born at different times in the year are conceived by women with different socioeconomic characteristics. We document large seasonal changes in the characteristics of women giving birth throughout the year in the United States. Children born in the winter are disproportionally born to women who are more likely to be teenagers and less likely to be married or have a high school degree. We show that controls for family background characteristics can explain up to half of the relationship between season of birth and adult outcomes. We then discuss the implications of this result for using season of birth as an instrumental variable; our findings suggest that, though popular, season-of-birth instruments may produce inconsistent estimates. Finally, we find that some of the seasonality in maternal characteristics is due to summer weather differentially affecting fertility patterns across socioeconomic groups.

Kasey Buckles
Department of Economics
University of Notre Dame
436 Flanner Hall
Notre Dame, IN 46556
kbuckles@nd.edu

Daniel M. Hungerman
Department of Economics
University of Notre Dame
439 Flanner Hall
Notre Dame, IN 46556-5602
and NBER
dhungerm@nd.edu

Research across the social and natural sciences has consistently found that the month of a child's birth is associated with later outcomes involving health, educational attainment, earnings and mortality. Much of this work shows that on average individuals born in the winter have worse outcomes (less schooling, lower wages) than other individuals. What drives this association remains unclear. Some prior work has speculated that this association may be driven by social and natural factors (such as compulsory schooling laws, changes in temperature, or exposure to illness) that could affect children born in the winter in particular ways, but there is no consensus about the importance of these or other explanations.

Moreover, most work has explicitly dismissed the possibility that seasonality in outcomes might reflect inherent differences in personal attributes or family background. For example, Hoogerheide et al. (2007) write, "one's birthday is unlikely to be correlated with personal attributes other than age at school entry"; Kleibergen (2002) writes, "quarter of birth is randomly distributed over the population"; and in a survey on the returns to schooling literature, Card (1999) concludes that relationships between wages, education, and season of birth "are probably not caused by differences in family background." These claims are often made (or implicitly relied upon) in the large body of work using season of birth as an instrumental-variable.[1]

Yet despite the widespread use of season of birth as an instrumental variable and the assertion among researchers that family background is unrelated to season of birth, we know of no rigorous investigation of the relation between season of birth and family background. In this paper we undertake such an investigation. Using data from live birth certificates and the census, we first see whether the typical woman giving birth in the winter looks different from the typical woman giving birth at other times of year. We find that women giving birth in the winter look different from other women: they are younger, less educated, and less likely to be married.

These differences are large. For example, we find that the fraction of children born to women without a high school degree is about 10 percent higher (2 percentage points) in January than in May. By way of comparison, this 2-percentage-point-effect on the fraction of mothers without a high school degree is about ten times larger than the effect from a one-percentage-

[1] Papers using season of birth as an instrumental variable or arguing for its suitability as such include Angrist and Krueger (1991, 1992, 1995, 2001), Neal and Johnson (1996), Staiger and Stock (1997), Levin and Plug (1999), Gelbach (2002), Chamberlain and Imbens (2004), Honoré and Hu (2004), Skirbekk, Kohler, and Prskawetz (2004), Chesher (2005); Cruz and Moreira (2005), Imbens and Rosenbaum (2005), Chernozhukov and Hansen (2006), Lefgren and McIntyre (2006), Dufour and Taamouti (2007), and Leigh and Ryan (2008).

point increase in unemployment estimated by Dehejia and Lleras-Muney (2004). We also document a 10 percent decline in the fraction of children born to teenagers from January to May. This effect, which is observed every spring, is about as large as the decline in the annual fraction of children born to teenagers observed over the entire 1990s. We show similar seasonality in maternal characteristics using the 1960, 1970, and 1980 censuses.

We then see whether variation in family background characteristics can account for much of the difference in outcomes typically ascribed to season of birth. Our estimates from census data suggest that a parsimonious set of family background controls can significantly reduce differences in education and earnings between people born in different quarters of the year. Our controls generally reduce the magnitude of season of birth by 25 to 50 percent. Thus the well-known relationship between season of birth and later outcomes is largely driven by differences in fertility patterns across socioeconomic groups, and not merely natural phenomena or schooling laws that intervene after conception.

We then discuss the implications of this result for research using season of birth as an instrumental variable (IV). The fact that family background characteristics have strong relations with both season of birth and later outcomes indicates that season of birth will likely fail the exclusion restriction in most IV settings where it has been used. A key point is that season of birth will be related to unobservable phenomena in both the first stage and the structural equation of an IV regression; this complicates the relationship between the validity of the instrument and the bias in the estimates. Adding controls for family background to an IV estimation may lessen season-of-birth's correlation with unobservables, but this could lead to the asymptotic bias of the estimator staying the same or even increasing. We add controls for family background to IV estimates in a returns-to-schooling regression and find the results show sensitivity to the inclusion of family background controls, with the estimated returns to schooling increasing by 20 to 50 percent. However, our discussion highlights the fact that the true bias in the estimates could be large even if the estimates remained unchanged with the addition of these controls.

These findings build on past work critiquing the validity of season-of-birth as an instrument, such as Bound, Jaeger and Baker (1995). However, past work on the validity of this instrument has focused primarily on the instruments being "weak," and as mentioned above many researchers continue to argue that season of birth satisfies relevant exclusion restrictions. The findings here pose a potentially fatal challenge to such arguments. More importantly, this paper does not just critique work using season-of-birth as an instrument, but explores *why* outcomes vary by season of birth and in so doing documents a striking seasonal pattern in maternal characteristics that is important in its own right. Our findings also have implications for other work comparing cohorts of children born at certain times of year to those born at other times of year, such as work on school entry dates (e.g., Elder and Lubotsky, 2006; Dobkin and Ferreira, 2007), and tax-induced timing of births (Dickert-Conlin and Chandra, 1999). We discuss this more in the conclusions.

Given that the relationship between season of birth and later outcomes seems in part driven by fertility patterns among different groups of women, it is natural to ask what causes these different fertility patterns. We explore one possibility, which is that the fertility-decreasing effects of hot summer temperatures disproportionately affect low socio-economic populations. To test this, we document fertility patterns for married and unmarried women, and add controls for weather at conception. We find that including weather controls attenuates the dip in births to unmarried women in the spring (nine months after the peak of summer heat), but does not affect fertility patterns for married women. This suggests that differences in exposure to extreme temperatures can account for some of the relationship between season of birth and family background.

The remainder of the paper is organized as follows. Section I provides some background on season of birth and later outcomes. Section II examines season of birth and mothers' characteristics using birth certificate and census data. Section III looks at how family background controls can explain season of birth's relation to later outcomes. Section IV examines using season of birth as an instrumental variable, and Section V explores causes for seasonality in maternal characteristics. Section VI concludes.

I. Season of Birth and Later Outcomes

Economists have long recognized that the month of a child's birth is associated with later outcomes such as test performance, wages, and educational attainment.[2] These studies overwhelmingly show that children born in the winter months (or in the first quarter of the year)

[2] Examples include Angrist and Krueger (1991 and 1992); Bound, Jaeger and Baker (1995); Staiger and Stock (1997); Bound and Jaeger (2000); Donald and Newey (2001); Plug (2001); Kleibergen (2002); Chamberlain and Imbens (2004); Honoré and Hu (2004); Cruz and Moreira (2005); Cascio and Lewis (2006); Chernozhukov and Hansen (2006); Chesher (2007); Dufour and Taamouti (2007); Hoogerheide, Kleibergen, and van Dijk (2007).

have relatively low educational attainment, wages, and (using metrics such as Armed Forces Qualification Test scores) intellectual ability.

Similarly, a large body of research outside of economics has proven that season of birth is associated with health outcomes such as developing schizophrenia (Watson et al., 1984; Torrey et al., 1997; Davies et al., 2003; and Tochigi et al., 2004), autism (Gillberg, 1990), dyslexia (Livingston et al., 1993), severity of menopausal symptoms (Cagnacci et al., 2006), extreme shyness (Gortmaker et al., 1997), risk for suicide (Rock et al., 2006) and life expectancy among the elderly (Costa and Lahey, 2005; and Doblhammer et al., 2005). Research has even suggested an association between season of birth and self-reported "luckiness" (Chotai and Wiseman, 2005) and season of birth and the likelihood of being left-handed (Martin and Jones, 1999). Many (but not all) of these studies find that children born in winter months have worse outcomes than other children.[3]

It remains unclear why these seasonal relationships exist. Prior explanations involve social and natural phenomena that intervene after conception or birth to create differences in outcomes. This type of explanation was notably considered by Angrist and Krueger (1991), who posit that compulsory schooling laws intervene to create different outcomes for children. Since children born in the winter are likely to be older when they begin school, they will have attained less schooling on average than other children when they reach an age where they can legally drop out. Angrist and Krueger argue that season of birth can therefore be used as an instrumental variable to study the long-term impacts of compulsory schooling on wages.

Researchers have cast doubts on Angrist and Krueger's assumption that these laws are the *only* reason schooling and wages change with season of birth. The best-known critique is by Bound, Jaeger and Baker (1995) (see also Bound and Jaeger, 2000), who question whether quarter-of-birth dummies are valid instruments. However, Bound, Jaeger and Baker admit that "we know of no indisputable evidence on the direct effect of quarter of birth on education or earnings." In this paper, we provide strong evidence regarding the relationship between quarter of birth and family background and we show that between-quarter correlations of the type they

[3] Some of these studies are international in focus. While a relationship between season of birth and later outcomes has been documented in other countries, they sometimes differ from those found in the U.S.; it is unclear what explains these differences (Rosenberg, 1966). For example, in Australia (an interesting case because its natural seasons are opposite of those in the U.S.), shyness (Gortmaker et al., 1997) and life expectancy (Doblhammer and Vaupel, 2001) exhibit the opposite pattern of the U.S. while results for education are the same (Leigh and Ryan, 2008). As in most prior work, our focus is on the U.S. case.

briefly investigate mask much larger within-quarter correlations. Furthermore, the great majority of work building on their paper has focused on the concern they raise over weak instruments; our evidence suggesting that the instrument is invalid is of potentially greater consequence.

Most importantly, our paper goes beyond past critiques of season-of-birth by rigorously considering *why* quarter of birth is related to later outcomes. A relatively small amount of work has considered this topic. In addition to the compulsory schooling explanation, researchers have pointed out that phenomena such as in-utero exposure to weather (Gortmaker et al., 1997) or illness (Sham et al., 1992; Suvisaari et al., 1999; Almond, 2006) may help to explain why winter births have worse outcomes. The "fetal origins hypothesis" (Barker, 2001) contends that nutrient deprivation at various stages of fetal development may be linked to adult diseases; if nutritional intake is seasonal, this could explain seasonal variation in health outcomes. Additionally, children born in the winter are likely to start school at an older age than other students, and this relative age difference may affect (for instance) their likelihood of being diagnosed with debilitating mental or physical conditions (Williams et al., 1970; Tarnowski et al., 1990; Plug, 2001).

There is little work establishing the practical importance of any of these explanations and none of these alternative explanations seriously consider the possibility that children born in the winter are different from other children at conception. Moreover, many researchers continue to assume that children conceived throughout the year are initially similar. We hypothesize that children born in different seasons are not initially similar but rather are conceived by different groups of women. It is certainly possible that this hypothesis would be a complement, rather than a substitute, to existing explanations of season of birth's impact on outcomes. We think that intervening phenomena such as schooling laws and exposure to influenza might help explain season of birth's association with later outcomes.

But evidence of this alternative explanation—for instance, evidence showing that children born in the winter are much more likely to be born to teenage mothers or unmarried mothers—would be important for at least two reasons. First, such evidence would help explain the widely-noted but poorly-understood relationship between outcomes and season of birth. Second, such evidence would present a serious challenge to the large amount of research assuming that season of birth is randomly distributed across the population. We know of no research using recent U.S. data and no research at all in economics which rigorously investigates the hypothesis that children conceived at different times of year are different.[4] In the next section we provide such an investigation.

