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Childhood Circumstances and Adult Outcomes: Act II†

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That prenatal events can have life-long consequences is now well established. Nevertheless, research on the fetal origins hypothesis is flourishing and has expanded to include the early childhood (postnatal) environment. Why does this literature have a "second act?" We summarize the major themes and contributions driving the empirical literature since our 2011 reviews, and try to interpret the literature in light of an overarching conceptual framework about how human capital is produced early in life. One major finding is that relatively mild shocks in early life can have substantial negative impacts, but that the effects are often heterogeneous reflecting differences in child endowments, budget constraints, and production technologies. Moreover, shocks, investments, and interventions can interact in complex ways that are only beginning to be understood. Many advances in our knowledge are due to increasing accessibility of comprehensive administrative data that allow events in early life to be linked to long-term outcomes. Yet, we still know relatively little about the interval between, and thus about whether it would be feasible to identify and intervene with affected individuals at some point between early life and adulthood. We do know enough, however, to be able to identify some interventions that hold promise for improving child outcomes in early life and throughout the life course.(*JEL* I12, J13, J16, Q51, Q53)

1. *Introduction*

The fetal origins literature has been particularly active over the last several years, rendering reviews by Currie (2009) and Almond and Currie (2011a, 2011b) somewhat dated. Figure 1 shows the number of papers about "fetal origins" in several leading journals by year.

Why does this literature "have legs"? By now, the rudimentary point is familiar. Currie and Hyson (1999), using longitudinal data, showed that long-term outcomes seemed to respond to circumstances in utero; Costa (2000) found that chronic health conditions among older men were predicted by early-life infant mortality rates in their natal areas, which can proxy for the disease environment. Papers exploiting natural experiments to show the long-term impact of fetal and early life shocks such as

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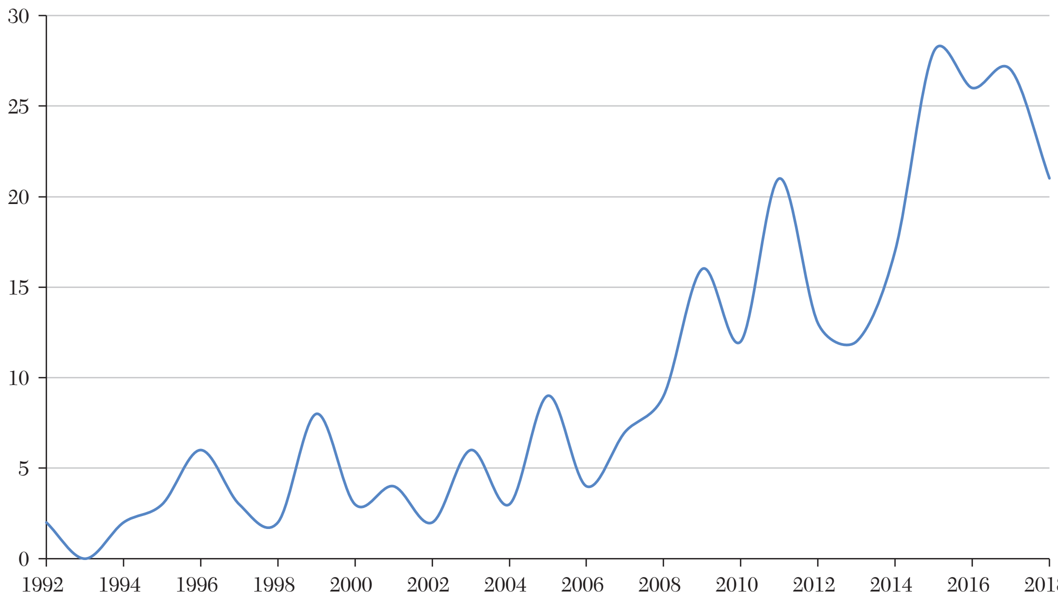

Figure 1. "Fetal (origins, health)" in Top-Five and Top Field Economic Journals by Year

Notes: Figure 1 shows the number of annual publications from January 1993 to October 2015 in the *Quarterly Journal of Economics*, *American Economic Review*, *Journal of Political Economy*, *Econometrica*, *Review of Economic Studies*, *Journal of Labor Economics*, *Journal of Econometrics*, *Journal of the European Economic Association*, *Review of Economics and Statistics*, *Journal of Human Resources*, *Journal of Public Economics*, *American Economic Journal: Applied Economics*, *Journal of Development Economics*, *American Economic Journal: Economic Policy*, and *Journal of Health Economics.*

Almond (2006), van den Berg, Lindeboom, and Portrait (2006), and Bleakley (2007), are over a decade old.

One reason for continued interest is that the large magnitude of the fetal origins effects that have been found and the short time interval in utero suggest that in principle, Pareto improvements can be made by reallocating resources from later to earlier in the life cycle. Given the common definition of economics as the study of the allocation of scarce resources (e.g., Backhouse and Medema 2009), this literature resonates with a core interest of economists: efficiency. Of course, the separation in time and across people (first the mother, then the child) makes it far from obvious how this potentially high-return reallocation of resources can best be achieved.

A second reason for enduring interest in the fetal origins hypothesis (FOH) is that it has proven to describe a surprisingly general phenomenon. Although FOH was first formulated as a specific theory about the effects of prenatal nutritional deprivation on chronic health conditions in adulthood (Barker 1998), economists have found that a wide range of early life experiences matter and that many other (non-health) outcomes are affected. Outcomes of surpassing interest to economists, including IQ and wages, have been linked to early life influences, as have some newer areas of focus such as personality traits.

This evolving discovery speaks to another area of abiding interest for economics: the debate about nature versus nurture. It has become increasingly clear that we are shaped by many occurrences in early life that interact with our genetic endowments to either help or hinder us in reaching our potential and/or adapting to our environment (Manski 2011). The FOH literature suggests that it may be possible to respond to entrenched disadvantage by altering the environment in a way that promotes economic equality (Currie 2011). Thus, the FOH remains important because it suggests that it may be possible to counter-balance forces leading to greater inequality (such as skill-biased technical change) with investments in pregnant women, children, and their environments broadly defined.[1]

In addition to surveying studies that focus on shocks that occur while the child is in utero, this review considers shocks in early childhood. Angrist and Pischke (2010) herald a "credibility revolution" in which clear *a priori* definitions of treatment and control groups combined with time-series variation in environmental conditions help to generate sharp predictions. The FOH hypothesis lends itself to "severe tests" (DiNardo 2007) given that the in utero period is very well defined, and children subjected to an external shock in utero can often be compared to similar children born a little earlier or later who escaped the shock. The beginning and ending dates of the period of "early childhood" are less well defined than the period in utero, making it somewhat more difficult to find clean "natural experiments." It is nevertheless possible to employ compelling identification strategies, and we feel the majority of papers discussed in this review employ compelling research designs.

In view of the large number of relevant studies, we organize the review around a series of "handbook" style tables. In lyric opera fashion, the tables briefly summarize each study's highlights. We also report the data sets used, sample sizes, the empirical strategy employed, main results obtained, and any heterogeneity by subgroup in the tables. We have also tried to express the main effects both as a percent with respect to the outcome mean (when the outcome mean was provided in the paper) and in terms of a standard deviation (SD) (when the outcome's SD was provided). To some extent, reporting estimates in percent and in SD facilitates the comparison of the effects across studies when these focus on a similar outcome (e.g., test scores).

Consistent with the broader trend in economics, many of these papers pay particular attention to the use of large-scale administrative data sets. Beyond reducing measurement error and recording additional outcomes, the use of administrative data can help mitigate problems of selective attrition from surveys and the large sample sizes contribute statistical power to detect milder treatments. These tables largely speak for themselves, so rather than walk through them, we focus in the text on a few studies from each table in an attempt to draw some general lessons from the existing literature and identify promising areas for future research.

We begin by providing a conceptual framework for our review in section 2. This framework emphasizes the child's human capital accumulation process and parent's optimal investment decisions in the presence of in utero and early-childhood shocks

[1] In describing "Six examples of the Long-term Benefits of Anti-Poverty Programs" in 2015, the White House's Council of Economic Advisers summarized research in this literature by economists, noting:

> Economists have traditionally argued that anti-poverty policy faces a "great tradeoff"—famously articulated by Arthur Okun—between equity and efficiency. Yet, recent work suggests that Okun's famous tradeoff may be far smaller in practice than traditionally believed and in many cases precisely the opposite could be the case.

given production functions and budget constraints. The framework can be used to elucidate potential pathways that underlie the empirical findings that we observe in the literature. Section 3 then provides an overview of the literature on the importance of "mild" shocks in the early years. In addition to new evidence about the wide range of factors that matter to child development, an important theme that emerges is that there is often considerable heterogeneity in the effects of specific shocks. Some of the heterogeneity in the effects of shocks may be due to parental responses that either exacerbate or mitigate the effects. Hence, we will also consider the evidence documenting some of these responses and their impacts in section 4.

In addition, a small but growing literature exploits situations where there are "two shocks" in order to either separately identify the effects of initial shocks and responses to them, or to investigate potential interactions between various types of shocks. Since this is an interesting and novel development that resonates with the theory of capacity formation (Heckman 2007), some of these studies are highlighted in section 5.

As discussed above, economists are beginning to investigate policy responses to the FOH. Recent contributions to this literature are reviewed in section 6. A striking feature of the most recent literature is that the growing accessibility of administrative data has allowed researchers to conduct policy evaluation by linking current adult outcomes with past "exposures" to policies in a way that was not possible previously.

One practical difficulty with this approach is that it takes many years to see the effects of fetal or early-childhood shocks on adult outcomes, while timelines for policy decisions are typically much shorter. Thus, one of our conclusions is that it would be extremely useful to know more about the "missing middle" years, and whether long term effects can be predicted using indicators in early and middle childhood. This question is explored in section 7. We summarize our impressions of the literature and its future directions in section 8.

Because the literature is growing so rapidly and in so many directions, this review will not do justice to it all. To make the review more tractable, we focus mainly on studies that appeared after our previous reviews were published, and we do not do justice to the "disaster" literature that relies on lethal natural catastrophes such as famines, pandemics, wars, and hurricanes as natural experiments. Although these papers were very important in the emergence of the FOH, most economists now accept that disasters early in life are likely to have negative long-term effects on survivors, i.e., shocks that are "extreme enough" are likely to have persistent effects. Moreover, the fetal origins perspective will never be pivotal in a cost–benefit analysis of measures designed to forestall such disasters.[2] Even without the benefit of the recent economic and scientific evidence on the FOH, those suffering disaster often acted in a way to shield pregnant women and young children (such as by giving them larger food rations in a famine). Third, the long-term effects of events that involved high mortality can be difficult to discern, given the possibility of mortality selection. If the individuals most vulnerable to catastrophe die, then the remaining population could possibly be stronger on average. Selection can be a particular problem when risk of death is higher for groups with lower socioeconomic status, as it often is.

We will also neglect most of the research on conditional cash transfers, in part because

[2]We do not intend to suggest that insight and nuance cannot be gleaned from the analysis of such events. For example, Anttila-Hughes and Hsiang (2013) study natural disasters and show that the short-run mortality effects are followed by arguably more important future disinvestments which occur with a lag and kill girls.

it has been reviewed elsewhere (see, for example, Fiszbein and Schady 2009). In addition to these deliberate omissions, we will undoubtedly omit important studies by mistake, given how active the research area has become.