II. Season of Birth and Mother's Characteristics

A. *Natality Detail Files*

In this section we document clear within-year patterns in the characteristics of women giving birth that are persistent throughout the second half of the twentieth century. We first use the Center for Disease Control's Natality Detail Files from 1989 to 2001, which contain data from all live birth certificates in the United States in each year. Below, we perform a similar analysis using decennial Census data for 1960, 1970, and 1980, representing births between 1944 and 1980.

In addition to the infant's month of birth, the Natality Detail Files provide information on a number of maternal characteristics, including marital status, age, race, and education. As of 1985, all states report 100% of their birth certificate data, representing over 99% of all births in the United States. We choose 1989 as a starting year because the standard birth certificate was substantially revised in this year. Marital status is first reported directly in 1989, though six states still impute marital status in this year. Only Michigan and New York still impute marital status in 2000, where a woman is considered to be unmarried if paternity acknowledgement was received or the father's name is missing. In 1989, 8.9% of birth certificates do not report mother's education; this number decreases to 1.4% by 2000.

Figure 1 depicts trends in the characteristics of mothers from month to month, for 1989 to 2001. There are approximately 52 million total births used in each picture. Panel A shows the percent of women giving birth each month during this period who are teenagers. Panel B shows the percent of mothers giving birth who are married, Panel C shows the percent of women giving birth who are white, and Panel D shows mothers' average years of education. All the panels

[4] There is a small and inconclusive body of research outside of economics which uses small-scale and/or international data to consider whether seasonality of conception differs for certain women. Warren and Tyler (1979) find that women living in certain census tracts in Fulton County, Georgia, have less seasonality in conception than other women. Pasamanick et al. (1960) look at births in Baltimore in the early 1950s and find that high-socioeconomic-status (SES) women have less seasonality in conception. Lam, Miron, and Riley (1994) find that white women in Georgia from 1968 to 1988 have less seasonality in births than nonwhite women. Kesterbaum (1987) uses census data to find that for births between 1977 and 1979 there is more seasonality for low SES women. In contrast, James (1971) examines births in Great Britain and Bobak and Gjonca (2001) look at seasonal conception in the Czech Republic and in both cases they find greater seasonality among higher-SES women. Mitchell et al. (1985) find that seasonal conception patterns varied by profession in nineteenth century Tasmania.

depict a clear seasonal pattern that is highly persistent across years. Children born in the winter are more likely to be born to a teenage mother, less likely to be born to a married mother, more likely to be born to a mother who is not white, and more likely to be born to a mother with less education.[5]

These seasonal trends are strikingly large. For instance, Panel A shows that the percent of women who are teenagers decreases by about one percentage point between May and January, about a 10 percent effect. By comparison, this is roughly equal to the decline in the *annual* percent of births to teenagers that occurred during the 1990s, which was driven by much-noted declines in the teen birth rate (Ventura, Curtin, and Mathews, 2000; Arias et al., 2003). The increase in percent unmarried between May and January seen in Panel B is about two percentage points on average, which is roughly the same size as the increase in nonmarital childbearing from a one standard deviation increase in monthly welfare benefits in Rosenzweig (1999). In Panel C, we see that the percent of mothers who are white is about two percentage points higher in May than in January; this effect is about 25 times larger than the increase in births to white mothers associated with a one-percentage-point increase in the unemployment rate (Dehejia and Lleras-Muney, 2004). Panel D shows an increase in mother's education of 0.15 years every spring; by way of comparison, Oreopoulos, Page, and Stevens (2006) estimate that increasing a state's compulsory schooling law from 8 to 9 years will typically cause a single parent's schooling to rise by between 0.075 and 0.235 years.

Figure 2 shows a similar pattern in the percent of mothers who have finished the twelfth grade. Here, we plot the data separately by race, to show that these patterns exist within racial groups. While the percent of nonwhite mothers with a high school degree is increasing over this period, both whites and nonwhites giving birth in May are more likely to have graduated high school relative to those giving birth in January. For each group we observe that the magnitude of this difference is about 2 percentage points. By way of comparison, this is almost ten times larger than the effect of a one-percentage-point increase in unemployment estimated by Dehejia and Lleras-Muney (2004).

One might wonder whether this result on high-school degree attainment is mechanically

[5] A few colleagues have questioned whether standard errors are needed in the figure since the birth certificate data represent virtually the entire population of births in the United States from 1989 to 2001. While the conceptual need for confidence intervals in the figure may be debatable, from a practical standpoint the confidence intervals are so small as to be indistinguishable from the trends depicted; consequently they are omitted.

related to the result for teen births in Panel A of Figure 1 since many teenage mothers are not old enough to have completed high school. Interestingly, Panel B of Figure 2 shows that the pattern on percent of mothers without a high school degree is preserved even if one restricts the observations to women giving birth at age 19 or above. While fewer women in this group do not have a high school degree, the effect is very similar even when births to women of high school age are omitted.

To assess the magnitudes of the seasonal trends we collapse the data into county-of-birth/month-of-birth/year-of-birth cells.[6] Using cell *c* as the unit of observation we estimate

$$Outcome_c = \alpha + \beta * \text{month} + \theta_y + \varepsilon_c \tag{1}$$

where $Outcome_c$ is the fraction of children in the cell born to (a) married mothers (b) white mothers (c) mothers with a high-school degree or (d) teenage mothers. The term "month" in equation (1) represents a set of 11 dummy variables for month of birth (with January omitted). The term θ_y represents a third-order polynomial for birth-month trends, which is included to capture broad trends in the dependent variable occurring over this time. The term ε_i is noise. Regressions are weighted by cell size and robust standard errors clustered by county are reported in brackets.

The estimates can be seen in the regression results in Table 1. Not surprisingly, the set of month dummies is highly significant in all regressions. For each of the four outcomes, January is the month with the lowest SES mothers, and the peak is in May.

Are these results driven by differences in regional birth patterns throughout the year? Table 2 addresses this question by adding county fixed effects to equation (1). The results are somewhat smaller, especially for the spring months. But from the summer on, the coefficients are close to before and still clearly significant. The patterns here are thus not primarily driven by regional differences in births during the year but instead are mostly driven by within-county changes during the year.[7]

The Natality Detail Files include information on measures of health outcomes such as birth weight and Apgar score. It will be useful to examine these measures as they are strongly

---

[6] The data are collapsed for computational tractability. Estimation at the individual level produces identical results.

[7] The NIH dataset does not identify some smaller counties, although some of these smaller counties become identifiable in 1993. To facilitate comparisons with Table 1, we include these smaller counties in the results in Table 2 and create a state-specific "unidentified county" dummy for these observations. However, the results are extremely similar if observations without county data are excluded.

related both to family background (cf. Forssas et al., 1999; Thorngren-Jerneck and Herbst, 2001) and to later outcomes linked to season of birth (Behrman and Rosenzweig 2004; Black, Devereux, and Salvanes 2005; Case, Paxson, and Fertig 2005; Currie, 2008).

Table 3 presents month dummy variables from regressions on birth weight, fraction low-birth-weight births, and a 5 minute Apgar score. In all regressions the omitted month is January and all regressions include a third-order polynomial trend for birth month. The last three columns include county fixed effects.[8] The results show that children born in January have lower average birth weights than other children; the highest average birth weights are in the spring. Infants born in April weigh 23.3 grams more on average than those born in January; this effect is three-fourths the size of the effect of AFDC participation on poor whites estimated by Currie and Cole (1993) and is larger than their estimated effect of AFDC participation for blacks. The results on Apgar score also show seasonality with spring and summer births having larger scores on average than births early in the year; although the magnitudes of these effects are small.[9] Thus, the data show seasonal variation in child health outcomes in addition to variation in maternal characteristics.

B. *Decennial Census*

We now turn to the decennial census to see if season of birth relates to family characteristics in earlier years and in a different data set. The census data have limitations, including the fact that they represent only a sample of all births and that the most recent usable censuses do not contain month-of-birth information but instead report quarter-of-birth information. However, analyzing census data will allow us to verify how persistent the relationship between season-of-birth and family background is over time. The analysis is also pertinent since census data will be used in the following section.

We use IPUMS data from 1960 (1% sample), 1970 (the 1% Form 1 and 1% Form 2 state, metro, and neighborhood samples) and 1980 (5% sample).[10] In each census year, the unit of observation is the child and our sample consists of children ages 16 and under living with their biological mothers. As before, all regressions include third-order polynomials for birth-quarter

---

[8] Observations without a FIPS code are treated as in Table 2, and excluding the small number observations without a county FIPS code yields very similar results.
[9] The Apgar score ranges from zero to 10, with higher scores corresponding to healthier newborn children.
[10] Age in months is available in 1940 and 1950 only for individuals under age 1 at the time of the census, and for individuals under age 5 at the time of the census in 1930 and 1920. Quarter- or month-of-birth information is not available from IPUMS for the 1990 and 2000 censuses.

trends. For each outcome, the regressions for each census year are run separately.

Table 4 reports results from regressing quarter-of-birth dummies (and time trends) on a number of outcomes; the omitted quarter is the first quarter of the year. Panel A reports the results from a linear probability regression on the likelihood that a child's mother has a high-school degree; all of the coefficients in all of the regressions are positive, indicating children born in the second through fourth quarters of the year are more likely to have a mother with a high school degree. For the 1960 regression, a Wald test that the season of birth coefficients are jointly zero is marginally significant, with a *p* value of 0.12. For the other two regressions in Panel A—and all the other regressions in the table—a test that the birth-quarter coefficients are jointly zero can be rejected at the one percent level. The coefficients are also reasonably large in magnitude; with the second-quarter coefficient representing a little less than 2 percent of the (steadily rising) mean. The results are generally similar across census years; although seasonality (especially for the third and fourth quarters) is more precisely estimated in later years. These results are also very similar to those found in the Natality Detail Files for 1989-2001; that the census results are smaller in magnitude reflects the fact that using quarters rather than months masks monthly within-quarter variation.

Panel B considers the fraction of children whose mothers were married at the time of the census. The coefficients here are very comparable to those in Panel A; showing that children born in the first quarter are more likely to be born to unmarried parents, and that this result grows somewhat stronger over time. Panel C shows that the fraction of children who are white is lower among children born in the first quarter of the year, and in this case the results are consistent for all quarters and for all census years. For both Panels B and C the estimated effects are about one percent of the mean or less in magnitude; although again these results underestimate the magnitude of seasonality's relation to family background since the Vital Statistics results show significant variation within birth quarters. For all the regressions in Panels B and C a Wald test can reject that the quarter-of-birth coefficients are jointly zero at the one-percent level.

Panel D reports regressions from each census on the likelihood that a child lives in an impoverished household; an outcome that is not directly observable in the Vital Statistics data. For each census it is clear that children born in the first quarter of the year are more likely to live below the poverty line than other children. The effects here are reasonably large, suggesting for each census year a relative increase from the first to the second quarter of the year that is about 4 percent of the mean. As with the prior estimates, the difference between the first and second quarters is the largest, and again a Wald test rejects for each census year that the quarter-of-birth coefficients are jointly zero.

Taken with the Vital Statistics results, Table 4 shows that the relationship between season of birth and family background has persisted for at least the second half of the twentieth century, and the results for the second and third quarter appear in some cases to be stronger in later years. In the next sections we consider how this relationship might account for season-of-birth's impact on later outcomes, and the implications of our finding for past work using quarter of birth as an instrumental variable.

III. Implications for Later Outcomes

The striking patterns of seasonal birth characteristics are important in their own right, but they also may have implications for past work on seasonality of birth and later outcomes. In this section we consider to what extent the relationship between season of birth and later outcomes is accounted for by variation in maternal and family background characteristics of children born throughout the year.

As in most prior studies, we use the decennial census for this investigation. In addition to quarter of birth information, the census has information on completed schooling and earnings. However, for our study we also need to observe measures of individuals' family backgrounds. Such information is readily available for individuals living at home with their parents when the census is completed, but most such individuals are children for whom the outcomes of interest (wage and completed schooling information) are not available. For most adults in the census information on family background is limited.

To confront this problem, we combine information on cells of individuals across multiple census years, where cells are defined by state of birth, year of birth, and quarter of birth. Using the 1960 census (the earliest census usable for this investigation since quarter-of-birth information is not readily available for the 1920-1950 censuses), we gather information on the typical conditions for individuals ages 16 and under living with their biological mothers.[11] We then match this information to information on the outcomes realized as of the 1980 census (the

[11] Over 95% of all children in the 1960 census ages 16 and under live with their biological mother. Migration from the household is significantly more evident for individuals ages 17 and over.

latest available year), when individuals are ages 20 to 36. This combination of cells across census years is similar in spirit to Angrist and Krueger (1992).[12] Following prior work, we restrict our attention to males.

Using census data from 1960 (1% IPUMS sample) and 1980 (5% IPUMS sample), we estimate

$$Outcome_c = \alpha_1 + \beta_1 \mathrm{Q} + \gamma_1 \phi_s + \theta_1 \mathrm{Y} + \lambda_1 age + \rho_1 age^2 + \varepsilon_1 \tag{2}$$

and

$$Outcome_c = \alpha_2 + \beta_2 \mathrm{Q} + \delta \mathrm{X}_c + \gamma_2 \phi_s + \theta_2 \mathrm{Y} + \lambda_2 age + \rho_2 age^2 + \varepsilon_2 \tag{3}$$

where the dependent variable $Outcome_c$ is either (a) the average years of school obtained by individuals in cell *c* (b) the percent of individuals in *c* without a high-school degree (c) the log of average wages [13] for cell *c* or (d) average wages (in levels) for cell *c*.[14] The term Q represents a set of quarter-of-birth dummies (with one quarter omitted), ϕ_s is a set of state-of-birth dummies, Y is a set of year dummies, and *age* and age^2 are linear and quadratic controls for age (measured in birth quarters). The numerical subscripts index the coefficients and error terms in the two equations.

The difference between (2) and (3) is that the latter includes the matrix X_c which contains controls for family background characteristics. These family-background controls include cell averages for mother's education, mother's age at birth, and family income as a percent of the poverty line, and the fraction of mothers in each cell who are teenagers, who are working, who are married, the fraction white, and the fraction of mothers without a high-school degree. Maternal controls are measures for *c* as of 1960 and family income is for 1959.

For both equations (2) and (3), the coefficients for the quarter-of-birth dummies report the difference in the likelihood of a given outcome occurring for a child born in each quarter relative to the omitted quarter. We can test whether background characteristics drive these

---

[12] One might wonder how best to interpret results from younger individuals for whom wage information may not perfectly predict lifetime income. The cohorts used here are as old as possible while still allowing us to measure family characteristics in 1960. The results shown below are similar if the sample is restricted to cohorts born in 1955 or earlier and thus observed in 1980 when schooling has largely been completed. For our youngest cohort—those born in 1960—87 percent of individuals on average report positive earnings in 1980, suggesting that our sample sizes are sufficiently large for including all available cohorts.

[13] Using the average of logged wages, instead of the log of average wages, produces similar results to those shown below.

[14] Wages are constructed as total individual pre-tax wage and salary income in the past year over weeks worked in the past year. As wages are measured in only one year, there is no need to adjust for inflation.

seasonal relationships by comparing the quarter-of-birth coefficients in (2) and (3). There are two conditions under which adding controls for family characteristics would not change the estimates of the quarter-of-birth coefficients β : if family characteristics are orthogonal to quarter of birth, or if they have no direct impact on the outcomes (that is, the δ coefficients in equation (3) are zero). If neither condition is satisfied, excluding maternal characteristics will lead to inconsistent estimates of β_1 in equation (2). Alternatively, if one of these conditions is met, then equation (2) is correctly specified and estimates of (2) will be not only consistent but will also be efficient, since they would exclude the superfluous variables added into equation (3). A Hausman test can thus be performed to test the null hypothesis that $\beta_1 = \beta_2$.

A drawback of the traditional Hausman test is that it imposes that the covariance between the coefficients in the two models is zero. A more general version of the Hausman-style test can be conducted by "stacking" the census data on top of itself and estimating both equations (2) and (3) simultaneously using Seemingly Unrelated Regression estimation. This allows for a more robust estimation of a variance-covariance matrix between coefficients in the two models; based on this variance-covariance matrix, it is straightforward to test whether the quarter-of-birth coefficients from the two models are the same.

Results from estimating (2) and (3) are shown in Table 5. The regressions are for cohorts of males ages 16 and under as of the 1960 census. Regressions are weighted by cell size.[15] The first pair of columns estimate (2) and (3) where the outcome of interest is years of completed schooling. The first column shows that, as expected, children born in the second through fourth quarters of the year obtain more school on average than other children; these results are similar in magnitude to those shown in Angrist and Krueger (1991).[16] However, column 2 shows that these effects are made significantly smaller by adding controls for family characteristics; the decline in the estimates ranges from 23 percent to nearly 50 percent. A Wald test strongly rejects that the coefficients are the same in each column.[17]

The next two columns look at the fraction of men in a cell who have not completed high

[15] Cell size is taken from the 1980 census. The correlation between cell sizes in the two census years is over 0.99 and using either year to weight the data gives (not surprisingly) similar estimates. The education regressions weight by total individuals in a cell; the wages/earnings regressions weight by total individuals reporting positive earnings in a cell. The regressions on wages have 3,463 cells totaling 1,295,279 individuals; the regressions on education have 3,463 cells totaling 1,459,473 individuals.

[16] See the second line of Table I in their paper for the most comparable regression (although note they exclude the fourth-quarter dummy).

[17] The family background coefficients are not reported here for brevity but generally accord with intuition.

school. The first set of results is again similar in magnitude to estimates from past work and suggests that those born in the first quarter of the year are more likely to drop out. Controlling for family background again significantly reduces these estimates for all three quarter-of-birth dummies; the changes are economically and statistically significant. The last two pairs of columns look at logged wages and wages in levels. The logged wage regressions are comparable to the estimates in Angrist and Krueger (1991), finding about a 1-percent difference in wages for those born in the first quarter to others. Again, adding family background controls significantly weakens the magnitude of this effect. The results are even more dramatic when looking at wages in levels, where for two quarter-of-birth coefficients the result is essentially eliminated by controlling for family characteristics. (The average weekly wage in the sample is about $300, so the implied proportional effect for the average individual in the last two columns is comparable to the proportional effects found using the log of wages in columns 4 and 5.) In all cases the null hypothesis that $\beta_1 = \beta_2$ can be rejected at the one-percent level.

It is interesting to note that, while the magnitude of the effect is much smaller, season of birth is sometimes still predictive even after family background controls are included. The persistence of seasonality may be partly driven by our use of cohort-level data and the parsimonious set of family-background characteristics available from the census. This persistence may also be driven by the various other explanatory phenomena put forward by past work, including compulsory schooling laws. But clearly variation in family background plays a crucial role in explaining differences in outcomes for those born at different times of year.

IV. Implications for Quarter of Birth as an Instrumental Variable

Season of birth is often used to instrument for schooling in a returns-to-education setting; this depends upon season of birth satisfying an exclusion restriction so that the only relation between season of birth and wages comes through education. The fact that family background characteristics have strong relations with both season of birth and later outcomes (including earnings) indicates that season of birth will likely fail this exclusion restriction. However, the effect of this failure on the IV estimates is hard to predict. To illustrate this, consider an estimation of the following equations:

$$\mathrm{x} = \mathrm{Z}\Pi + v \tag{4}$$

$$\mathrm{y} = \mathrm{x}\beta + \varepsilon \tag{5}$$

where (for simplicity) Z is a dummy that equals unity for winter births and zero otherwise; y, x, ε, and *v* are $N \times 1$ vectors of realizations of the random variables *y*, *x*, $\boldsymbol{\varepsilon}$, and $\boldsymbol{v}$; and Π and β are scalar constants. For returns to education, x would be educational attainment and y would be wages or earnings, and unobservable components ε and *v* might reflect family background or ability.

It is straightforward to show that in this case the IV estimate of β is asymptotically $\beta + \dfrac{\bar{\varepsilon}_w}{\Pi + \bar{v}_w}$, where $\bar{\varepsilon}_w$ and $\bar{v}_w$ represent the expected values of unobservable determinants of *y* and *x* for winter births.[18] If winter births are correlated with family background, then even if ε and *v* are in expectation zero it could be that $\bar{\varepsilon}_w$ and $\bar{v}_w$ are not zero and IV estimates of β will be inconsistent.[19] Regressions that add controls for family background would likely decrease systematic differences in ε and *v* so that $\bar{\varepsilon}_w$ and $\bar{v}_w$ would fall towards zero. But the effect of this on the IV estimator is ambiguous; the asymptotic bias could stay the same, fall, or even rise.[20]

Thus, while it will be interesting to see how IV results change when family controls are added, there is little to guide us in terms of predicting how the IV estimates should change. Moreover, even if the IV results were unchanged with the addition of family backgrounds, this would *not* imply that the instrument is uncorrelated with unobservables; it could instead indicate that the instrument is correlated with unobservables in both the first-stage and structural equations.

Table 6 shows regressions using quarter-of-birth variables as IVs in a returns-to-education regression. The dependent variable in the first two pairs of regressions is the log of average cell wages; the last two pairs of regressions use average wages in levels. The

---

[18] The IV estimator of β considered is $\beta_{iv} = (\mathrm{x}'\mathrm{P}_z\mathrm{x})^{-1}\mathrm{x}'\mathrm{P}_z\mathrm{y}$, where $\mathrm{P}_z = \mathrm{Z}(\mathrm{Z}'\mathrm{Z})^{-1}\mathrm{Z}'$. This discussion extends to the more general case where Z is an $N \times K$ matrix and Π is a $K \times 1$ vector of constants. In that case the asymptotic bias of the IV estimator is $\left[\Pi'\Omega\Pi + 2\alpha_v\Pi + \alpha_v\Omega^{-1}\alpha_v'\right]^{-1}\left[\Pi' + \alpha_v\Omega^{-1}\right]\alpha_\varepsilon'$, where $\Omega = \mathrm{plim}\,\dfrac{1}{n}\mathrm{Z}'\mathrm{Z}$, $\alpha_\varepsilon = \mathrm{plim}\,\dfrac{1}{n}\varepsilon'\mathrm{Z}$ and $\alpha_v = \mathrm{plim}\,\dfrac{1}{n}v'\mathrm{Z}$.

[19] Note that this discussion differs meaningfully from Bound, Jaeger, and Baker (1995) as we are considering cases where $E(\mathrm{Z}'v) \neq 0$.

[20] As the asymptotic performance of OLS does not depend upon the relationship between Z and the unobservables, this discussion of the bias of IV is also applicable to a discussion of the relative bias of IV compared to OLS.

regressions use the same samples and controls as those in Table 5. We show results using quarter-of-birth dummies as instruments and quarter of birth interacted with year-of-birth dummies as instruments.[21] The first two regressions without family controls (in columns 1 and 3) show a return to education of 10.3 and 7.5 percent, respectively, estimates close to those in Angrist and Krueger (1991). However, the estimates display sensitivity to the addition of family controls, with the increase in the coefficient ranging from 20 percent (from 0.075 to 0.09) to 43 percent (0.103 to 0.147). The last two pairs of regressions use wages in levels; here the coefficient increases by 28 to 48 percent when maternal controls are added.

However, as our discussion above should make clear, one should not infer from the results of Table 6 that past returns-to-education estimates which fail to fully account for family background are smaller than the true returns to education. Given our parsimonious set of controls it is likely that the regressions in Table 6 do not fully control for family background, and that further inclusion of controls would alter the coefficients on quarter of birth in both the first stage and the reduced form. The main conclusion is not that the returns to education are truly as high as 15 percent, but rather that past work using season of birth as an instrument has failed to consider the instrument's relation to background characteristics.