2. *Conceptual Framework*

Following Heckman (2007), the production technology we consider is a two-period constant elasticity of substitution (CES) function:

(1)

$$h = A\left[\gamma\left(\overline{I}_1 + \mu_{1g}\right)^{\phi} + (1-\gamma)\left(I_2 + \mu_{2g}\right)^{\phi}\right]^{1/\phi}$$

where h denotes health or human capital as assessed after childhood, A represents factor productivity, and $\overline{I}_1$ and I_2 are the investments made in the first and second periods (e.g., parental investments). The first childhood period is denoted with subscript 1 (e.g., in utero) and the second period of childhood (e.g., preschool years) with subscript 2.[3] A bar superscript indicates that the first-period investment is already set, and what is under consideration is the second-period investment.

Following Almond and Currie (2011a), we assume that μ_{1g} is an exogenous shock to first-period investments (e.g., during pregnancy) and μ_{2g} is an exogenous shock to second-period investments (e.g., during preschool years). The g subscript follows from the fact that exogenous shocks in observational studies typically appear at the group level, whereas the other components of investments, $\overline{I}_1$ and I_2 may vary at the level of the individual child. In general, we will consider the effect of investment shocks (μ_{1g} and μ_{2g}) holding fixed the child-specific investments during the first period of childhood. If we also hold fixed second-period investments (i.e., $\overline{I}_2$ instead of I_2), then we might consider impacts from shocks on h to be "biological" (Royer 2009). The parameter γ, where $\gamma \in [0,1]$, represents the weight each childhood period receives in the production of adult health (or more generally, adult human capital).[4] The parameter ϕ, where $\phi \in (-\infty, 1]$, denotes the extent to which investments in different periods are substitutes or complements, often a key question determining the efficacy of interventions.

We assume that parents make the investment decisions for their (only) child. Investments are costly, and are valued insofar as they improve h. The effects of investments on h are traded off against parental consumption, i.e., parents maximize their utility, $U = U(C,h)$, which is increasing in both arguments. Parents have a budget constraint (expressed in monetary units) of:

$$Y = p_C C + p_I I_1 + p_I I_2/(1+r),$$

where Y denotes family income, p_C and p_I are the market prices of consumption and investment, and r is the interest rate. We assume a Cobb–Douglas utility function of the form:

$$U = (1-\alpha)\log C + \alpha \log h, \quad (2)$$

and consider how the production technology can shape the observed investment response. In particular, we consider two "extreme" production technologies that have polar opposite predictions for the investment response. The first special case is one

[3] For simplicity, we consider only two childhood periods, however, this framework can be extended to any number of periods (Heckman 2007).

[4] γ is the "capacity multiplier" in Heckman (2007).

of perfect substitutability of investments. If $\phi = 1$, then production technology simplifies to:

$$h = A\left[\gamma\left(\overline{I}_1 + \mu_{1g}\right) + (1-\gamma)(I_2 + \mu_{2g})\right]$$

and optimizing parents set:

$$\delta U/\delta C^* = \delta U/\delta h \cdot \delta h/\delta I_2^*(1+r)/p_I.$$

So under this scenario:

$$\frac{1-\alpha}{C^*} = \frac{\alpha}{h} A(1-\gamma)(1+r)/p_I,$$

$$\frac{1-\alpha}{y - p_I\overline{I}_1 - p_I I_2^*/(1+r)} = \frac{\alpha(1-\gamma)(1+r)/p_I}{\gamma\left(\overline{I}_1 + \mu_{1g}\right) + (1-\gamma)(I_2^* + \mu_{2g})},$$

$$I_2^* = \alpha(y - p_I\overline{I}_1)(1+r)/p_I - (1-\alpha)(\gamma/(1-\gamma))(\overline{I}_1 + \mu_{1g}) - (1-\alpha)\mu_{2g},$$

$$\frac{\delta I_2^*}{\delta \mu_{1g}} = -\frac{(1-\alpha)\gamma}{(1-\gamma)} < 0.$$

If the μ_{1g} shock is positive (e.g., prenatal Food Stamps, now known as the Supplemental Nutrition Assistance Program (SNAP)), then optimized postnatal investments fall in response. If μ_{1g} is negative (e.g., prenatal stress), then postnatal investments increase in response. That is, period-two investments are compensatory. When investment responses are compensatory, reduced form analyses of the impact of μ_{1g} will tend to understate biological effects (Royer 2009).

Following Heckman (2007), we now consider the opposite extreme of perfectly complementary investments:

$$h = A \min\left[\gamma\left(\overline{I}_1 + \mu_{1g}\right), (1-\gamma)\left(I_2 + \mu_{2g}\right)\right].$$

Now optimizing parents[5] set:

$$\gamma\left(\overline{I}_1 + \mu_{1g}\right) = (1-\gamma)\left(I_2^* + \mu_{2g}\right),$$

so

$$\frac{\delta I_2^*}{\delta \mu_{1g}} = \frac{\gamma}{1-\gamma} > 0.$$

The period-two investment response is now reinforcing. Attempting to ameliorate a negative prenatal shock is completely ineffective, so it is optimal to match period-one investments (subject to weighting by γ) but consume the rest.

The takeaway from these two examples is that whether parents reinforce or compensate shocks can depend on the production technology. Above, we have assumed an "intermediate" substitutability in parental preferences between consumption and their child's h: Cobb–Douglas. By a similar argument, the substitutability of consumption and child outcomes h will also govern the response to early-childhood shocks. That said, we might suspect that parameters of parental preferences are particularly difficult to modify.

We might think that in addition to low income, y, poor families face restricted access to production technologies. Given a productivity factor $A' < A$ for disadvantaged families, we would see worse child outcomes for equivalent income and investments. It is also possible that poor families have different values of γ and ϕ, which would generate more nuanced predictions for investments and child outcomes.

There have been few attempts to estimate this underlying production function (1), in order to directly measure the key parameters ϕ and γ, presumably because of the detailed data necessary and the strong assumptions that must be made in order to render

[5] For whom period 1 investments are "low," i.e., $\delta U/\delta C^* < \delta U/\delta h \cdot \delta h/\delta I_2^*(1+r)/p_I$.

the production function simple enough to be estimable (Cunha and Heckman 2008; Cunha, Heckman, and Schennach 2010). However, arguably this underlying framework serves to motivate, guide, and interpret the more reduced form and observational work that is discussed below.

The framework also lays bare the multiple mechanisms that can underlie a given empirical result. For instance, if we observe that parents do or do not make compensating later-life investments in a child who suffered from an early life shock, is this because of parental preferences, budget constraints,[6] or the production function they are facing? Answering this question is important because without a knowledge of the mechanisms and responses, a policy designed to address this issue will be a shot in the dark.

Similarly, given the different pathways through which a child's outcomes can be affected, it is not surprising to see pronounced heterogeneity in the effects of many shocks by parental education, income, and other indicators of socioeconomic status (such as race or gender in some contexts). Subgroups may be more or less exposed to correlated shocks that interact with the "primary" shock considered (μ_{1g}), either to magnify or dampen its effect. And even within finely sliced subpopulations, the same group-level shock can yield varying individual exposures depending on other aspects of the production function (A, γ) or the degree to which investments in different periods are substitutes or complements (ϕ). For example, a house that is airtight may let in less air pollution than a neighboring house that is drafty. Third, families have differential access to knowledge and resources that can be used to offset the effects of negative shocks. For instance, while some individuals may have access to credit markets or savings, others may be credit constrained (constraints on I_2). They may also have different preferences for such intervention. For example, in communities where gender discrimination is the norm, parents may not endorse interventions targeted to girls. Finally, children of low socioeconomic status may simply be located at a steeper portion of the production function, yielding a larger effect of a shock of any given size (Almond and Currie 2011a).

Even our focus on the missing research on the "middle years" can be seen as a response to the difficulties involved in understanding the underlying production function for human capital. If it could be shown that outcome measures in middle childhood satisfied the "exclusion restriction" (that early-childhood impacts adult outcomes only *through* observed outcomes in the middle years), this would greatly simplify the data requirements necessary to estimate a structural production function.

We should acknowledge that our stylized framework does not lend itself to considering dynamic complementarities—the idea that "skill begets skill," or alternatively that stocks of capacities acquired by period $t-1$ may make investment in period t more productive (Heckman 2007). Nor does it do justice to "self-productivity" (Heckman 2007), which includes the idea that a given dimension of capacity may also affect the accumulation of another, distinct dimension.[7] For example, cognitive capacity might promote health (or vice versa). Were we to "force" dynamic complementarities into (1) and consider $\frac{\delta h}{\delta \mu_{2g}} / \frac{\delta h}{\delta \mu_{1g}}$, for instance, one would find that the interaction of such shocks is always positive (which departs from what some of the recent empirical literature finds, as discussed below). Additionally, dynamic complementarities are defined by Heckman

6 See page 1,330 (bottom) and footnote 7 of Almond and Currie (2011a).

7 Along with "mechanical" effects on the same dimension.

(2007) in terms of the return to investments and how they vary with the baseline *stock,* which is absent from our stylized model. Thus, we will not attempt to model dynamic complementarities here, but merely reiterate Heckman's definition, namely:

$$\delta^2 f_t(p, \theta_t, I_t)/\delta\theta_t \delta I_t$$

where f is monotone increasing in its arguments, twice continuously differentiable, and concave in I, p represents parental capabilities, and θ_t represents (a vector of) child capabilities. Heckman assumes that dynamic complementarities are positive. With instruments for both the baseline stock of human capital and endogenous subsequent investments, we could shed light on the magnitude of dynamic complementarities without making assumptions about their sign or functional form.

In practice, it is often not empirically possible to distinguish between dynamic complementarities, self-productivity, and the possibility that parents (or society) invest more (or less) in children with higher baseline stocks of human capital in unobserved ways (e.g., Malamund, Pop-Eleches, and Urquiola 2016). Nevertheless, distinguishing among these alternatives remains conceptually important because the source of heterogeneity in the dynamic effects of shocks has implications for the effectiveness of remediation, and specifically, whether investments later in childhood can reduce or eliminate damage originating from the prenatal or early-childhood period. For instance, if a child has cognitive difficulties as a result of being premature, a parent may respond by spending more time with the child, reading to them, and assisting with homework. We may wish to examine the effects of these interventions, but the interventions themselves are endogenous to the child's state. Moreover, while we would like to be able to consider each potential investment as a stand-alone intervention, in reality, many aspects of the environment are in flux at any point in time, and different types of investments may complement or substitute for each other. A few studies that attempt to address dynamic complementarities are discussed in section 5, and illustrate the challenges researchers face. We begin below with the simpler case of single shocks experienced in early childhood.

3. *Make Mine Mild*

Events and circumstances that are commonly experienced can have lasting effects on children's trajectories. For example, there is growing consensus that relatively mild nutritional deprivation at critical periods can seriously impair fetal and child development. In terms of our conceptual framework, both $\delta h/\delta\mu_{1g}$ and $\delta h/\delta\mu_{2g}$ may be sizable, even when the shock considered is small in magnitude, relative to total investments, or short in duration. Critically, "mild" prenatal shocks are much more common than extreme ones like famine. Table 1 summarizes much of the recent literature about mild shocks, which are divided into several categories including: nutrition, stress, disease, pollution, weather shocks, and alcohol and tobacco. The last column reports on heterogeneity in the estimated effects on different groups, a format that is followed in all the tables that follow. With some exceptions, these papers aim to capture the biological effect of early-childhood shocks, implicitly assuming that second-period investments are unresponsive to the shocks and fixed ($I_2 = \overline{I}_2$).