V. Causes of Seasonality in Maternal Characteristics

The results of this paper show that mothers who are younger, unmarried, nonwhite, and less educated are disproportionately more likely to give birth in winter months than higher socioeconomic status (SES) women. It is natural to wonder why these striking patterns in maternal characteristics exist. As a starting point, Figure 3 shows the mean residuals each month from regressions of logged births per day for (a) married women and (b) single women.[22] The regressions include a third-order polynomial trend in months and county fixed effects.[23] To better capture seasonal variation in conceptions, we have imputed the month of birth by using gestational age to estimate the month of conception and assuming a 40 week gestation.

One noticeable feature in Figure 3 is the drop in births to single women in the spring.

[21] The 2SLS specification with quarter of birth*year of birth as the instrument is most similar to the estimation strategy in Angrist and Krueger (1991).
[22] For what follows we have also considered other measures of socioeconomic status, such as comparing teenage births to adult births. Such results are very similar to those shown here and so we focus on married versus single births for ease of exposition. That single mothers have lower socioeconomic status than other mothers is well known; see for instance the comparison of single mothers to married mothers in Meyer and Sullivan (2003).
[23] Removing county fixed effects does not significantly alter the figure.

This drop may partly be driven by the impact of weather patterns in the summer. Lam and Miron (1996) show that extreme heat may reduce conceptions, in part because heat reduces sperm count and sperm motility. Low SES individuals may be more exposed to temperature extremes, and work has also shown that temperature may have larger effects on the health outcomes of low SES populations than others.[24] If low SES women or their partners are more responsive to summer heat than other women, this may explain the dip in spring births in Figure 3 (nine months after the hottest months of summer).

To test this hypothesis, we repeated the regressions in Figure 3 adding controls for the weather at the estimated time and place of conception, identified by the woman's county of residence and gestation.[25] We obtained monthly weather data from the National Climatic Data Center; controls include the mean temperature, the minimum and maximum average temperatures, number of days over 90 degrees Fahrenheit, and the departure from normal temperature over the month (in degrees).

The results are reported in Figure 4. Panel A shows residuals from regressions of logged births per day for single women and Panel B shows residuals for married women. The springtime dip for births to single women in Panel A gets notably smaller once weather controls are added. On the other hand, the pattern in births for married women is little affected by the weather controls, which we would expect if these women are better able to insulate themselves from the effects of heat. Thus, it seems clear that differential impacts of weather can explain some of the seasonality in maternal characteristics—especially the strong improvement in maternal characteristics seen each spring.

A second noteworthy aspect of Figure 3 is the decrease in births to married women in the winter.[26] There is some evidence that women would like to avoid giving birth in the winter—for example, Rodgers and Udry (1988) survey undergraduate students, and find that almost half of the respondents name either December or January as the worst month for birth. The winter dip

[24] For instance, Curriero et al. (2002), O'Neal, Zanobettir and Schwartz (2003), and Schwartz (2005) all find evidence that the relationship between mortality and extreme temperatures may be greater for low SES individuals.

[25] Where the mother's county of residence is not large enough to be uniquely identified in the birth certificate data, we use weather conditions for the state capital or (in the few cases where weather information for the capital is unavailable) the most populous city in the state. Results omitting these unidentified counties from the regressions are very similar to the results shown here.

[26] As the dependent variables in these regressions are in logarithms, these means should be interpreted as proportional effects of month of birth. Thus, the "more negative" residuals in the winter for married births are not being driven by the fact that there are more births to married women than single women.

to married women in Figure 3 could be generated if high-SES women are either more likely to have these preferences, or are better at executing them (perhaps because their births are more likely to be planned).[27] We leave more thorough investigation of this and other explanations of these patterns to future research.

VI. Conclusion

Research throughout the social and natural sciences has demonstrated an association between the month of a child's birth and a variety of later outcomes, including health, education, and earnings. Past explanations of this relationship have been limited to factors that intervene after conception, such as compulsory schooling laws or seasonal exposure to disease and nutrition. In this paper, we consider the possibility that individuals born at different times of year are born to mothers with significantly different characteristics. Using birth certificate data and census data, we document large and regular seasonal changes in the socioeconomic characteristics of women giving birth. Women giving birth in winter are more likely to be teenagers and less likely to be married or to have a high school degree. These effects are large in magnitude and are observable for children born throughout the second half of the twentieth century. We show that these seasonal changes can account for a large portion of the poorly understood relationship between season of birth and other outcomes.

These results suggest that future researchers should use caution when considering season of birth as an instrument. While concerns of the instrument have been raised before, it remains in common use. Further, while Bound, Jaeger, and Baker "know of no indisputable evidence" on the direct effect of quarter of birth on education or earnings, they point out that "even a small direct association between quarter of birth and wages is likely to badly bias the estimated

[27] We have also considered whether the patterns seen reflect differential patterns in conception outcomes besides live birth, such as ectopic pregnancy or abortion. Exploring these factors is made difficult by "inadequacies in the reporting of all end products of conception" and "the difficulty in estimating the precise time when conception occurs" (Petersen and Alexander, 1992). However, Warren, Gwinn, and Rubin (1986) find no significant seasonal pattern in induced or spontaneous abortions or in ectopic pregnancies once seasonality in conceptions are controlled for. Additionally, Parnell and Rodgers (1998) state that "it is clearly not the case that abortion patterns contribute to the birth seasonality" and Stupp and Warren (1994) conclude that "seasonality of each pregnancy outcome can best be understood by understanding the seasonality of conception for all pregnancies." Further, Petersen and Alexander (1992) find little variation in the percent of adolescent pregnancies conceived over the year which end in induced abortion, except for a decline in this percent for conceptions in early autumn. But even if such a decline were particular to adolescents, it would likely work against the seasonal patterns we find here; Parnell and Rodgers (1998) also argue that abortion use may actually lead to underestimates of the importance of seasonality inferred from studying live births. This suggests that while other pregnancy outcomes may play some role in our results, given data limitations it is reasonable to focus on live births.

coefficient on education." Here we provide evidence for such a problematic association.

These results may also have implications for work comparing cohorts born in certain times of year to other cohorts, such as work on age at school entry or tax-based responses to fertility (e.g., Dickert-Conlin and Chandra, 1999; Elder and Lubotsky, 2006; Dobkin and Ferreira, 2007). Many of the studies on age at school entry exploit state-level variation in school cutoff dates. The results of this paper show a steady decline throughout the fall in maternal characteristics; since most schools have cutoff dates in autumn even a comparison across states may confound underlying trends in family background. Future work in this area should regard such underlying trends as a potentially serious concern.

References

Almond, Doug. 2006. "Is the 1918 Influenza Pandemic Over? Long-Term Effects of *In Utero* Influenza Exposure in the Post-1940 U.S. Population." *Journal of Political Economy,* 114, 672-712.

Angrist, Joshua and Alan Krueger. 1991. "Does Compulsory School Attendance Affect Schooling and Earnings?" *Quarterly Journal of Economics*, 106, 979-1014.

Angrist, Joshua and Alan Krueger. 1992. "The Effect of Age at School Entry on Educational Attainment: An Application on Instrumental Variables with Moments from Two Samples." *Journal of the American Statistical Association,* 87, 328-336.

Angrist, Joshua and Alan Krueger. 1995. "Split Sample Instrumental Variables Estimates for the Return to Schooling." *Journal of Business & Economic Statistics*, 13, 225-235.

Angrist, Joshua and Alan Krueger. 2001. "Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments." *Journal of Economic Perspectives*, 15, 69-85.

Arias, Elizabeth, Marian MacDorman, Donna Srobino, and Bernard Guyer. 2003. "Annual Summary of Vital Statistics—2002." *Pediatrics*, 112(6), 1215-1230.

Barker, David. 2001. "Fetal and Infant Origins of Adult Disease." *Monatsschrift für Kinderheilkunde*, 149(13), 2.

Behrman, Jere and Mark Rosenzweig. 2004. "Returns to Birthweight." *Review of Economics and Statistics*, 86(2), 586-601.

Black, Sandra, Paul Devereux, and Kjell Salvanes. 2005. "From the Cradle to the Labor Market? The Effect of Birth Weight on Adult Outcomes." NBER Working Paper 11796.

Bobak, Martin and Arjan Gjonca. 2001. "The Seasonality of Live Birth is Strongly Influenced by Sociodemographic Factors." *Human Reproduction*, 16, 1512-1517.

Bound, John and David Jaeger. 2000. "Do Compulsory School Attendance Laws Alone Explain the Association Between Quarter of Birth and Earnings?" *Worker Well-Being*, 19: 83-108.

Bound, John, David Jaeger, and Regina 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.

Cagnacci, Angelo, Francesco Pansini, Alberto Bacchi-Modena, and Annibale Volpe. 2006. "The Relation of Season of Birth to Severity of Menopausal Symptoms." *Menopause—the Journal of the North American Menopause Society*, 13, 700-705.

Card, David. 1999. "The Causal Effect of Education on Earnings." In *Handbook of Labor Economics 3A*, Orley Ashenfelter and David Card (eds.) Chapter 30. Oxford: Elsevier.

Cascio, Elizabeth, and Ethan Lewis. 2006. "Schooling and the Armed Forces Qualifying Test." *The Journal of Human Resources*, XLI, 294-318.

Case, Anne, Angela Fertig, and Christina Paxson. 2005. "The Lasting Impact of Childhood Health and Circumstance." *Journal of Health Economics,* 24(2), 365-389.

Chamberlain, Gary and Guido Imbens. 2004. "Random Effect Estimators with Many Instrumental Variables." *Econometrica*, 72, 295-306.

Chernozhukov, Victor and Christian Hansen. 2006. "Instrumental Quantile Regression Inference for Structural and Treatment Effect Models." *Journal of Econometrics,* 132, 491-525.

Chesher, Andrew. 2007. "Instrumental Values." *Journal of Econometrics*, 139, 15-34.

Chesher, Andrew. 2005. "Nonparametric Identification Under Discrete Variation." *Econometrica*, 73, 1525-1550.

Chotai, Jayanti and Richard Wiseman. 2005. "Born Lucky? The Relationship Between Feeling Lucky and Month of Birth." *Personality and Individual Differences*, 39, 1451-1460.

Costa, Dora and Joanna Lahey. 2005. "Predicting Older Age Mortality Trends." *Journal of the European Economic Association*, 3, 287-293

Cruz, Luiz, and Marcelo Moreira. 2005. "On the Validity of Econometric Techniques with Weak Instruments." *The Journal of Human Resources*, XL, 393-410.

Currie, Janet and Nancy Cole. 1993. "Welfare and Child Wealth: The Link Between AFDC Participation and Birth Weight." *The American Economic Review*, 83(4), 971-985.

Currie, Janet. 2008. "Healthy, Wealthy, and Wise: Socioeconomic Status, Poor Health in Childhood, and Human Capital Development." NBER Working Paper 13987.

Curriero, Frank, Karlyn Heiner, Jonathan Samet, Scott Zeger, Lisa Strug, and Jonathan Patz. 2002. "Temperature and Mortality in 11 Cities of the Eastern United States." *American Journal of Epidemiology*, 155, 80-87.

Davies, Geoffrey, Joy Welham, David Chant, E. Fuller Torrey, John McGrath. 2003. "A Systematic Review and Meta-analysis of Northern-Hemisphere Season of Birth Studies in Schizophrenia." *Schizophrenia Bulletin*, 29, 587-593.

Dehejia, Rajeev and Adriana Lleras-Muney. 2004. "Booms, Busts, and Babies Health." *Quarterly Journal of Economics*, 199, 1091-1130.

Dickert-Conlin, Stacy and Amitabh Chandra. 1999. "Taxes and the Timing of Births." *Journal of Political Economy*, 107, 161-177.