3.1 *Nutritional Shocks*

Panel A of table 1 summarizes some of the recent literature on nutrition-related shocks. Fasting is of broad interest, as roughly three-quarters of the world's 1.6 billion Muslims spent some portion of the *in*

TABLE 1
EFFECTS OF MILD EARLY LIFE SHOCKS ON FUTURE OUTCOMES

Study	Microdata, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/effects
Panel A. Nutrition shocks				
Adhvaryu et al. (2016). Effects of introduction of iodine fortification in the United States on age 25–55 education and labor market outcomes.	1) Census 1950–80 that provide data on educ., wages, $N = 418{,}791$ observations. 2) Data on the geographic distribution of iodine deficiency prior to salt iodization comes from spatial distribution of goiter in 1924.	DD: Compare cohorts exposed in utero (1920–27) to iodized salt with those slightly older (& unexposed) (1928–31), across states with high versus low iodine deficiency rates prior to the salt fortification. Models include rich controls, region × birth year dummies, & year of birth FE & region of birth FE using nine Census Bureau divisions.	Labor force participation: +1.35pp (2.2% = 0.03 SD) (women: 1.63pp). Positive wage earning: +0.8pp (2.0% = 0.016 SD). No significant effects on education. Income quintiles: the likelihood of being in the second wage income quantile rose by 0.35 to 0.68pp more during and after the rollout of iodized salt in high goiter compared to low goiter states.	Results are driven by impacts on women: salt iodization accounts for 5% of the rise in female participation 1950–90. Effects on LFP were larger in the first & second income quintiles: effect = 1pp.
Almond and Mazumder (2011). Effects of exposure to Ramadan fasting on birth outcomes and adult disability, education, and mortality in Michigan, Iraq, and Uganda.	1) Census data for: Iraq 1997; $N = 250{,}000$ (Muslims: 11%), Ages 20–39 Uganda 2002; $N = 80{,}000$ (Muslims: 11%), Ages 20–80. 2) Michigan natality data, universe of births, 1989–2006, $N \sim 2.5$M birth records.	Exploit the timing (month) of Ramadan as a natural experiment in diurnal fasting and fetal health. DD model: compare Muslim outcomes (treatment) to non-Muslim outcomes (control). Identifying assumption: pregnancies are not timed relative to Ramadan along unobserved determinants of health. Models include controls for month of birth FE, geographic location FE, and rich individual controls (estimates are ITT).	Exposure to Ramadan: BW = −18gr for Arab-named pregnancies (−0.6%). Effects by trimester: −21, −26, 0 grams, effects by month: −40 grams in first 2 months of pregnancy & in months 5th/7th significant effects. Adult disability: +22% (eff. in first month only, driven by mental or learning disabilities.) Mortality: "due to aging" +0.37pp (~+70% wrt the mean). Wealth: −2.6pp, −2.1pp less likely to own a home (males only). Education: no effects.	Most of the estimated effect of early pregnancy exposure is in the middle of the distribution. No gradient in BW by maternal education, Medicaid use, or month prenatal care was initiated. Effect sizes are similar in Uganda and Iraq.
Almond, Mazumder, and van Ewijk (2015). Effect of exposure to Ramadan fasting in utero on age 7 schooling attainment in England.	1) England's Register data "key stage 1 scores," students' academic performance for those who attend state schools, 1998–2007. 2) Pupil Level Annual School Census (PLASC), covers all enrolled pupils in each year, includes demog. & socioeconomic characteristics including ethnicity. Authors link data on the key stage 1 scores to the PLASC for e/year using unique student identifier from 2002 onwards and a two-step matching process prior to 2002. $N = 326{,}592$ observations.	DD strategy: authors take the effect on Muslims and use and non-Muslims to control for possible seasonal effects. Design exploits the fact that Ramadan moves through the calendar. Control group: Caribbean students. Models include child's state of birth × child's YOB FE, cubic time trend of the N_days between the DOB & January 1, 1960. Authors also fully interact each regressor (except for the geographic FE) w/a dummy for Muslim.	Ramadan exposure in the first trimester: Test scores (math, reading, & writing "Key Stage 1"): −0.05 to −0.08 SD. By months of pregnancy: math: −0.068, −0.059, −0.081 SD in first, second, & third months of pregnancy (no effects in other months). Reading: −0.054, −0.067, −0.073 SD. Writing: −0.052, −0.053, −0.055 SD. Effects rise monotonically over the course of the first trim.; largest effects in third trim. Estimates are downward biased to the extent that Ramadan is not universally observed.	NA

(*Continued*)

TABLE 1
Effects of Mild Early Life Shocks on Future Outcomes (*Continued*)

Study	Microdata, *N*	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Feyrer, Politi, and Weil (2013). Effect of introducing iodine fortification in the United States in 1924 on military skill levels (young adult males) and thyroid related deaths.	1) Statistics from draft physicals for WWI, include info. on the incidence of goiter prior to treatment for 151 regions. 2) Data set of men who enlisted in the Army during WWII; indicates who was drafted into the air force (highly skilled) versus ground forces (less skilled) based on an Army General Classif. Test (AGCT), source: National Archives & Records Administration $N = 2$ million records in 1938–46.	Compare cohorts born just before & after iodized salt introduced in 1924. Two sources of variation: i) preexisting (<1924) iodine deficiency; ii) timing of the intervention. Also exploit the fact that the air force was assigned draftees w/higher test scores than ground forces. This nonrandom assignment is key for identification strategy. Linear Prob (& Logit) Models include interaction of goiter in 1924 in region of birth × YOB dummies, YOB dummies × enlistment year dummies, enlistment month dummies.	Individuals born in 1925 & 1926 (introduction of iod. salt was in 1924): Prob(being assigned to air forces—indicator of high skill): +0.3 to 0.6pp (full sample); +2.5–8.7pp (individuals in initially high goiter areas). Thyroid-related deaths: +10,000 in 1925–42 (older groups more affected because they were iodine deficient for a longer period). Note: In 1926 death rates were >6 times as high for women as for men though sample is male.	NA
Fitzsimons and Vera-Hernandez (2014). Effect of breast feeding in the United Kingdom on cognition and health at age 7.	UK Millenium Cohort Study; 9 months (2000/2001), 3 years (2004/05), 5 years (2006), 7 years (2008). Data includes hour of child's birth. $N = 18{,}500$ babies born (sample excludes C-section deliveries). Authors corroborate data w/Maternity Users Survey, a postal survey conducted on 26,000 mothers, three months after birth.	Instrumental variables: Exploit timing in day of the week children are born (children born on weekend, or just before, are less likely to receive breast-feeding support services). IV: instrumental variable is being born on a weekend.	Breast feeding has large effects on cognitive development, but NOT on noncognitive skills or physical health. Breast feeding: Cognitive dev index: +0.6 SD.	NA
Greve, Schultz-Nielsen, and Tekin (2015). Examine the effect of Ramadan fasting on student outcomes in Denmark.	1) Danish administrative records on Danish, English, Math, & Science test scores in ninth grade. 2) Danish birth registry, which includes exact info on gestation length and birth date $N = 11{,}291$ children.	DD: exploit the overlap between time in utero of children born in Denmark with the month of Ramadan. Treatment group: children born to immigrant parents from predominantly Muslim countries Control group: children born to immigrant parents from predominantly NON-Muslim countries.	Child is Muslim × Child was exposed to Ramadan: No overall effects on Danish, English, math, or science test scores. Authors estimate models by gender & by gender-SES.	Estimates are larger for girls and children of lower socioeconomic status mothers. Danish test scores: −1.08 SD (females and low SES children). English test scores: −1.84 SD; −1.6 SD (females and low SES children). Math test scores: −1.04 SD; −0.98 SD (males and low SES children).

(*Continued*)

TABLE 1
EFFECTS OF MILD EARLY LIFE SHOCKS ON FUTURE OUTCOMES (*Continued*)

Study	Microdata, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Hoffmann (2014). Effects of Ramadan fasting in 7 Muslim countries on sex ratios of 0–60 month olds.	DHS data from 7 Muslim countries, 1987–2013; $N = 275{,}627$ births.	Exploit variation in the timing of Ramadan throughout the year, across countries. Treatment group: individuals exposed to Ramadan (at least 1 month) during gestation, controls not exposed. Models include month of birth, year of birth, & country FE, & country-specific time trends, mother's FE.	Exposure to Ramadan during pregnancy: Prob(child is a girl): +2.4% (+0.024 SD). Exposure to Ramadan in the first three months of pregnancy: Prob(miscarriage): +1% (0.004 SD). No effects on neonatal death or infant death.	Effects somewhat larger in rural areas and in mothers without primary education. e.g., for less educated mothers: Pr(child is a girl): +3.4% (+0.035 SD) Pr(miscarriage): +1.7% (+0.017 SD) Pr(neonatal death): no effect Pr(infant death): 1.4% (0.014 SD) (driven by exposure to Ramadan in the month of birth).
Linnemayr and Alderman (2011). Effect of nutritional supplementation in Senegal on weight for age for children 0–3.	Baseline survey conducted in April 2004 in 212 villages, includes info on health status of children, SES of the children's households, nutrition, child care, etc.; follow-up in 2006; $N = 200{,}000$ households.	1) DD comparing 111 treatment and 110 control villages. 2) IV: use planned treatment assignment as an instrument for actual treatment. 3) Propensity score matching across treatment and control villages. Models include initial village-level characteristics (e.g., distance to the next village), interactions of village characteristics and planned treatment, dummies for child age.	Weight-for-age: Using DD model: +0.1 SD Using IV: +0.31 SD (effect only observed on children <6 months). Using PSM: +0.27 SD	By child's age: authors find significant weight gain for younger children (these children were impacted in utero). "Most malnutrition occurs by 18 months w/limited catch-up after that."
Ludwig, Rouse, and Currie (2013). Maternal weight gain during pregnancy and child BMI in Arkansas.	1) Vital Statistics Natality data: universe of births in Arkansas 1989–2005, $N = 42{,}133$ women (91,045 offspring). 2) State mandated data on childhood BMI from public schools (August 18, 2003 to June 2, 2011).	1) Exclude pre & post terms, multiple gestational N, maternal diabetes, & extremes in BWs. 2) incorporate measured confounders in models. 3) Sibling FE design. Models include rich maternal controls, month of child's age, & year of birth FE.	One additional kg of pregnancy weight gain: Childhood BMI: +0.022 (0.06% = 0.004 of a SD). Childhood overweight/obesity: OR increased by 1.007. Variations in pregnancy weight gain accounted for a 0.43 kg/m2 difference in childhood BMI.	NA
von Hinke Kessler Scholder et al. (2014). Examines short- and long-run effects of maternal alcohol consumption during pregnancy.	1) Avon Longitudinal Study of Parents and Children (ALSPAC); Panel follows cohort born in Avon, England in ~1991–92. $N = 4{,}088$ children. 2) Children's scores are obtained from the National Pupil Database, a census of all pupils and measured at 7, 11, 14, and 16.	Exploit genetic variation in the maternal alcohol-metabolism gene ADH1B to instrument for fetal alcohol exposure. Authors claim that at a population level, genetic variants are unrelated to socioeconomic characteristics. Instrument: dummy for whether an individual carries either one or two copies of the rare allele. Models control for child's genotype on the same variant, and for the ancestry-informative principal components.	Exposure to an additional unit of alcohol (instrumented by mother having the rare allele): First stage: Mothers who carry the rare allele are −11 to −15pp less likely to consume any alcohol during pregnancy (−53% w.r.t. the mean). Key Stage examination test scores (at ages 7, 11, 14, 16): −0.2 to −0.3 SD (no mean stats provided to compute % changes of the coefficient).	Estimates are slightly larger for children of lower education and lower-income mothers. No difference by gender or partner's social class at birth.

(*Continued*)

TABLE 1
EFFECTS OF MILD EARLY LIFE SHOCKS ON FUTURE OUTCOMES (*Continued*)

Study	Micro-data, *N*	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/effects
Panel B. Stress				
Aizer (2011). Impact of domestic violence on birth outcomes in California.	Hospital admissions for assault during pregnancy in California, 1991–2002 matched with universe of births in California. $N \sim 500{,}000$ pregnant women/yr.	Two challenges: i) possible omitted variables bias, ii) nonrandom under-reporting of domestic violence. Author uses: i) IV: A control function where IV is the enforcement of laws against domestic violence across jurisdictions, ii) Matching estimates on many covariates ($N = 1{,}542$ women matched). Models include rich indiv. controls, county × year dummies, a quadratic in year, county FE for the five largest counties in California.	As criminal sanctions increase, domestic violence declines. Using control func. method: BW: −163gr due to hospitalization for an assault while pregnant (OLS models predict a BW decline of −161gr). Effects of violence on BW are larger in first half of pregnancy than in 3rd trim.'s (−166, −118, & −97gr in e/trim. respect.) Using matching: BW = −159gr	NA
Aizer, Stroud, and Buka (2016). Examine relationship between measured cortisol levels during third trimester and education at age 7.	National Collaborative Perinatal Project (NCPP); mothers' cortisol levels were measured in third trim. and their children were followed up to age 7; years of birth: 1959–65, sample used in study are two cities: Boston and Providence. $N = 1{,}093$ pregnancies (368 siblings).	Regression model w/indicator of cortisol exposure in pregnancy and rich individual controls and sibling FE.	Being exposed to highly elevated cortisol in utero: Education: −0.39 to −1.1 yrs of schooling (0.58 SD) (sibling FE)	Children born to mothers without a HS diploma & exposed to highly elevated cortisol in utero: Education: −2 yrs of schooling (sibling FE). No effect among children of more educ. moms.
Currie and Rossin-Slater (2013). Effect of stress due to potential hurricane exposure during pregnancy on infant health outcomes in Texas.	1) Vital statistics, 1996–2008, includes info on mothers' names, DOB, & residential addresses (helps identify mothers who were in the path of major tropical storms & hurricanes), child's exact DOB, county of birth $N = 1{,}270{,}441$ births 2) Data on hurricanes come from the Weather Underground Hurricane Archive; publicly available.	Exploit the temporal & geographic variation in the occurrence of hurricanes in Texas. Mother FE (to account for mother's time invariant characteristics) with IV to account for a mother's endog. migration in response to a hurricane. Instrument is a mother's county of residence in first pregnancy.	Exposure to hurricanes: No effects on LBW or gestation. Prob. of abnormal cond.: +60% (including meconium aspiration syndrome or being on ventilator >30 min). Prob. of having complications during labor/delivery: +30%.	NA

(*Continued*)

TABLE 1
Effects of Mild Early Life Shocks on Future Outcomes (*Continued*)

Study	Micro-data, *N*	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Lee (2014). Intergenerational effect of stress pregnant mother suffered (due to Kwangju uprising in Korea) on her children's birth outcomes 20–22 years later.	1) Korean vital statistics, 2000 & 2002, N = 1,124,848 births.	Natural experiment: Massacre of >500 civilians and wounding of 3,000 in the Kwangju (KU), Korea in 1980. DD: Assume that individuals whose mother resided in Kwangju in May 1980 & were born between June 1980 & February 1981 were exposed to stress in utero caused by violence. Models include cubic time trends and rich mother controls.	Exposure to the KU shock by trimester of pregnancy: BW: −37grams (−1.1%) (1st trim.), −105 grams (−3.2%) (2nd), no effect (3rd trim.) LBW: +1.7% (1st trim.), +4.0% (2nd trim.), +1.3% (3rd trim.) Preterm: no effect (1st trim.), +4.6% (2nd trim.), +1.5% (3rd trim.).	NA
Persson and Rossin-Slater (2018). Asks how death of a family member during pregnancy affects birthweight, mental and physical health, hospitalizations, and income up to age 30.	1) Universe of children in Sweden in 1973, 1977, 1983, 1988, 1995, 1999, 2001, & 2005. Link child to information on siblings, parents, grandparents, aunts and uncles, and maternal great-grandparents. Review cause of death register for all family members, combine with information about child's exact DOB, birth outcomes, and later health outcomes as well as income and taxation register with labor income up to age 30. N = 63,756 observations.	Exploit the quasi-random variation in the exact timing of bereavement relative to the child's expected date of delivery at full-term. Models include year & month of conception FE, & municipality where a mother lived at conception of child FE.	In utero exposure to the death of a relative: Mental health outcomes Uses prescription drug: +6% (No standard deviations of ouctomes provided) Uses antianxiety drugs: 11% Uses antidepression drugs: 9% Daily dose of ADHD med.: 23% BW: −18gr (−0.5% = −0.03 SD) (effect(s) driven by lower tail of distrib) LBW: +20%; VLBW: +30%; Preterm: +15% No significant effects on physical health or income.	NA
Quintana-Domeque and Rodenas-Serrano (2017). Effect of in utero stress due to terrorist attacks in Spain on birth outcomes.	1) Vital stats; live births conceived btw 1980–2003; *N* = 6.5 million live births 2) The Victims of ETA Dataset: provides the *N* of casualties committed by ETA between January 1980 & February 2003 in each day & region Datasets merged at the trimester and province levels.	DD: exploit the variation in casualties across provinces (50 geographical regions) & months-years (more than 275 conception month-years) Models include mother's province of residence FE, year & month of conception FE, a vector of control variables (birth order, mother's age, marital status, etc.), size of the municipality of residence categories, province-specific linear time trends.	One additional bomb casualty in the first trimester of pregnancy: BW: −0.7grams (−0.02%) (no standard deviations provided in table 1) Prematurity: +0.9 per 1,000 live births (−0.02%) Normality: 0.6 per 1,000 live births. Results are driven by exposure to terrorism in the first trimester.	By gender: no differential effect for both boys and girls (results not shown).

(*Continued*)

TABLE 1
EFFECTS OF MILD EARLY LIFE SHOCKS ON FUTURE OUTCOMES (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Panel C. Disease				
Almond, Currie, and Herrmann (2012). Effect of disease environment as proxied by postneonatal mortality rates on the health of women observed in the US vital statistics natality data.	US vital statistics natality & mortality records: authors are able to link the postneonatal mortality rates in the mother's state of birth & provide info on outcomes of mother & infant. 1) Vital statistics natality micro-data, 1989–2006, N ~ 3.5–4 million births/yr. 2) Mortality microdata, 1960–91.	Exploit the geographic & temporal variation in postneonatal mortality rates (across racial groups) from 1960–90 in five large states. Aggregate data into cells by mother's state and YOB, age, and race, and child's state and YOB. Regression models (defined at the mother's race, state of birth, in YOB & state, age that mother gave birth) include mother characteristics, mother's state of birth FE, child's YOB × child's state FE, maternal single year age FE, mother's state of birth linear time trends, linear time trends in maternal age FE.	An additional postneonatal death per 1,000 in the year after mother's YOB: Health: Diabetes: 1.8% (0.009 SD); 1.4% = 0.007 SD (whites), 3.5% = 0.012 SD (blacks). Hypertension: no effects SES: Educ. attainment: −0.1% (−0.012 SD) Married: −0.6% (−0.009 SD) Maternal behav.: smoking +2% (−0.02 SD); high weight gained 1.7% (0.01 SD).	Larger impacts for blacks than for whites. The mean *PNMRt*+1 for whites (4.0) and the mean *PNMRt*+1 for blacks (8.4) suggest that the early life disease environment increased the probability of diabetes during pregnancy by almost 30% for blacks compared to 5.6% for whites.
Baird et al. (2016). Effects of deworming on test scores and anthropometrics of 8–15-year-old children in Kenya.	1) Longitudinal data from 75 rural schools treated 1998–2001. 2) Kenya Life Panel Survey (KLPS) 2007–2009, tracked N = 7,500 respondents who had been enrolled in grades 2–7 in the 75 treated schools at baseline in 1998.	Reduced form model: includes dummy for treatment, N of treatm. pupils in 6km, & N of treatm. schools in 6km & baseline indiv. & school characteristics. Estimate exposure to spillovers using the N of pupils attending deworming treatment schools within 6km, conditional on total N of primary school pupils within 6km.	Health: Self-reported health is v. good: +4.1pp (+ 0.085 SD); Prob of miscarriage: −2.7pp (−0.69 SD) (females only). Education: yrs. of schooling +0.3 (+0.10 SD), English vocab. tests +0.076 SD. Labor market outcomes: work hours: +1.76hrs = 12% (+0.12 SD); wages: +30.1 log points = 3.8% (0.36 SD). Shifts in employment towards full-time jobs with higher wages (i.e., manufacturing) (males) & away from casual labor & domestic services (females).	No differences in labor supply effects by gender or by age or by initial infection rate. Externality effects: an increase of 1 SD in local density of treatment school pupils (917 pupils = treating 20% of local primary school pop.), leads to: +3 hours worked/wk.

(*Continued*)

TABLE 1
EFFECTS OF MILD EARLY LIFE SHOCKS ON FUTURE OUTCOMES (*Continued*)

Study	Micro-data, *N*	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Beach et al. (2016). Typhoid rates in three-yr. MA around birth on adult education and earnings.	1) Census data of 1900 & 1940. 2) City-year level typhoid fatality rates for 75 cities (source: Whipple (1908); 10th annual Census mortality statistics). $N = 189{,}515$ observations	Exploit variation in typhoid fatality rates during early life as a proxy for water quality. Instrument typhoid fever using lagged city-level typhoid rates that lie upstream). "Cities that dump their sewage into a river will increase future typhoid rates for cities downstream." Models include controls for being black, city & year of birth FE, birth order FE.	First stage: Lagged typhoid rates in the feeder city are a strong predictor of typhoid rates in the receiving city (*F*-stat >517.81). Educational attainment: +1 month of schooling (OLS) (0.9% = 0.026 SD) (no effect obtained from IV). Earnings: +1% (OLS) (0.012 SD); +9% (IV) (0.10 of a SD). No effect on home owning.	NA
Bhalotra and Venkataramani (2013). Effects of diarrheal disease on test scores of children in Mexico at age 9–15.	1) Mexican Family Life Survey (MxFLS), $N = 8{,}500$ HHs in 150 communities in 16 states, waves: 2001–02; includes month & year of birth, birth state, indicators of HH wealth, parental investment. 2) PISA Test score data: waves 2003, 2006, & 2009 for cohorts born in 1987/1988, 1990, & 1993; includes school quality, parental investments. 3) Census micro-data 1960–2000 from IPUMS (to study empl. & occup. trends by gender).	Reduction in the risk of waterborne disease from a major water reform in Mexico in 1991. Reform introduced suddenly in reaction to threat of cholera in neighboring countries. Exploit state × yr variation in program intensity. DD model: includes respiratory disease as a control disease unaffected by the reform but a leading cause of child morbidity & mortality. ITT estimates identifying assumption: test scores are uncorrelated w/the timing of the water reform. Models include indiv. controls in pre-1991 × dummy post, state & year of birth FE, state time trends.	A 1 SD reduction in childhood diarrhea mortality rates: Test scores (Raven): +0.1 SD (0.6%) (girls only) Reading: 0.04 SD (+0.7%) (girls only) Math: 0.05 SD (+0.8%) (girls only) A 1 SD decrease in diarrheal mortality rates in childhood reduces gender gap by 80% (MX gender gap smaller than the OECD avg. gap: 11 in 500 points).	Effects are driven by low SES girls.
Bhalotra and Venkataramani (2015). Examine the impacts of pneumonia in infancy on adult (males) education, employment, disability, income and income mobility.	1) US Census micro data for 1980–2000; authors focus on men only who were born born between 1930–43; $N = 2{,}018{,}898$ men (of which less than 10% are Blacks).	Exploit state variation in 1937 in the introduction of sulfa antibiotics to prevent pneumonia. Treatment group: cohorts in their infancy in 1937 or later. Control group: cohorts in their infancy before 1937. Models include an interaction between: (the pre-sulfa pneumonia mortality rate in the birth state in 1930–36) × (Dummy for cohorts who were in their infancy in 1937 or later) Models include indiv. controls, birth state & birth year varying observables, state linear time trends.	A 1 SD decline in pneumonia exposure in the birth state due to the introduction of antibiotics: Years of schooling: +0.1 (no SD provided in paper) HS completion: +1.5% College completion: +1.2% Cognitive disability: −0.6% Work-related disability: −0.6% Employment: +0.4% Income: +1.5% Having income in the lowest quintile: −0.47% Having income in the highest quantile: +0.41%	By levels of institutional-racial segregation: "Black men born in the least segregated states reaped substantial gains from infant exposure to sulfa drugs, while blacks born in the more segregated states saw muted gains."