Dobkin, Carlos and Fernando Ferreira. 2007. "Do School Entry Laws Affect Educational Attainment and Labor Market Outcomes?" http://ssrn.com/abstract=1007492.

Doblhammer, Gabriele, Rembrandt Scholz, and Heiner Maier. 2005. "Month of Birth and Survival to Age 105+: Evidence from the Age Validation Study of German Semi-supercentenarians." *Experimental Gerontology*, 40, 829-835.

Doblhammer, Gabriele, and James Vaupel. 2001. "Lifespan Depends on Month of Birth." *Proceedings of the National Academy of Sciences of the United States of America*, 98(5), 2934.

Donald, Stephen and Whitney Newey. 2001. "Choosing the Number of Instruments," *Econometrica*, 69, 1161-1191.

Dufour, Jean-Marie, and Mohamed Taamouti. 2007. "Further Results on Projection-Based Inference in IV Regressions with Weak, Collinear or Missing Instruments." *Journal of Econometrics*, 139, 133-153.

Elder, Todd and Darren Lubotsky. 2006. "Kindergarten Entrance Age and Children's Achievement: Impacts of State Policies, Family Background, and Peers." forthcoming, *Journal of Human Resources*.

Forssas, Erja, Mika Gissler, Marja Sihvonen, and Elina Hemminki. 1999. "Maternal Predictors of Perinatal Mortality: the Role of Birthweight." *International Journal of Epidemiology*, 28, 475-478.

Gelbach, Jonah. 2002. "Public Schooling for Young Children and Maternal Labor Supply." *American Economic Review*, 92, 307-322.

Gillberg, Christopher. 1990. "Do Children with Autism have March Birthdays?" *Acta Psychiatrica Scandinavica*, 82, 152-156.

Gortmaker, Steven, Jerome Kagan, Avshalom Caspi, and Phil Silva. 1997. "Daylength During Pregnancy and Shyness of Children: Results from Northern and Southern Hemispheres." *Developmental Psychobiology*, 31, 107-114.

Honoré, Bo and Luojia Hu. 2004. "On the Performance of Some Robust Instrumental Variables Estimators." *Journal of Business & Economic Statistics*, 22, 30-39.

Hoogerheide, Lennart, Frank Kleibergen , and Herman van Dijk. 2007. "Natural Conjugate Priors for the Instrumental Variables Regression Model Applied to the Angrist-Krueger Data." *Journal of Econometrics*, 138, 63-103.

Imbens, Guido and Paul Rosenbaum. 2005. "Robust, Accurate Confidence Intervals with a Weak Instrument: Quarter of Birth and Education." *Journal of the Royal Statistical Society*, 168 109-126.

James, W. H. 1971. "Social Class and Season of Birth." *Journal of Biosocial Science*, 3, 309-320.

Kesterbaum, Bert. 1987. "Seasonality of Birth: Two Findings from the Decennial Census." *Social Biology*, 34, 244-248.

Kleibergen, Frank. 2002. "Pivotal Statistics for Testing Structural Parameters in Instrumental Variables

Regression." *Econometrica*, 70, 1781-1803.
Lam, David and Jeffery Miron. 1996. "The Effects of Temperature on Human Fertility." *Demography*, 33, 291-305.
Lam, David, Jeffery Miron, and Ann Riley. 1994. "Modeling Seasonality in Fecundability, Conceptions, and Births." *Demography*, 31, 321-346.
Lefgren, Lars and Frank McIntyre. 2006. "The Relationship between Women's Education and Marriage Outcomes." *Journal of Labor Economics*, 24, 787-830.
Leigh, Andrew and Chris Ryan. 2008. "Estimating the Returns to Education Using Different Natural Experiment Techniques." *Economics of Education Review*, 27, 149-160.
Levin, Jesse and Erik Plug. 1999. "Instrument Education and the Reutrns to Schooling in the Netherlands." *Labour Economics*, 6, 521-534.
Livingston, Richard, Balkozar Adam, and H. Stefan Bracha. 1993. "Season of Birth and Neurodevelopmental Disorders: Summer Birth is Associated with Dyslexia." *American Academy of Child and Adolescent Psychiatry*, 32, 612.
Martin, M. and G. Jones. 1999. "Handedness and Season of Birth: A Gender-invariant Relation." *Cortex*, 35, 123-128.
Meyer, Bruce D. and James X. Sullivan. 2003. "The Effects of Welfare and Tax Reform: The Material Well-Being of Single mothers in the 1980s and 1990s." *Journal of Public Economics*, 88, 1387-1420.
Mitchell, R. M. Kosten, and P. Ward. 1985. "Social Class and Seasonality of Birth in the Midlands of Tasmania during the Nineteenth Century." *Human Biology*, 57, 213-228.
Neal, Derek, and William R. Johnson. 1996. "The Role of Premarket Factors in Black-White Wage Differences." *Journal of Political Economy*, 104, 869-895.
O'Neil, Marie, Antonella Zanobetti, and Joel Schwartz. 2003. "Modifiers of the Temperature and Mortality Association in Seven US Cities." *American Journal of Epidemiology*, 157, 1074-1082.
Oreopoulos, Philip, Marianne E. Page, Ann Huff Stevens. 2006. "The Intergenerational Effects of Compulsory Schooling." *Journal of Labor Economics*, 24, 729-760.
Pasamanick, Benjamin, Simon Dinitz, and Hilda Knobloch. 1960. "Socio-Economic and Seasonal Variations in Birth Rates." *The Milbank Memorial Fund Quarterly*, 38, 248-254.
Parnell, Allan M. and Joseph L. Rodgers. 1998. "Seasonality of Induced Abortion in North Carolina." *Journal of Biosocial Science*, 20, 321-332.
Petersen, Donna J. and Greg R. Alexander. 1992. "Seasonal Variation in Adolescent Conceptions, Induced Abortions, and Late Initiation of Prenatal Care." *Public Health Reports*, 107, 701-706.
Plug, Erik. 2001. "Season of Birth, Schooling and Earnings." *Journal of Economic Psychology*, 22, 641-660.
Rock, D., D. Greenberg, and J. Hallmayer. 2006. "Season-of-Birth as a Risk Factor for the Seasonality of Suicide Behavior." *European Archives of Psychiatry and Clinical Neuroscience*, 256, 98-105.
Rodgers, Joseph Lee and J. Richard Udry. 1988. "The Season-of-Birth Paradox." *Social Biology* 35, 171-185.
Rosenberg, Harry. 1966. "Seasonal Variation of Births, United States." Vital and Health Statistics: Series 21, no. 9. U.S. Dept. of Health, Education, and Welfare, Government Printing Office: Washington D.C.
Rosenzweig, Mark. 1999. "Welfare, Marital Prospects, and Nonmarital Childbearing." *The Journal of Political Economy*, 107, 3.
Schwartz, J. 2005. "Who is Sensitive to Extremes of Temperature? A Case-Only Analysis." *Epidemiology*, 16, 67-72.
Sham, P., E. O'Callaghan, N. Takei, G. Murray, E. Har, and R. Murray. 1994. "Schizophrenia Following Pre-natal Exposure to Influenza Epidemics Between 1939 and 1960." *The British Journal of Psychiatry*, 160, 461-466.
Skirbekk, Vegard, Hans-Peter Kohler, and Alexia Prskawetz. 2004. "Birth Month, School Graduation, and the Timing of Births and Marriages." *Demography*, 41, 547-568.

Staiger, Douglas and James Stock. 1997. "Instrumental Variables with Weak Instruments." *Econometrica*, 65, 557-586.

Stupp, Paul W. and Charles W. Warren. 1994. "Seasonal Differences in Pregnancy Outcomes: United States, 1971-1989." *Annals of the New York Academy of Sciences*, 709, 46-54.

Suvisaari, Jaana, Jari Jaukka, Antti Tanskanen, Tapani Hovi, Jouko Lönnqvist. 1999. "Association Between Prenatal Exposure to Poliovirus Infection and Adult Schizophrenia." *The American Journal of Psychiatry*, 156, 1100-1102.

Tarnowski, Kenneth, Deborah Anderson, Ronald Drabman, and Patricia Kelly. 1990. "Disproportionate Referrals for Child Academic/Behavior Problems: Replication and Extension." *Journal of Consulting and Clinical Psychology*, 58, 540-243.

Thorngren-Jerneck, Kristina and Andreas Herbst. 2001. "Low 5-Minute Apgar Score: A Population-Based Register Study of 1 Million Term Births." *Obstetrics & Gynecology*, 98, 65-70.

Tochigi, Mamoru, Yuji Okazaki, Nobumasa Kato, and Tsukasa Sasaki. 2004. "What Causes Seasonality of Birth in Schizophrenia?" *Neuroscience Research*, 48, 1-11.

Torrey, E. Fuller, Judy Miller, Robert Rawlins, and Robert Yolken. 1997. "Seasonality of Births in Schizophrenia and Bipolar Disorder: A Review of the Literature." *Schizophrenia Research*, 28, 1-38.

Ventura, Stephanie, Sally Curtin, T. J. Mathews. 2000. "Variations in Teenage Birth Rates, 1991-98: National and State Trends." National Vital Statistics Reports: Series 48, no. 6. National Center for Health Statistics: Hyattsville, Maryland.

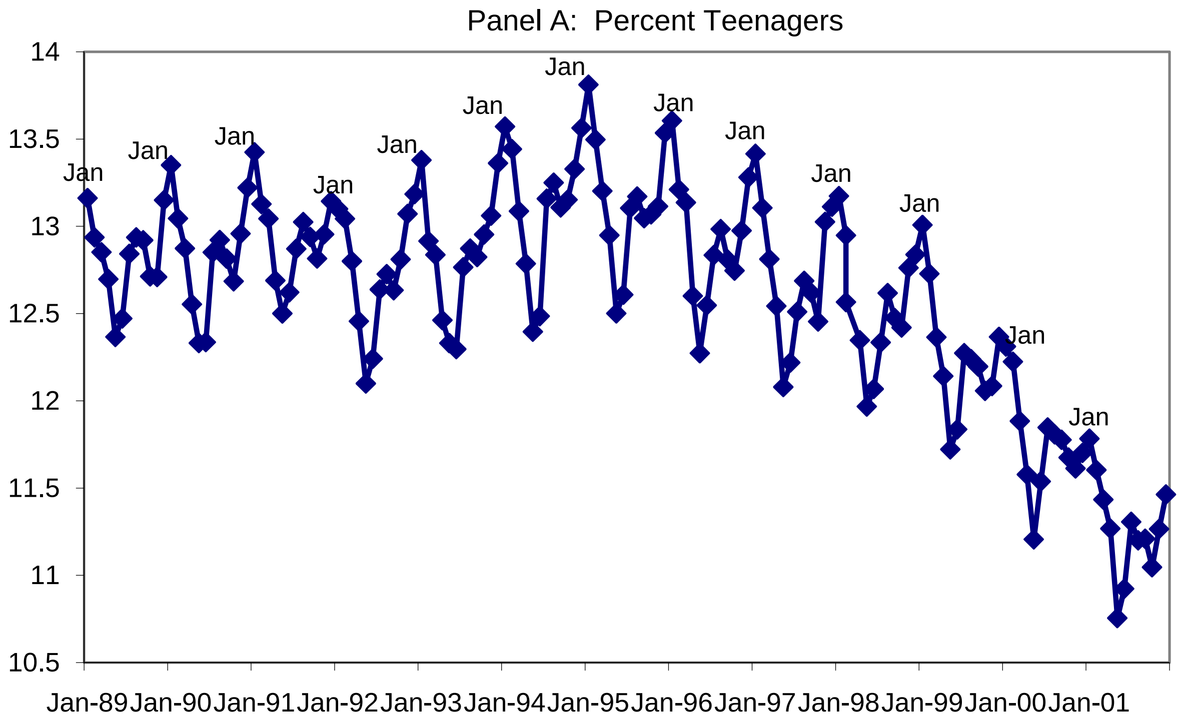
Warren, Charles and Carl Tyler. 1979. "Social Status and Season of Birth: A Study of a Metropolitan Area in the Southeastern United States." *Social Biology*, 26, 275-288.