(*Continued*)

TABLE 1
Effects of Mild Early Life Shocks on Future Outcomes (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Currie and Schwandt (2013). Shows that there is seasonality in health at birth within mother and that this may reflect seasonal flu epidemics.	1) Vital Statistics Natality data in NJ (1997–2006), NYC (1994–2004), & PA (2004–2010). N = 647,050 pairs of siblings (1,435,213 children). 2) Info. on prevalence of Influenza is obtained from the Center for Disease Control (1997–onward).	Analyze the seasonality of health at birth by comparing siblings conceived by the same mother at different times using sibling FE. Compare impact of coming to term in early winter in high flu and low flu years.	Conception from Jan. to May is associated with significant reductions in gestation (−0.08 week) and prematurity within families: +1pp (13.2%). Birth weight falls by −4gr (increases by 8gr if conception occurs in June–August). More severe flu seasons show stronger effects. In children coming to term in high flu season the risk of negative birth outcomes is much higher, suggesting that exposure to flu late in pregnancy causes preterm delivery.	The seasonal pattern in health outcomes is observed across SES, child gender, & birth order groups.
Ozier (2014). Spillover effects of the Kenya deworming program measured at ages 8–15.	Data on children were collected in 2009 and in 2010 at all of the deworming project schools in Samia and Bunyala districts of Kenya's Western Province; includes N = 20,000 children with info on collected height, weight, and migration status; and 2,400 children, cognitive measures were collected.	"Conditional on child's age & data collection year, deworming exposure was randomized." Treatment group: children born in 1998 in communities w/ the deworming program. Control group: children born in 1998 in a community w/out the deworming program (the program only started to operate in 2001 in control communities, i.e., when these cohorts were age 3).	Community deworming before age 1: Raven's matrices: +0.22 SD PPVT: no effect Verbal fluency: +0.19 SD. No effects on height. "That Raven's Matrices are responsive to the intervention suggesting that even mild disease burdens early in childhood can alter cognitive development."	By gender: no differences. By differential exposure within the HH: Having older siblings in an affected school: Raven's matrices +0.42 SD. Having older female siblings in an affected school: Raven's matrices +0.84 SD (females more likely to care for younger siblings).
Schwandt (2017). Effect of seasonal influenza during pregnancy on birth outcomes, earnings, welfare dependence, etc. at 19–32 in Denmark.	1) Danish Birth Records, 1980–93; N = 700,000 births. 2) Income Register & Population Register, 1980, 2012; ages 19–32. 3) National Patient Register, 1980–2012, ages 18+; used to identify influenza-like illness, infections in pregnant women, and link births. Register merged using personal identifiers. 4) Monthly surveillance data of nation-wide influenza spread.	Identifying variation at cohort and individual level: 1) society-wide influenza spread; 2) information on individual mothers hospitalized with influenza-like illness. Month and mother FE are included to control for seasonal confounders and selection into individual maternal infections. Balancing regressions to test exclusion restriction.	Influenza admission during pregnancy (dummy): BW: −77grams (−2.2% = −0.14 SD). LBW: +2.9pp (+66%). Gestation (weeks): −0.3 (−0.8% = −0.17 SD). Preterm: +4pp (+88%). Sex ratio: no effect. LT outcomes: Earnings: −9% (0.09 SD). Labor force participation: −5%. Welfare dependence: +33%. Individual-level effect of influenza hospitalization during pregnancy 1.5–3 times larger than cohort-level estimate of average influenza infection.	Effects on birth outcomes driven by exposure during third trimester. Labor mkt. outcomes most affected by second trimester exposure. Both effects on birth and labor market outcomes stronger for low-income mothers.

(*Continued*)

TABLE 1
EFFECTS OF MILD EARLY LIFE SHOCKS ON FUTURE OUTCOMES (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Venkataramani (2012). Effects of malaria exposure in Mexico on adult cognition.	1) 2002 Mexican Family Life Survey; N = 1,649 men and 2,184 women. Data include test scores, employment, HH & individual income, expenditure, education, anthropmetrics, morbidity, health care utilization, migration. 2) State-level data on the avg. death rate (per 100,000) from malaria 1949–53 (eradication began in 1957).	Exploit the nationwide introduction of malaria eradication efforts in Mexico: DD strategy: compare the change in outcomes btw cohorts born before & after the intervention in areas that benefited more from the policy against the same change for cohorts born in less malarious regions. Models include state and year of birth FE and birth-state-specific linear time trends, individual controls.	Birth year exposure to malaria eradication: Raven Progressive Matrices test scores: +0.11 to 0.22 SD (+25 to 51%). Household consumption expenditures: +6.5 to 13.6%. Total Schooling: no effect. Cohorts affected by the policy entered and exited school earlier: Age at school entry: falls by −0.15 to −0.37 years. Age at school exit: falls by −0.55 to −1.06 years.	By gender: effects are only observed for men.
Ward and Phipps (2014). Exposure to flu in utero on health and cognition of 4–5 year old children in Canada.	1) National Longitudinal Study of Children and Youth (NLSCY), 1992 (week 37) to 2011 (week 34), N = 11,888. 2) Rate of laboratory-confirmed influenza includes influenza laboratory surveillance rates from the Canadian Respiratory Virus Detection/Isolation Surveillance System (RVDI). 3) Hospital counts from records of inpatient discharges, 1996–2006; & Google Flu Trends data.	Exploit the weekly variation in influenza surveillance rates across provinces to estimate effects of exposure during gestation on child cognition & health. Models include the influenza term & its square to capture nonlinear effects. Also year, month, & province FE, seasonal factors ,& individual characteristics. Conception date: N of gestational weeks before e/child's DOB where gestational length is based on the date of the mother's last menstrual period.	An increase of 1 SD from the mean Influenza surveillance rate (in the whole pregnancy) has no statistically significant effect. The effect of each week of Influenza during the first trimester (13 week-period): PPVT: −1.1pp (1.1% = 0.07 SD) Chronic condition: −2.8pp (−14.7% = −0.08 SD).	NA

(*Continued*)

TABLE 1
EFFECTS OF MILD EARLY LIFE SHOCKS ON FUTURE OUTCOMES (*Continued*)

Study	Micro-data, *N*	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Panel D. Pollution				
Aizer et al. (2016). Examine the effects of Rhode Island's policies to reduce preschool blood lead levels on third grade test scores.	1) Blood lead levels (BLL) from Rhode Island (RI) Department of Health: includes age at test, test method (capillary or venous), census tract, and BLL. 2) Child's test scores from the RI Department of Education: include NECAP12 test scores in third grade. 3) Confidential birth certificates of children born in RI: include child's home address + individual and maternal characteristics. $N = 71{,}000$ children.	IV to control for confounding and for measurement error in blood lead levels (instrument: introduction of a lead remediation program). Models control for individual covariates, Census tract FE, average test scores in the child's school & grade, year, and month of birth FE. Key assumption: Growth in the *N* of lead safe certificates in a neighborhood is uncorrelated with other factors increasing test scores. Authors also estimate models using the subset of children who have both venous & capillary measures using the former as instruments for the latter.	A 1-unit increase in mean blood lead: Reading test score: −0.07 SD (−2%) Probability of substantially below proficient in reading: +25.7%. The BLL levels declined by 2.23 milligrams per deciliter from 1997 to 2005.	By score distribution: "The effects are larger at the lower end of the score distribution."
Arceo, Hanna, and Oliva (2016). Asks how variations in air pollution (CO and PM10) due to inversions in Mexico City affect infant mortality.	1) Mortality data from the Ministry of Health; includes birth & death certificates, & contains info on date of birth & municipality of resident. *N* = not specified. 2) Pollution: Automatic Network of Atmospheric Monitoring (RAMA) longitudinal data; includes PM10, SO2, CO, O3; years of data 1997–2006 for 48 municipalities. 3) Thermal inversions data from Ministry of Environment.	1) Reduced form model that includes municipalities FE, week FE, & municipality-specific year trends. 2) IV approach: Exploit the meteorological phenomenon of thermal inversions; use the *N* of inversions in a given week to instrument for pollution levels that week. IV Models include rich controls, municipality & year FE, & week-municipality trends.	IV results: A 1% increase in CO: Infant mortality: a 0.23% increase. A 1% increase in PM10 over a year: Infant mortality: a 0.42% increase. First-stage results: E/inversion leads to a 3.5% increase in PM10 & a 5.4% increase in CO. The overall decline in pollution from 1997 to 2006 predicts a decline of 277 infant deaths per 100,000 births.	Nonlinearities in the effects of pollution: using estimates from Currie & Neidell (2005) authors find suggestive evidence of nonlinearities only in the CO effect.
Bharadwaj et al. (2017). Effect of fetal exposure to carbon monoxide on fourth grade test scores in Chile.	1) Vital statistics: Universe of births 1992–2002; $N = 627{,}530$ births. 2) Education data (SIMCE): test scores (math, language) for e/student, 2002–2010. 3) Data from pollution monitors (CO, PM10, ozone 3), 1998–2001. Authors construct an Air Quality Index (AQI). 4) Data on air quality alerts to help address concerns related to avoidance behavior. Data are merged using individual IDs.	Sibling FE regressions control for child's gender, & for seasonality, temperature, precipitation, fog, wind, & month and year FE. Models also include a measure of avoidance behavior based on air quality alerts. As a robustness check, authors use PM10 instead of CO & include ozone pollution level controls.	A 1 SD increase in CO exposure during the third trimester of pregnancy: fourth grade math test scores: −0.036 SD. Fourth grade language test scores: −0.042 SD. No significant effects were observed in first or second trim. Sibling FE slightly larger than OLS estimates. Controlling for avoidance behavior, has a modest impact on estimates.	By mother's educ.: effects of CO exposure are larger for children of mothers w/out a high school diploma. Language test scores: −0.096 SD in first trim. & −0.082 SD in third trim. whereas for children more educ. mothers effect is −0.029 SD in third trimester.