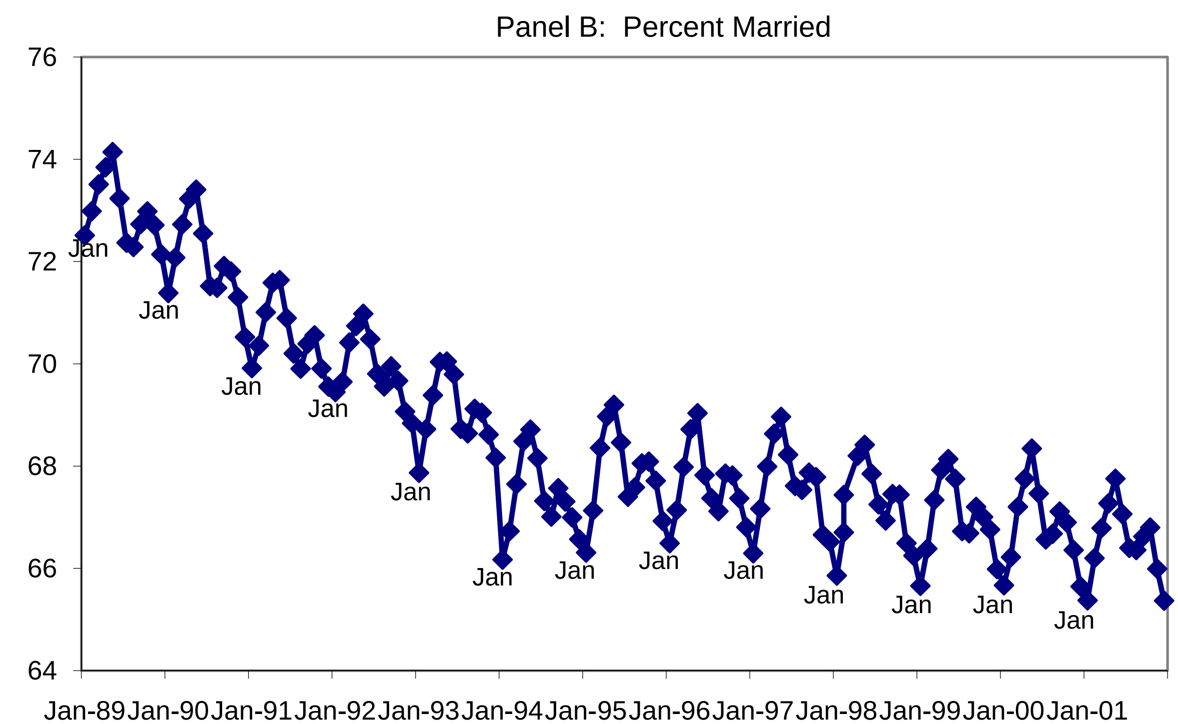
Warren, Charles W., Marta L. Gwinn, and George L. Rubin. 1986. "Seasonal Variation in Conception and Various Pregnancy Outcomes." *Social Biology*, 33, 116-126.

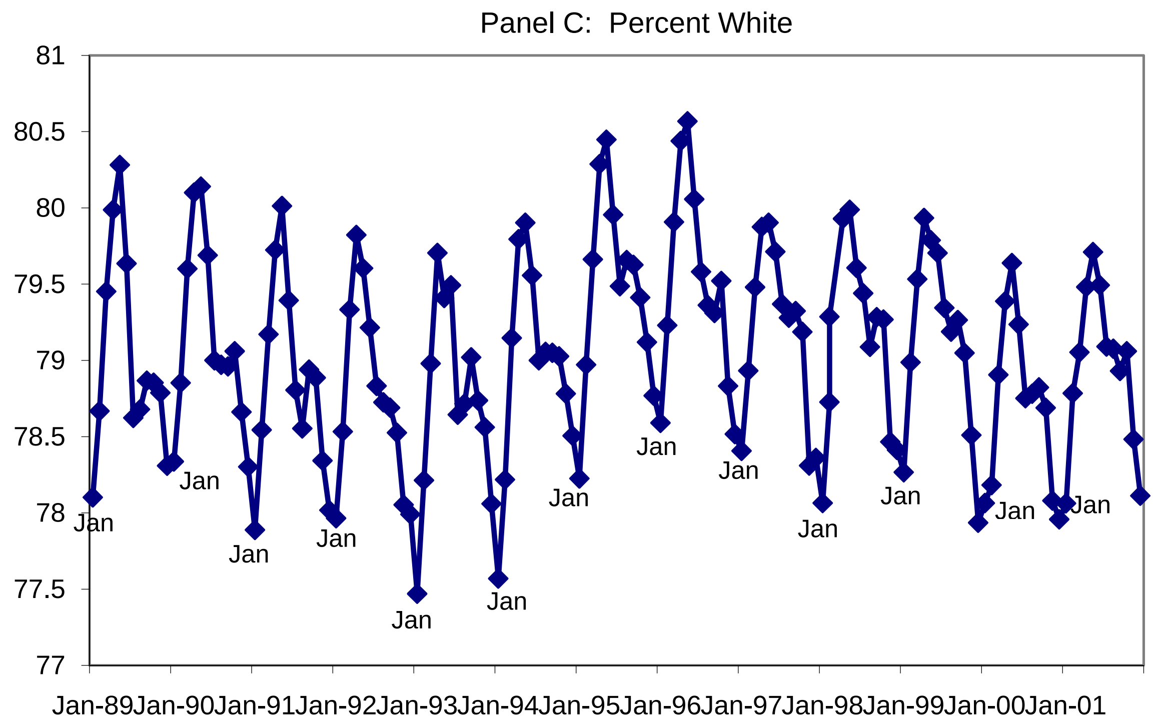
Watson, C., T. Kacuala, C. Tilleskjor, and L. Jacobs. 1984. "Schizophrenic Birth Seasonality in Relation to the Incidence of Infectious Diseases and Temperature Extremes." *Archives of General Psychiatry*, 41, 85-90.

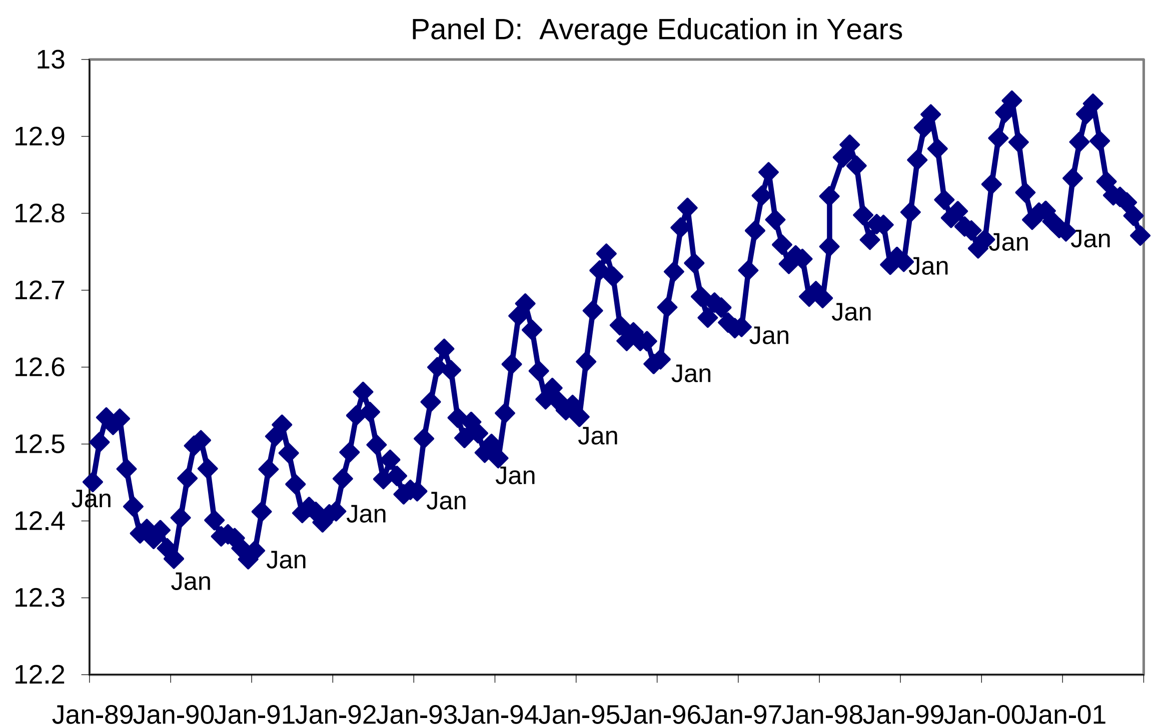
Williams, Phillip, Pay Davies, Roy Evans, Neil Ferguson. 1970. "Season of Birth and Cognitive Development." *Nature*, 228, 1033-1036.