(*Continued*)

TABLE 1
Effects of Mild Early Life Shocks on Future Outcomes (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Billings and Schnepel (2018). Effects of an early intervention for children exposed to lead.	1) Admin data from the Lead Poisoning Prevention Program in Charlotte NC, includes preschool blood lead level tests. 2) Public school records: k-garten to 12th grade, 1998–99 to 2010–11. 3) Criminal arrest records 2006–13. 4) Birth certificate records from NC: 1990–97, provides parental info & child's BW. 5) County assessor's data for all parcels; match to lead test results based on home address. $N = 312$ children (treatment 119; control 193). Authors match 54% to 86% of data.	Children with 2 consecutive tests of 10 micrograms of lead per deciliter of blood (μg/dL) receive an elevated BLL intervention. DD: Compare individuals in treatment group (2 tests with BLL $\geq 10\mu$g/dL) with control group (first test with BLL $\geq 10\mu$g/dL & second test of 5μg/dL $\leq$ BLL $\leq 10\mu$g/dL). "Basic intervention": education for caregivers, optional home investigation, referral to lead remediation services "Intensive intervention": services in basic + nutritional assessment + medical evaluation + WIC	Children with high BLL who were assigned to: Basic intervention: Antisocial behavior (Index based on absences & N of days suspended, school reported crimes, adolescent criminal arrests, positive effect is good): +0.179 SD. Education (Index based on math & reading test, grade retention): +0.128 SD. Intensive intervention: Antisocial behavior: +0.382 SD. Education: +0.368 SD.	NA
Black et al. (2017). Ask how prenatal exposure to fallout from above-ground nuclear testing in the 1950s and 1960s affected IQ, earnings, education at 18–35 years in Norway.	1) Norwegian registry data covers the population of Norwegians up to 2009 (education register, family register, tax and earnings register); $N = 37{,}000$. 2) Norwegian military records, provides IQ scores for men only; $N = 94{,}649$. 3) Norwegian Defense Research Establishment : Total beta radiation in the air expressed as Bq/m3, and (ii) total beta radiation on the ground) expressed in Bq/m2.	Regional fallout was determined by wind, rainfall, & topography. Significant fallout in 1957–58 & in 1962–63. Authors compare individuals born within the same municipality but born in diff. month/year of birth (and thus exposed to different levels of radiation in utero). Models include individual/family charact.,municipality of birth FE & YOB × month of birth FE's, municipality linear trends, interactions between municp. × yr,. & munip. × month sibling FE.	A 1 SD increase in monthly exposure to ground(air) radiation: Male IQ scores: −0.04 (−0.06) of an SD (effect size: −2% (−1%) SD) (exposure in months 3 & 4). Yrs. of schooling: −0.08 (−1%) (men), −0.1 (−1%) (women) (exposure in months 3 & 4). Earnings and adult height: negative although weak effects. Intergenerational transmission of HK: Exposure of parents in utero leads to son's IQ: −0.025 SD (no effect for daughters).	Little evidence for non-linearities (the estimates are monotonically increasing in magnitude w/quintile); only for quintiles 3–5 of exposure that there are any significant negative impacts of radioactive fallout. Effects are greater for individuals born to more educated parents.
Currie (2011). Asks whether minority and less educated mothers are more likely to be exposed to toxic releases from plants and/or Superfund sites during pregnancy in five large US states.	1) Individual-Level natality data, 5 large states (FL, MI, NJ, PA, & TX), 1989 ($N = 3{,}948{,}042$ singleton births) & 2006 ($N = 4{,}121{,}898$); data include a mother's residential location. 2) Data on pollution: Superfund sites (see column J) & facilities listed in the EPA TRI.	DD model: Exploit timing in exposure to the pollution cleanups & the distance of mother's residence to pollution sites. The treatment is "Close × (After Cleanup)" which represents the extent to which the area surrounding a Superfund site became "Y" (e.g., "whiter") after a cleanup. Models include rich mother controls & controls for county & yr. of child's birth FE. Also examine effects of information about toxic release inventory sites on migration.	Following cleanups, mothers in the immediate vicinity of a Superfund site are more likely to be: "white college educated" mothers: +10.1%. Also, white college educated mothers are more likely to leave an area when new information about toxic releases is revealed −8.7%.	Whites and educated mothers are more likely to respond to information or changes in pollution levels, which may partially explain lower exposure levels.

(*Continued*)

TABLE 1
EFFECTS OF MILD EARLY LIFE SHOCKS ON FUTURE OUTCOMES (*Continued*)

Study	Micro-data, *N*	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Currie et al. (2013). Asks how potential exposure to contaminated drinking water affects birth outcomes in New Jersey.	1) NJ vital statistics natality data—all births, 1997–2007, include mother's residence, siblings matched using mother's full maiden name, race, & birth date, father's information, & SSN; $N = 521{,}978$. 2) Records of drinking water violations in NJ, 1997–2007. 3) Temperature & precipitation statistics. 4) Map of drinking water service areas in New Jersey.	Sibling FE with IV (instrument for actual contamination using the contamination that would have been experienced had gestation lasted exactly 39 weeks). Models control for temperature & other controls, & year × month of birth effects. Authors address the mechanical correlation btw gestation length, and exposures by using IV.	Living in a water district with contaminated water during pregnancy: using mother-FE + IV: LBW: +6% due to any chemical cont. +14% due to any contamination. Prob(preterm): no effects (full sample). Authors address the mechanical correlation btw gestation length & exposures by using IV.	LBW: +14.6% (SD) for mothers with HS educ. or less; Prob(preterm birth): +10.3% (of an SD) for mothers with HS educ or less.
Currie and Walker (2011). Estimate effects of E-ZPass (which reduced traffic congestion and vehicle emissions near highway toll plazas) on birth outcomes.	1) Vital Statistics Natality records from PA, 1997–2002. 2) Vital Statistics Natality records from NJ, 1994–2003. 3) Data on housing prices in NJ, 1989–2009 to test if housing prices. $N = 412{,}884$ observations. Authors know the exact addresses of mothers.	Exploit the introduction of electronic toll collection (E-ZPass). Diff-in-diff: compare mothers within 2 km of a toll plaza to mothers who are 2 to 10 km from a toll plaza. Models include month and year of birth FE, toll plaza FE, distance to highway, and maternal characteristics.	E-ZPass adoption reduced NO2 by 10.8%, likely reduced CO by 40% near toll plazas. E-ZPass adoption (comparing children of mothers within 2 km of a toll plaza to those of mothers who are 2 to 10 km from a toll plaza): Prematurity: −9.0%; LBW: −11.3%. A 1–4% decline in pollution from cars leads to a 1% decline in LBW.	African Americans only: Prematurity: −22.4% LBW: −29.5%
Ferrie, Rolf, and Troesken (2014). Asks how lead in the water supply in the early twentieth century affected the intelligence of Army Air Corps members in WWII.	1) 5% sample of the 1930 US Pop. Census. 2) Data on assignment to the air corps among Army recruits during WWII. $N = 44{,}040$ enlistees in 293 cities. 3) Data on pH level of water used by the public water company in the enlistee's city of residence & w/the enlistee's air corps status.	Authors use "enlistee's state of birth" to identify early exposure to lead. Water with high pH creates scale in lead pipes which reduces lead in water. Models include year & state of birth FE, a dummy for SES and an interaction btw SES and both pH and pH-squared.	Intelligence (dummy for assignment to the Army Air Corps): The probability of assignment to air corps was significantly reduced when water pH decreased (below 7.5) or increased (above 7.5), and this U-shaped relationship was particularly strong for enlistees from low SES backgrounds.	Living in a city with acidic water increases the probability that a recruit from a blue collar family was assigned to the air corps by 7%. No effect for recruits from white collar families. Similar contrasts observed comparing children from unemployed versus employed fathers and in HHs with low rent versus high rent.

(*Continued*)

TABLE 1
Effects of Mild Early Life Shocks on Future Outcomes (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/effects
Isen, Rossin-Slater, and Walker (2017). Effects of reductions in air pollution in non-attainment counties due to the 1970 Clean Air Acts on employment and earnings at ages 29–31.	Longitudinal Employer Household Dynamics (LEHD); 1998–2007, includes location & DOB. $N = 5.7$M indiv.; universe of employed workforce quarterly earnings records; authors collapse data to the county × year (888 units in total). Earnings records: UI-covered earnings by employer/quarter. Algorithm to match county of birth in LEHD to GNIS (95% of indiv. matched). 2) Authors match data to the REIS for county characteristics. 3) Authors match data to NCHS to examine infant health & use maternal, paternal, child characteristics.	Exploit sharp changes in ambient air pollution due to the implementation of the 1970 Clean Air Act Amendments (CAAA) to investigate effects of cleaner air on adult earnings. Compare cohorts born just before & just after the CAAA. Three methods: 1) reduced form model of the LT effect of TSP on earnings; these models include county FE, birth-state × year FE, indiv. controls. 2) two-step estimator: to construct group-level adjusted earnings (p. 9). 3) IV for air quality in county at birth. IV: dummy for the 1970 CAAA introduction at the county-year level.	A 10-unit decrease in TSP in utero: Quarters employed: +0.7% Annual earnings: +1% Gains in lifetime income: +\$4,300 (using a 5% annual discount rate) (2008 dollars). Total wage bill attributable to improved early life air quality: \$6.5Bill./cohort (2008 dollars). First stage: CAAA reduced TSP concentrations by 8–12 g/m3 (10% reduction; mean 95.9 g/m3).	By percentiles of the earnings distribution: most of the mean earnings effect is being driven by the bottom tail of the distribution (CAAA is associated with a decrease in the fraction of indiv. at the bottom tail of the distrib. & an increase in the fractions in middle parts of the distribution). Authors find little heterogeneity in effects of TSP on labor market outcomes across age groups (age 28, 29, 30, & 31). Little heterogeneity across gender, race (results not shown).
Knittel, Miller, and Sanders (2016). Ask how zip code level variations in air pollution due to traffic patterns affect infant health outcomes in California.	1) Vital statistics, 2002–07, birth & death records. 2) Freeway Performance Measurement System (PeMS); traffic measures from freeways in Sacramento Valley, the Bay Area, & Los Angeles Basin. 3) EPA data on ambient pollution levels. 4) National Climatic Data Center info on ambient weather conditions. Authors collapse the data into mother zip code by birth week by total weeks survived cells; $N = 1{,}436{,}739$ obs.	Exploit the relationship between traffic fluctuations, ambient weather conditions, & various pollutants (CO, PM10 micrometers, & ground-level ozone) at the week & zip-code levels in California. Instrument for week-to-week pollution using zip-level traffic & zip-level traffic interacted w/linear & quadratic weather variables). Models include rich weather and individual-level controls, a flexible spline in age in weeks, zip_code FE, zip × month × year FE.	A one-unit decrease in PM10: Infant mortality: −18 lives per 100,000 live births (−6%). Neither CO nor ozone have a statistically significant impact on child mortality. First stage: local pollution instrumented by car traffic & the interaction btw car traffic & weather measures is strong; however, authors do not show results on first stage.	A one-unit decrease in PM10: Blacks: no effect (but perhaps few blacks in California). Births covered by Medicaid: −23 lives per 100,000 live births (∼−8%). Births to HS dropouts: −29 lives per 100,000 live births (∼−10%).

(*Continued*)

TABLE 1
EFFECTS OF MILD EARLY LIFE SHOCKS ON FUTURE OUTCOMES (*Continued*)

Study	Micro-data, *N*	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Sanders (2012). Asks how variation pollution in the county and year of birth affects tenth grade math test scores in Texas.	1) Texas Education Agency (TEA) includes data on the Texas Assessment of Academic Skills (TAAS) & on the Texas Learning Index (TLI), 1994–2002, tenth graders; $N = 1{,}902{,}463$ students in 416 schools across 30 counties. 2) EPA database of historical air quality; includes readings from all pollution monitors within 20 miles of a county population centroid. 3) Global Surface Summary of the day: weather data. 4) REIS data on county characteristics.	Counties with more manufacturing saw greater decreases in pollution in the recession of 1981–83. Instrument pollution levels using county-level changes in relative manufacturing employment. Instrument = TSPs as a function of all workers in a county employed in the manufacturing industry (SIC code 400)/total county employment levels in all other sectors in a given year. Estimates are LATE. Models include rich controls, school FE, year of test FE, school × year pupil-to-teacher ratios from the CCD. Data is collapsed by demographic group, school of attendance, year of birth, and year of test; regressions are weighted.	A 1 SD decrease in TSP in a student's year of birth: High school test scores: 0.06 of an SD. First-stage: a 1pp increase in the ratio of relative manufacturing employment increases ambient TSP levels by 0.61 μg/m3 (F-test~33). IV estimates are larger than OLS estimates (0.06 versus 0.02 of an SD) which could be due to: measurement error & the fact that IV identify local effects.	Results are significant only in the periods of the most drastic pollution variation, suggesting a subtle relationship that may be difficult to separate from background trends.