FIGURE 1. MATERNAL CHARACTERISTICS BY MONTH, NATALITY FILES, 1989-2001



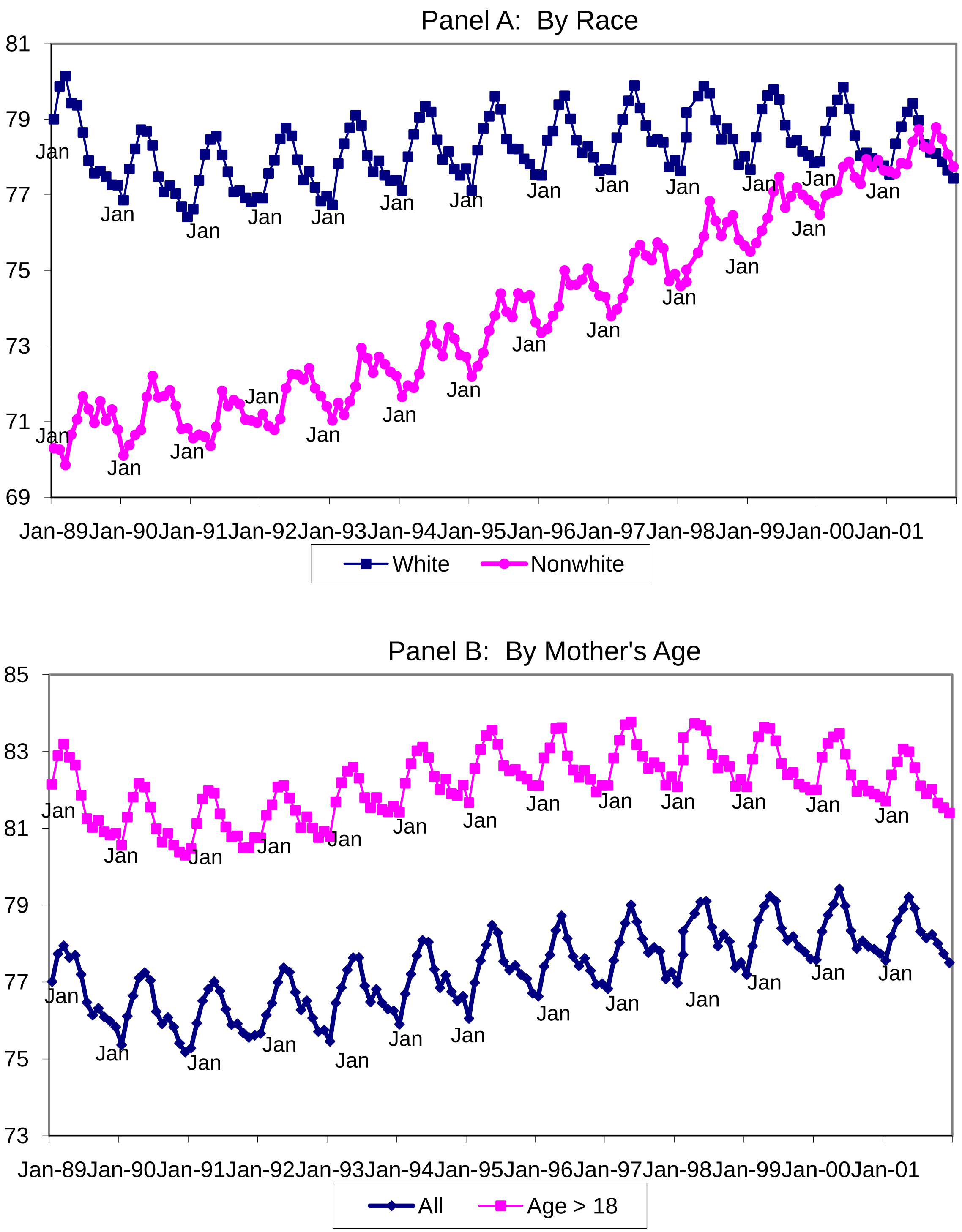






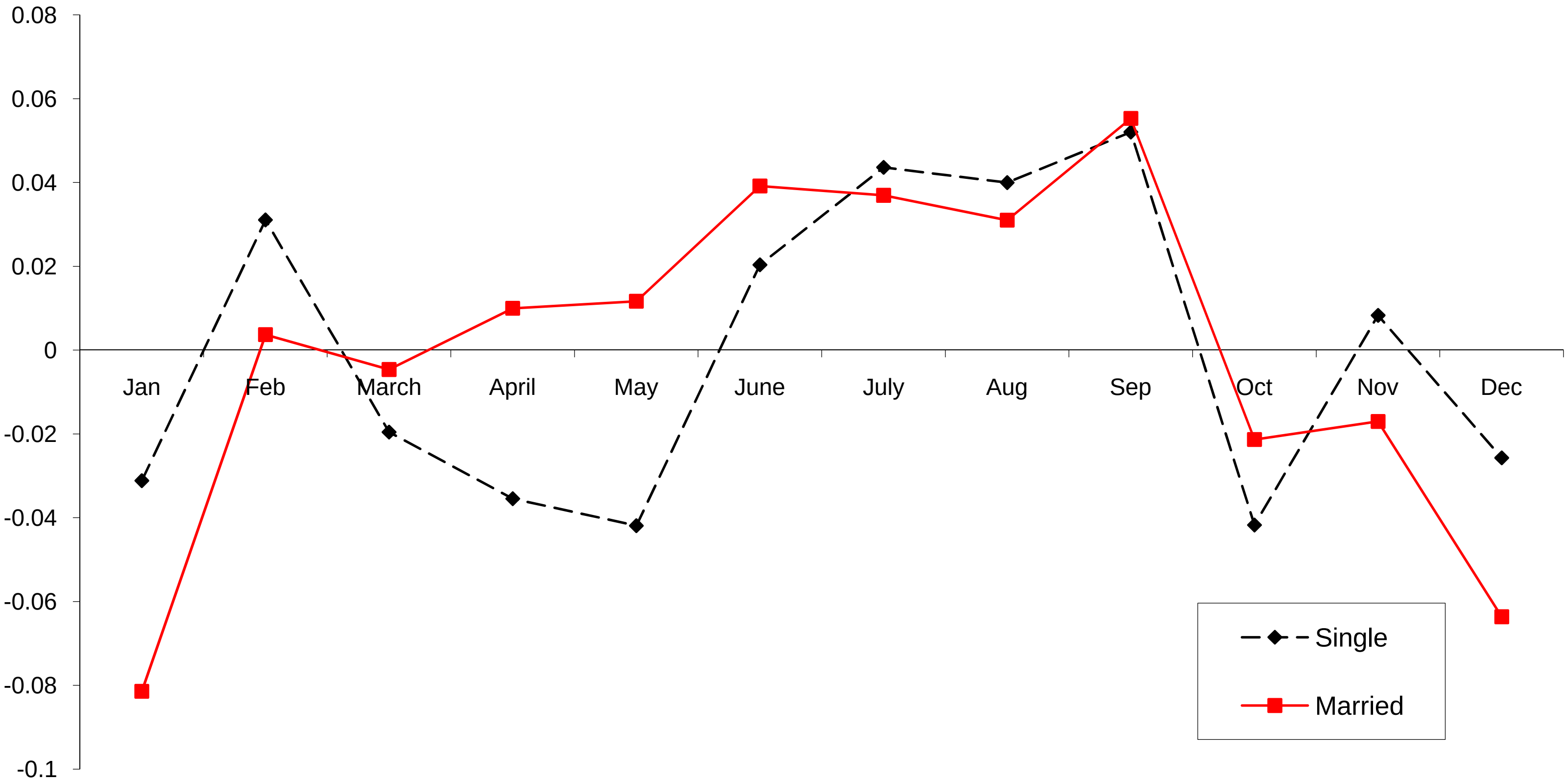
Notes: The sample for each figure includes all births in the Natality Detail Files from 1989-2001, for 52,041,054 observations.

FIGURE 2. PERCENT OF WOMEN GIVING BIRTH EACH MONTH WHO HAVE A HIGH SCHOOL DEGREE, NATALITY FILES, 1989-2001



Notes: The sample for each figure includes all births in the Natality Detail Files with mother's education reported, from 1989-2001, for 50,660,895 observations. There are 46,524,641 births to women over 18.

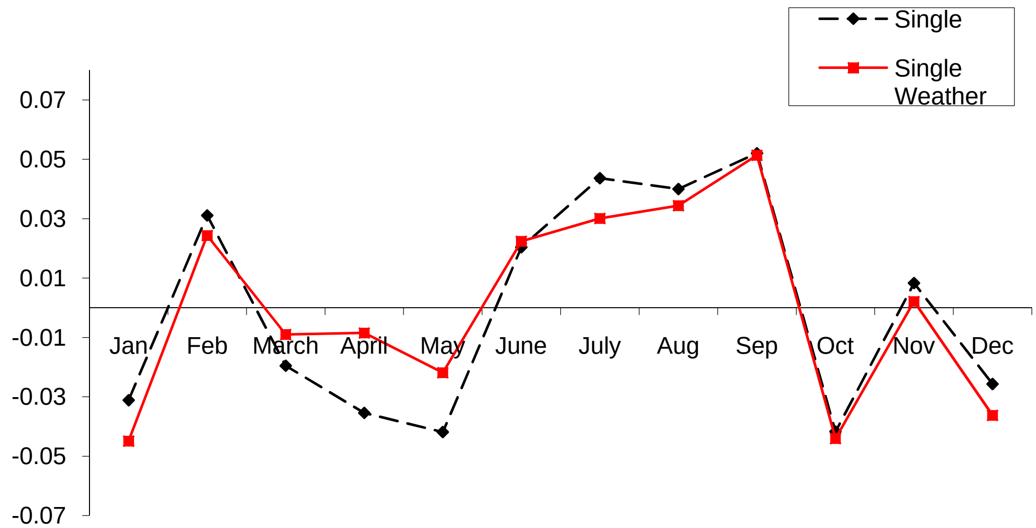
FIGURE 3. BIRTHS PER DAY



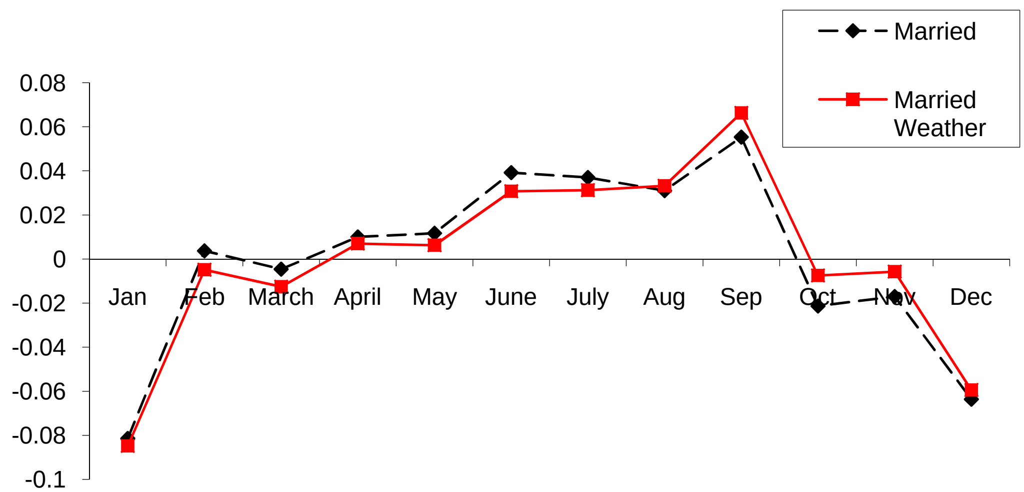
Notes: Figure shows the mean residuals each month from regressions of logged births per day on a third-order month-of-birth trend and county fixed effects. Data are from the Natality Detail Files, 1989-2001.

FIGURE 4. BIRTHS PER DAY, WITH AND WITHOUT WEATHER

Panel A: Births to Single Women



Panel B: Births to Married Women



Notes: Figures show the mean residuals each month from regressions of logged births per day on a third-order month-of-birth trend and county fixed effects. Data are from the Natality Detail Files, 1989-2001. Panel A includes births to single women and Panel B includes births to married women. Regressions with weather controls include information on weather at the estimated month and place of conception including mean temperature, mean maximum and minimum temperature, number of days over 90 degrees, and the departure from normal temperature over the month (in degrees). The regressions without weather controls are the same as in Figure 3.

TABLE 1. MOTHER'S CHARACTERISTICS BY MONTH: NATALITY FILES, 1989-2001

	Fraction of Moms Married	**Fraction of Moms White**	**Fraction Moms w/HS Degree**	**Fraction Moms Teenagers**
February	0.0070	0.0060	0.0073	-0.0024
	[0.0001]	[0.0001]	[0.0001]	[0.000]
March	0.0155	0.0127	0.0122	-0.0045
	[0.0001]	[0.0001]	[0.0001]	[0.000]
April	0.0219	0.0181	0.0163	-0.0074
	[0.0001]	[0.0001]	[0.0001]	[0.000]
May	0.0250	0.0189	0.0195	-0.0107
	[0.0001]	[0.0001]	[0.0001]	[0.000]
June	0.0185	0.0153	0.0174	-0.0093
	[0.0001]	[0.0001]	[0.0001]	[0.000]
July	0.0109	0.0102	0.0103	-0.0053
	[0.0001]	[0.0001]	[0.0001]	[0.000]
August	0.0102	0.0096	0.0068	-0.0043
	[0.0001]	[0.0001]	[0.0001]	[0.000]
September	0.0154	0.0103	0.0088	-0.0050
	[0.0001]	[0.0001]	[0.0001]	[0.000]
October	0.0154	0.0098	0.0055	-0.0054
	[0.0001]	[0.0001]	[0.0001]	[0.000]
November	0.0103	0.0050	0.0032	-0.0035
	[0.0001]	[0.0001]	[0.0001]	[0.000]
December	0.0056	0.0021	0.0025	-0.0011
	[0.0001]	[0.0001]	[0.0001]	[0.000]
Constant	0.7280	0.7818	0.7666	0.1331
	[0.0001]	[0.0001]	[0.0001]	[0.000]
F-stat for Month Dummies	20,172.35	6,001.24	17,363.73	22,390.43
Observations	52,041,054	52,041,054	50,660,895	52,041,054

Notes: Robust standard errors in brackets. Each column is a separate regression, where the data were collapsed into county-month-year cells. The data were then weighted by cell size; the total number of observations is shown in the table. The omitted month is January. All regressions include third-order polynomials for birth-month trends. The F statistic tests whether the coefficients for all of the moth dummies are jointly zero; the 1% critical value for the F-test is 2.25.

TABLE 2. MOTHER'S CHARACTERISTICS BY MONTH, WITH COUNTY FIXED EFFECTS: NATALITY FILES, 1989-2001

	Fraction of Moms Married	Fraction of Moms White	Fraction Moms w/HS Degree	Fraction Moms Teenagers
February	0.0060	0.0045	0.0058	-0.0019
	[0.0004]	[0.0004]	[0.0008]	[0.0002]
March	0.0133	0.0097	0.0098	-0.0034
	[0.0008]	[0.0007]	[0.0007]	[0.0003]
April	0.0186	0.0137	0.0130	-0.0058
	[0.0009]	[0.0010]	[0.0006]	[0.0003]
May	0.0216	0.0143	0.0160	-0.0091
	[0.0009]	[0.0010]	[0.0006]	[0.0003]
June	0.0160	0.0115	0.0148	-0.0082
	[0.0009]	[0.0007]	[0.0006]	[0.0004]
July	0.0095	0.0075	0.0089	-0.0048
	[0.0007]	[0.0005]	[0.0005]	[0.0003]
August	0.0089	0.0070	0.0064	-0.0041
	[0.0007]	[0.0005]	[0.0005]	[0.0003]
September	0.0141	0.0079	0.0087	-0.0048
	[0.0008]	[0.0006]	[0.0006]	[0.0003]
October	0.0143	0.0078	0.0056	-0.0051
	[0.0007]	[0.0006]	[0.0006]	[0.0003]
November	0.0097	0.0040	0.0038	-0.0035
	[0.0006]	[0.0005]	[0.0007]	[0.0003]
December	0.0055	0.0017	0.0032	-0.0014
	[0.0005]	[0.0004]	[0.0006]	[0.0003]
Constant	0.7334	0.7887	0.7672	0.1321
	[0.0019]	[0.0020]	[0.0023]	[0.0008]
F-stat for Month Dummies	101.50	31.09	128.59	93.98
Observations	52,041,054	52,041,054	50,660,895	52,041,054

Notes: Robust standard errors in brackets. Each column is a separate regression, where the data were collapsed into county-month-year cells. The data were then weighted by cell size; the number of observations is shown in the table. The omitted month is January. All regressions include third-order polynomials for birth-month trends. Regressions also include county-specific fixed effects, where counties are identified by the FIPS code in the birth certificate data for counties over 100,000 in population. Individuals living in smaller counties are aggregated by state; omitting these individuals does not significantly change the results. The F statistic tests whether the coefficients for all of the moth dummies are jointly zero; the 1% critical value for the F-test is 2.25.

TABLE 3. INFANT HEALTH OUTCOMES BY BIRTH MONTH: NATALITY FILES, 1989-2001

	Birth Weight	Low Birth Weight	Apgar Score	Birth Weight	Low Birth Weight	Apgar Score
February	12.2982	-0.0006	0.0016	11.5978	-0.0032	0.0020
	[0.4240]	[0.0001]	[0.0006]	[0.5036]	[0.0002]	[0.0007]
March	19.0584	-0.0005	0.0006	17.4826	-0.0046	0.0010
	[0.4135]	[0.0001]	[0.0006]	[0.5713]	[0.0002]	[0.0006]
April	23.3403	-0.0001	-0.0019	21.1374	-0.0041	-0.0013
	[0.4197]	[0.0001]	[0.0006]	[0.6886]	[0.0003]	[0.0007]
May	20.4308	-0.0001	0.0009	18.1620	-0.0031	0.0013
	[0.4151]	[0.0001]	[0.0006]	[0.8052]	[0.0003]	[0.0008]
June	12.768	-0.0004	0.0021	11.0367	-0.0014	0.0023
	[0.4167]	[0.0001]	[0.0006]	[0.9058]	[0.0003]	[0.0008]
July	7.7108	-0.0005	0.0027	6.7346	-0.0017	0.0027
	[0.4097]	[0.0001]	[0.0006]	[0.7772]	[0.0003]	[0.0007]
August	9.0698	-0.0006	0.0030	8.2412	-0.0027	0.0028
	[0.4084]	[0.0001]	[0.0006]	[0.7199]	[0.0003]	[0.0007]
September	13.3838	-0.0011	0.0062	12.5370	-0.0048	0.0060
	[0.4100]	[0.0001]	[0.0006]	[0.6357]	[0.0002]	[0.0008]
October	8.1768	-0.0001	0.0013	7.4711	-0.0018	0.0010
	[0.4145]	[0.0001]	[0.0006]	[0.6813]	[0.0002]	[0.0008]
November	7.8571	-0.0004	0.0016	7.5598	-0.0018	0.0013
	[0.4208]	[0.0001]	[0.0006]	[0.5983]	[0.0002]	[0.0007]
December	-0.8636	-0.0005	0.0027	-0.8519	-0.0005	0.0026
	[0.4169]	[0.0001]	[0.0006]	[0.5241]	[0.0002]	[0.0007]
Constant	3333.704	0.0337	8.9658	335.6042	0.0722	8.9653
	[0.4358]	[0.0001]	[0.0007]	[1.1911]	[0.0004]	[0.0045]
County Fixed Effects?	No	No	No	Yes	Yes	Yes
F-stat for Month Dummies	643.78	167.16	20.52	226.73	85.56	11.29
Observations	51,981,365	51,981,365	40,0793,32	51,981,365	51,981,365	40,079,332

Notes: Robust standard errors in brackets. Birth weight is measured in grams, low birth weight is defined as <2500 grams, and the Apgar score is a five-minute Apgar score. Each column is a separate regression, where the data were collapsed into county-month-year cells. The data were then weighted by cell size; the number of observations is shown in the table. The omitted month is January. All regressions include third-order polynomials for birth-month trends. The last three regressions also include county-specific fixed effects, where counties are identified by the FIPS code in the birth certificate data for counties over 100,000 in population. Individuals living in smaller counties are aggregated by state; omitting these individuals does not significantly change the results. The 1% critical value for the F-test is 2.25.

TABLE 4. SEASON OF BIRTH AND FAMILY BACKGROUND: RESULTS FROM THE CENSUS

Panel A: Regression on Dummy for Mother having a High School Degree

	1960 Census	1970 Census	1980 Census
Second Birth Quarter	0.0098	0.0126	0.0101
	[0.0019]	[0.0007]	[0.0008]
Third Birth Quarter	-0.0024	0.0025	0.0001
	[0.0018]	[0.0007]	[0.0008]
Fourth Birth Quarter	0.0002	0.0045	0.0003
	[0.0019]	[0.0007]	[0.0008]
Mean of Dep. Var.	0.513	0.619	0.731

Panel B: Regression on Dummy for having a Married Mother

	1960 Census	1970 Census	1980 Census
Second Birth Quarter	0.0023	0.0048	0.0068
	[0.0011]	[0.0005]	[0.0007]
Third Birth Quarter	0.0003	0.0024	0.0028
	[0.0010]	[0.0005]	[0.0007]
Fourth Birth Quarter	0.0006	0.0032	0.0036
	[0.0023]	[0.0005]	[0.0007]
Mean of Dep. Var.	0.916	0.873	0.815

Panel C: Regression on Dummy for White

	1960 Census	1970 Census	1980 Census
Second Birth Quarter	0.0064	0.0083	0.0092
	[0.0013]	[0.0005]	[0.0007]
Third Birth Quarter	0.0032	0.0018	0.0007
	[0.0012]	[0.0005]	[0.0006]
Fourth Birth Quarter	0.0037	0.0048	0.0018
	[0.0012]	[0.0005]	[0.0007]
Mean of Dep. Var.	0.876	0.858	0.827

Panel D: Regression on Dummy for Living in an Impoverished Household

	1960 Census	1970 Census	1980 Census
Second Birth Quarter	-0.0101	-0.0058	-0.0058
	[0.0017]	[0.0005]	[0.0006]
Third Birth Quarter	-0.0049	-0.0019	-0.0005
	[0.0016]	[0.0005]	[0.0006]
Fourth Birth Quarter	-0.0069	-0.0041	-0.0028
	[0.0016]	[0.0005]	[0.0006]
Mean of Dep. Var.	0.257	0.156	0.162

Notes: Robust standard errors in brackets. In each panel, each column is a separate linear-probability regression. The sample for each census year includes all children ages 16 and under living with their biological mother. There are 578,773 observations in 1960; 3,674,887 obs. in 1970; and 2,766,118 obs. in 1980. All regressions include third-order polynomials for birth-quarter trends. For all regressions except the first regression in Panel A, a Wald test that the quarter-of-birth coefficients jointly equal zero can be rejected at the one-percent level (see text).

TABLE 5. MATERNAL CHARACTERISTICS AND EDUCATION AND WAGE OUTCOMES: RESULTS FROM THE CENSUS

	Years of Schooling		**Percent Dropouts**		**Wages, Logged**		**Wages, in Levels**	
Second Birth Quarter	0.048	0.031	-0.299	-0.165	0.004	0.001	0.95	-0.017
	[0.013]	[0.011]	[0.117]	[0.107]	[0.004]	[0.003]	[1.070]	[0.984]
Third Birth Quarter	0.067	0.053	-0.92	-0.799	0.011	0.008	3.399	2.451
	[0.012]	[0.010]	[0.112]	[0.103]	[0.004]	[0.003]	[1.093]	[0.994]
Fourth Birth Quarter	0.062	0.032	-0.837	-0.595	0.009	0.004	2.562	0.594
	[0.012]	[0.010]	[0.119]	[0.109]	[0.004]	[0.003]	[1.056]	[0.973]
Wald Test that Birth-Quarter Coefficients Are the Same	$\chi^2[3] = 31.91$		$\chi^2[3] = 32.85$		$\chi^2[3] = 40.31$		$\chi^2[3] = 30.06$	
Family Characteristics?	No	Yes	No	Yes	No	Yes	No	Yes
R-Squared	0.904	0.92	0.887	0.899	0.949	0.952	0.929	0.935
Age Controls?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Dummies?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Weights?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors in brackets. Regressions come from cohorts of males born between 1944 and 1960. Cells are defined by state of birth, year of birth, and quarter of birth. For all cases, the Wald test that birth-quarter coefficients are equal can be rejected at the one-percent level. Family characteristics include controls for average mother's education, fraction of mothers without a high-school degree, average mother's age at birth, fraction of mother's giving birth as teenagers, fraction of mothers working, fraction of mothers married, fraction white, and average cell family income as a percent of the poverty line. The maternal characteristics and income controls are taken from the 1960 census and outcomes are taken from the 1980 census. The education regressions weight by total individuals in a cell; the wages/earnings regressions weight by total individuals reporting positive earnings in a cell. The regressions on wages have 3,463 cells totaling 1,295,279 individuals; the regressions on education have 3,463 cells totaling 1,459,473 individuals. Wages are pre-tax wage and salary income over weeks worked. Logged wages reports the log of average wages in the cell; using the average of logged wages produces qualitatively similar estimates. The age control measures age in birth quarters.

TABLE 6. IV REGRESSIONS ON RETURNS TO EDUCATION: RESULTS FROM THE CENSUS

	Wages, Logged: QOB Instruments		**Wages, Logged: Year*QOB Instruments**		**Wages, in Levels: QOB Instruments**		**Wages, in Levels: Year*QOB Instruments**	
Years of Education	0.103 [0.083]	0.147 [0.081]	0.075 [0.040]	0.09 [0.040]	33.16 [24.21]	49.16 [23.5]	24.13 [11.55]	30.94 [10.59]
Family Controls?	No	Yes	No	Yes	No	Yes	No	Yes
Instruments	QOB	QOB	YOB*QOB	YOB*QOB	QOB	QOB	YOB*QOB	YOB*QOB
Age Controls?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Dummies?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Weights?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors in brackets. Observations are county-of-birth/quarter-of-birth/year-of-birth cells and all regressions weight by total individuals reporting positive earnings in a cell. The dependent variable in the first two pairs of regressions is the log of average wages in a cell, in the last two pairs of regressions it is the average of cell wages in levels. Regressions are from cohorts of males born between 1944 and 1960; see Table 5 for a description of family characteristic and wage and age variables.