(*Continued*)

TABLE 1
Effects of Mild Early Life Shocks on Future Outcomes (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Panel E. Weather				
Aguero (2014). Examines the effect of high temperatures at various ages in childhood on adult heights in Mexico.	ENSANUT: Mexico's health & nutrition survey; cross-section; includes e/person's age & location; nationally rep. waves: 2000, 2006, 2012. $N = 65{,}000$. 2) Mexico's National Weather Service: includes meteorological stations across the country. 3) District-level poverty index from CONAPO. Match HH data w/weather info using the coordinates of each station & the district where each individual lives.	Exploit year-to-year variation in temperature across districts in Mexico. Author claims that the year-to-year variation in weather is orthogonal to other unobserved determinants affecting health status. Models include controls to approximate initial health endowment, FE's at the district, birth cohort, survey year, state time trends. Author reports effects of temp by stages: i) in utero (exposure in the year before birth), ii) infancy (ages 1–4), iii) childhood (5–9), iv) adolescence (10–15).	Hotter temperatures in infancy & adolescence (two periods when human growth is fastest) are negatively associated with adult height. Being exposed to hotter temperatures prior to birth & in childhood is NOT associated w/future height.	Author includes interaction terms with all the temperature variables: By gender: no differences. By district poverty level: negative effects of hot temp are stronger for individuals living in poorer districts. Hot temps help amplify health differences by SES.
Krutikova and Lilleor (2015). Variations in rainfall in rural Tanzania in ten years around birth on outcomes at 17 to 28.	1) the Kagera Health and Development Survey (KHDS); Baseline 1991–94 (915 households in 51 villages), first follow-up in 2004 (sample expanded to 2,500 HHs); 2nd follow-up in 2010 (sample expanded to 3,300 HHs). The last waves include the outcome of interest. Final sample $N = 897$ individuals. 2) Rainfall data at the monthly-village level.	Exploit the geographic and temporal variation in rainfall across villages in rural Tanzania. Siblings FE models. The coefficient of interest is the effect of rainfall in utero, in 0–1, 1–2 years of life.	A 10% increase in rainfall from the LR avg: "Core self-evaluation" (relative to siblings): +0.08 SD. (Note: no descriptive table with outcomes to convert the coefficient). Effect is significant ONLY in utero and not in the first two years of life. By trimester: the effect is similar across all trimesters (beta = 0.08SD).	By gender: little difference in the effects of rainfall.
Rocha and Soares (2015). Rainfall fluctuations in semiarid parts of Brazil during gestational period and effects on birth weight and infant mortality.	1) Birth and mortality registration records used to create a municipality-by-month panel, 1996–2010; $N = 188{,}640$ observations 2) Precipitation & temperature municipality-by-month weather data. 3) Census of 2000 & 2010: provides municipality info on the % of households w/access to piped water, sanitation.	Exploit variation in rainfall at the municipality & monthly levels. Health outcomes (measured as the municipality avg for children born in municipality i, on year y, month t) are regressed on average temperature in the municipality over last 12 months, municipality-by-month of birth FE, year of birth FE, & municipality-level trends.	A 1 SD increase in rainfall: Infant mortality: −5% w.r.t. the sample avg of 30 deaths/1,000 births. BW: +1.6 grams (+0.05% = +0.03 SD). Fraction of full-term pregnancies: +0.3pp (+0.32% = +0.027 SD). Effects are stronger during the 2nd trimester of gestation, for children born during the dry season, & for mortality immediately after birth. Potential benefits from expanding the piped water & sanitation systems exceed the cost.	By child's gender: slightly higher effects for girls, particularly for intestinal infections, malnutrition, & perinatal conditions; BW effects are larger for girls than for boys, while the coefficients for length of gestation are almost identical across genders.

(*Continued*)

TABLE 1
EFFECTS OF MILD EARLY LIFE SHOCKS ON FUTURE OUTCOMES (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Rosales-Rueda (2015). Effects of exposure to El Nino floods in utero and during first year on birth weight, height, and test scores.	1) Longitudinal HH survey on Ecuador's cash transfer program "Bono de Desarrollo Humano." First wave: 2003–04; second wave: 2005–06; $N \sim 8{,}000$ children. Sample overrepresents poor families. 2) Reproductive and Health Survey (RHS): 1994, 1999. 3) Living Standards Measurement Survey (LSMS): 1995, 1998, 1999. Last two are nationally representative.	DD model: Compare regions that experienced El Nino versus those that did not and during the years of El Nino 1998/1999 versus previous years. Model includes individual controls, village of residence FE, year of child's birth FE.	Exposure to El Nino floods (avg. exp. 3 months): HAZ = −0.09 SD (effects third trim); PPVT = −0.13 SD (effects first trim) LBW = +2.3pp (third trim) (14.6% = 0.06 SD).	1) By maternal educ.: effects on PPVT are smaller for children w/ more educated mothers (effects: −0.02 SD). 2) By rural/urban: effects on PPVT are stronger for rural children (effects: −0.01 SD). 3) By SES index (1–2 quintiles versus 4–5): effects on LBW significant for children in low quintiles (effects: +3.2pp).
Shah and Millett Steinberg (2017). Rainfall shocks in rural India in utero and current on outcomes for children and young adults.	1) Survey on educational achievement of primary school children in rural India conducted every year over five years from 2005–09; $N = 2$ million children. 2) Monthly district rainfall data. 3) NSS (National Sample Survey) collected by the Government of India in 2004–08; includes information on wages, labor, etc.	Rainfall variation: within district & across districts within a year. Authors explore different periods of exposure: i) current shocks; ii) exposure in utero up to age 4; iii) exposure in utero up to age 16. Sibling FE models also include district FE, age FE, year of survey FE.	Children exposed to drought this year or last year: Test scores: +0.09pp (+0.07 SD = +4.1%). Years education: +0.02. Children exposed to flood: Test scores: −0.05pp (−0.037 SD = −2.3%). Test scores (exposure at11–13 & outcome at 16): 0.05pp. Drought in utero to age 4: Test scores: −0.014 SD = −0.9%. Never enrolled in school: +8% (+0.0 1SD). Child not on track: +3pp (0.08 SD = 3.7%). Test scores (exposure in utero & outcome at age 16): −+0.05pp. Years education: +0.02. Children exposed to a flood in utero to age 4: Test score: +0.03pp (0.02 SD = 1.4%). Years education: −0.02.	By mother's education: effects are exclusively concentrated among children whose mother's had no schooling. By districts w/more educational expenditure: Investments in educ. help mitigate the negative effect of rainfall on test scores.
Wernerfelt, Slusky, and Zeckhauser (2017). Effects of in utero exposure to sunlight (vitamin D) on childhood asthma up to age 10.	Two independent datasets: 1) NHIS: private individual-level data, aggregated by state, month, & year of birth, 1914–87, $N = 260{,}000$. NHIS data merged w/historical weather data from the NOAA. 2) Asthma hospital discharge data from NJ & AZ, from the Health Care Utilization Project, and birth records from Vital Statistics; data aggreggated at the county, birth month, & year of birth, 1999–2009; $N = 2.1$ million births (3,000 birth month by county cohorts).	Exploit the exogenous within-location variation in sunlight levels across birth years in location of birth. Assumes sunlight variation correlates w/actual exposure, but not w/other factors affecting asthma incidence. Regressions include state of birth × month of birth FE, year of birth FE.	Doubling the amount of sunshine in an individual's location during the second trim: Data set 1) Prob(report asthma diagnosed): −1.15pp (−10%) (no standard deviations provided). Data set 2) Rate of asthma emergency department discharges: −2.21pp (−21.3%) (no standard deviations provided). No effects in first or third trimester in either data set.	NA

(*Continued*)

TABLE 1
EFFECTS OF MILD EARLY LIFE SHOCKS ON FUTURE OUTCOMES (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/effects
Panel F. Alcohol and Tobacco Policy				
Barreca and Page (2015). Focus on effects of changes in minimum legal drinking age in state and year of birth, 1978–88.	1) Birth outcomes from the National Center for Health Statistics (NCHS) natality files (1968–89), $N = 73{,}973$. 2) Month-year MDLA data from Distilled Spirits Council of the US. Datasets matched by mother's estimated age at conception, month of conception, & mother's state of residence at delivery.	DDD approach: exploiting variation in MLDA laws that occurred across states in 1970s–80s. Comparing birth outcomes btw: Treatment: infants of mother's 14–20 years old and Control group: infants born to mothers 21–24 years old. Models include state of birth, month, & year of birth FE, & age-by-year FE & state-by-age FE.	Children of mothers 18–20 years old exposed to the MLDA of 18 years experience: LBW: −0.10pp (−1.2%) (table 1 does not include SD!) Female child: +0.18pp (+0.4%) No effects on Apgar, preterm birth, congential defects.	By race - An MLDA of 18 years: Whites: LBW: small increase Sex ratio: no effects Blacks' fetuses are positively selected: Preterm: −0.3pp Sex ratio: +0.462pp.
Bharadwaj, Johnsen, and Løken (2014). Effects of a smoking ban in restaurants/stores in Norway on health at birth.	1) Birth records for all Norwegian births, 1967 to 2010, includes unique identifiers, & smoking behavior at the start and end of pregnancy. 2) Longitudinal administrative records: 1967–2010 (includes gender, DOB, city, marital status, years of education, LFP, earnings, occupation). $N = 4{,}030$.	Exploit a smoking ban in Norway as a natural experiment. Authors are able to identify mothers who worked in restaurants & bars during the period of interest. DD: by compares outcomes before & after the law change for people working in restaurants & bars to the same difference among people who work in similar occupations. Also estimate twin FE models.	Mothers who benefited while pregnant: VLBW: −1.8pp (−0.6pp controlling for gestational age = −26% = −0.04 SD). Preterm: −2.5pp (−39% = −0.10 SD). Twin FE: children born after the reform have better health outcomes. BW: +175gr (most of the effects come from the lower tails of the BW distribution). VLBW: −5.8pp. A 100 g increase in BW increases adult income at 28 by 1.7%, & income conditional on full time employment by 0.7%.	Effects of the reform: stronger for mothers who reported smoking at start of pregnancy. BW: +160 gr (mothers who smoked at the start of preg; effect is concentrated at the lower tails of the BW distribution); no effect on non-smoking mothers.
Nilsson (2017). The effect of alcohol consumption during pregnancy on long-term outcomes of the first and second generation.	1) LOUISE database covering all individuals of ages 16–65, living or working in Sweden 1990–2004; includes year & month of birth, gender & region of birth, education, labor market outcomes, welfare payments. Individuals linked to biological parents using the "multi-generational" register. $N = 4{,}104$ obs. 2) Military enlistment data on cognitive & noncognitive outcomes for 18 year old males.	Exploit an alcohol policy in Sweden in the late 1960s that temporarily and sharply increased access to strong beer in certain regions and among young people. DDD: compare the cohort that was exposed to the policy change in utero to cohorts exposed at other moments in their life exploiting variation in: i) year and month of birth, ii) region of birth, iii) age of the mother (below/above age 21). Models include mother FE.	Children born to mothers under the age of 21 at delivery, in the treatment regions, and conceived between July and October 1967: Earnings: −24% Prob(no earnings): +56% (+7.2pp). Prob(welfare recipient): +56% (+3.5pp). Prob(low cognitive ability): +27%. Prob(low non-cognitive ability): +16%. Years of schooling: −0.3 (−2.6%). Effects on the next generation: Health at birth outcomes: no effects on prematurely born, LBW, sex ratio.	Effects of the policy: Earnings: −24% (men only). Prob(no earnings): +74% (+8.3pp) (men only). Prob(welfare recipient): +79% (+4.5pp) (men); +40% (+2.7pp) (women). _Years of schooling: −0.5 (−4.3%) (men); −0.2 (−1.7%) (women). Males more likely to be premature or miscarried. Share of males: −7.3pp Gestation length: −1 week (−0.28 months) (boys only).

(*Continued*)

TABLE 1
EFFECTS OF MILD EARLY LIFE SHOCKS ON FUTURE OUTCOMES (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/effects
Simon (2016). Changes in maternal smoking due to tax changes and health of US 3–17 year olds.	1) NHIS restricted-use geocoded data, 1997–2010; $N = 118{,}271$. 2) Vital statistics, 1989–2004, $N \sim 2$ million.	Exploit variation in cigarette taxes btw 1989–2007 at the state and municipal levels. DD: identified off by variation in the timing & size of changes in taxes across states & over cohorts. Models include state and year-month FE, demographic and state policy controls, and linear time trends.	A $1 increase (in $2009) in state cigarette excise tax: Sick days from school: −10% (no SD available on outcomes). 2 or > doctor visits in past year: −4.5%. Hospitalizations: −19%. Asthma attacks: −16%.	Effects are twice as big on less educated mothers. Effects are significant for teen mothers but no effects for children of older moms.

Note: Acronyms used in this table are defined as follows: BW, birth weight; CONAPO, Mexico's National Population Council; CNIS, Conseil national de l'information statistique; DD, difference-in-difference; DDD, difference-in-difference-in-difference; DOB, date of birth; EPATRI, the Environmental Protection Agency's Toxic Release Inventory; ETA, Euskadi Ta Askatasuna; FE, fixed effect; HAZ, height-for-age *z*-score; HH, household; HK, human capital; HS, high school; ITT, intent to treat; IV, instrumental variable; LATE, local average treatment effect; LBW, low birth weight; LFP, labor force participation; LR, long run; LT, long term; MA, moving average; MLDA, minimum legal drinking age; NCHS, National Center for Health Statistics; NHIS, National Health Interview Study; NOAA, National Oceanic and Atmospheric Administration; OLS, ordinary least square; PM10, particulate matter 10 micrometers or less in diameter; PPVT, Peabody picture vocabulary test; REIS, Regional Economic Information System; SD, standard deviation; SIMCE, Sistema de Medición de la Calidad de la Educación (academic tests conducted in Chile that provide information to parents on the quality of schools); UI, unemployment insurance; VLBW, very low birth weight; YOB, year of birth.

utero period during Ramadan.[8] Almond and Mazumder (2011); Almond, Mazumder, and van Ewijk (2015); Hoffmann (2014); and Greve, Schultz-Nielsen, and Tekin (2015) all study the effects of Ramadan fasting during pregnancy. Ramadan cycles through the calendar, enabling the effects of Ramadan fasting to be separated from seasonal variation in nutrition. Moreover, most people break their fast at sundown, so that the fasting is only for a limited period of time during the day. Nevertheless, this mild and brief nutritional deprivation appears to have effects on sex ratios (reducing the number of boys, who appear to be more likely to be miscarried). For example, there are large effects on sex ratios among children of Arabian descent in Michigan. Perhaps surprisingly, in view of relatively modest effects on birth weight, prenatal Ramadan exposure is estimated to have pronounced effects on adult outcomes in a wide variety of settings (e.g., Uganda, Iraq, Indonesia, England, and Denmark), including to educational attainment, test scores, adult anthropometrics, mental disability, and wealth measures.

Likewise, positive nutrition-related shocks can have substantial effects even when relatively mild. For example, Linnemayr and Alderman (2011) examine nutritional supplementation for pregnant women and zero to three-year-old children in Senegal and find that supplementation during pregnancy has a significant effect on the weight-for-age of toddlers, but that post-birth supplementation had little impact, suggesting the uniqueness of the in utero period (a common refrain in the literature). Two papers by Feyrer, Politi, and Weil (2013) and Adhvaryu et al. (2016) build on Field, Robles, and Torero's (2009) ground breaking study of the effects of iodine deficiency in Kenya. The more recent studies use historical data about the rollout of iodine fortification in the United States. Because the rollout took place at different times in different places, it is possible to identify the effect of early exposure and show that it improved both female labor force participation and the probability that male World War I recruits were assigned to the Air Force (a marker for ability). They thus provide additional evidence that relatively mild nutritional deficiency can have large negative long-term effects even in otherwise high-resource settings.

Adhvaryu et al. (2016) also analyze measures of parental investments in children, albeit coarse ones, and find evidence that postnatal investments responded to the shock. In particular, they argue that postnatal vaccinations and breast-feeding behaviors reinforced the prenatal shock, i.e., $\delta I_2^* / \delta \mu_{1g} > 0$, so their reduced form estimates overstate the biological effect. As discussed above (and further in Almond and Currie 2011a), to the extent that period one and period two are complements, there are stronger tendencies for parents to reinforce endowment shocks.

Ludwig, Rouse, and Currie (2013) show that maternal weight gain during pregnancy predicts childhood obesity in the context of sibling fixed-effects models. This study is based on birth certificates for several entire cohorts of children born in Arkansas, which were linked to "body mass index (BMI) report cards" issued by the schools. It is one of an increasing number of studies that show how new access to large-scale administrative data sets can shed light on FOH questions.

Fitzsimons and Vera-Hernandez (2014) use a novel instrumental variables (IV) strategy for postnatal nutrition, focusing on non-C-section births to UK women. They note that mothers of infants born on weekends are less likely to receive breast-feeding instruction, and are correspondingly less

[8] Almond, Mazumder, and van Ewijk (2015) speculate that meal skipping, dieting, and morning sickness may all exert similar effects in non-Muslim populations. For example, Almond et al. (2016) find that severe morning sickness also reduces the likelihood of male birth in Sweden.

likely to go on to breast feed. Using this variation, they find large effects of breast feeding on cognitive development. However, the IV approach involves strong exclusion restrictions, in this case that there is nothing else about being born on a weekend (or about having a scheduled C-section) that might lead to poorer outcomes (such as different preferences, inferior nursing care, or less access to specialists).

As a group, these studies support the hypothesis that relatively ordinary variations in nutrition (positive and negative) that are within the experience of many contemporary families, even in rich countries like the United States and the United Kingdom, have the potential to impact children's health both at birth and in the longer term.

3.2 *Prenatal Maternal Stress*

Panel B of table 1 focuses on the impact of maternal stress during pregnancy on fetal outcomes. While the idea that excessive stress has negative health effects is widespread, it is difficult to assess. Cortisol, the most common biometric measure of stress, is not available in most health data sets and also varies widely over the course of a day, which even longitudinal cortisol data do not solve, per se. In the absence of a direct measure of stress, the most common approach in the literature is therefore reduced form: evaluating whether an exogenous event that is likely to have caused maternal stress can be shown to have affected children.

Currie and Rossin-Slater (2013) identify women in Texas who lived in the announced potential path of major hurricanes during pregnancy. It is important to note that most of these women were not, in the end, affected by the hurricane, so this is not a disaster study in the usual sense in that it is possible to separate the effect of stress from the direct economic or health effects of the event. They highlight an issue that often arises in the fetal effects literature, which is that infants with longer gestations are more likely to have been exposed to any periodic shock because they have a longer exposure window. Since infants with longer gestations are healthier, other things being equal, this mechanical relationship tends to bias the estimated effect of shocks toward zero.

They use a sibling fixed-effects strategy, which is not without controversy. Briefly, sibling fixed-effects control for fixed elements of family background, but do not control for unobservables that might vary between the siblings. Another potential problem with fixed-effects models is that the effect of random measurement error may be exacerbated (although if the measurement errors go in the same direction for both siblings, say a mother who overstates her education, then fixed effects would actually help). A particular problem in the context of hurricanes is that the hurricane itself may have caused the mother to move, so that differences in locational characteristics or exposure between the siblings are endogenous to the shock. This issue is addressed by instrumenting actual exposure with measures of "potential exposure" created by assuming that mothers stay in the same place that they were first observed, and that all gestations last exactly nine months. Using an IV strategy also helps to deal with potential measurement error. This counterfactual exposure is, in fact, highly correlated with actual exposure because most mothers do stay in the same place, and most gestations do last nine months. They conclude that stress increases the probability of an abnormal condition of the newborn, but they found no effects on the incidence of low birth weight or gestation length, two of the more common measures of fetal health.

Persson and Rossin-Slater (2018), and Quintana-Domeque and Rodenas-Serrano (2017) study the effect of more severe emotional shocks, including the death of a family member, in Sweden and terrorist attacks in Spain, respectively. The former uses Swedish registry data to follow affected children up to age thirty. An important innovation of their study, relative to some earlier work on the same question, is that they compare mothers who lost a family member while pregnant to mothers who lost a family member in the year after birth. Since families of lower socioeconomic status are more likely to lose family members, and since losing a family member could well have an economic impact, this design is cleaner than comparing mothers with a death in the family to mothers without such an event. While the effects on birth weight are small overall, they appear to be concentrated in the lower tail of the distribution, with a 20 percent increase in the incidence of low birth weight (birth weight less than 2,500 grams). In a second contribution, they are able to follow affected infants into adulthood, and they find negative effects on mental health outcomes measured using prescription drug data. For instance, affected individuals are 23 percent more likely to use ADHD medication, and 9 percent more likely to use antidepressants as adults. Quintana-Domeque and Rodenas-Serrano also find small but significant effects of terrorist attacks in Spain on overall birth outcomes.

Lee (2014) asks whether the grandchildren of women who suffered a severe stress are less healthy. This is a particularly exciting direction for future work, given that thus far, there is not a great deal of research on intergenerational effects of in utero shocks in humans, although they are known to exist in animal models. In this case, the initial shock was a massacre of civilian demonstrators by the civilian militia. He finds small but significant effects on the incidence of low birth weight and prematurity in the grandchildren, with the largest impacts for grandmothers who suffered the shock during the second trimester that the mothers were in utero.

Aizer, Stroud, and Buka (2016) have made an exceptional contribution to this literature because the data they use (which was collected by a consortium of perinatal centers in the 1960s) actually includes measured stress during pregnancy using cortisol. The data set includes a large number of sibling pairs, so that it is possible to conduct sibling fixed-effects analyses. They find that infants exposed to higher cortisol levels during pregnancy have up to one year less school at age seven than their siblings, indicating that they have been delayed in starting school or held back. Given rich background information on the mothers, this study is also able to ask which infants are most affected by higher maternal stress levels? They find that children born to less educated mothers suffer larger impacts of exposure to a given cortisol level, suggesting that perhaps there were fewer resources available to buffer the impact ex post.

We have included Aizer's (2011) study of the impact of assault (overwhelmingly due to domestic violence) in this section of the table, even though domestic violence can have direct effects on fetal health in addition to causing maternal stress. Our justification for doing so is that domestic violence is quantitatively important and vastly understudied as a source either of stress or physical injury. The study is based on California hospital discharge data linked to birth records. Variation in the probability of assault is induced by the strengthening of laws against domestic violence, which occurred at different times in different California counties. She finds that domestic violence has a large negative effect on birth weight. Since women of lower socioeconomic status are more likely to be assaulted, violence is therefore an additional cause of disparities in birth outcomes.

3.3 *Infectious Disease*

Panel C of table 1 deals with recent evidence about the effects of disease. Some diseases that have only mild effects in adults are known to have devastating effects on a developing fetus (e.g., rubella, Zika), while others, like pandemic influenza, killed millions and have also been shown to have effects on fetuses in utero. Recent studies focus on the related questions of whether milder diseases can have serious effects; whether the effects of early life exposure to disease are long lasting; and whether there are spillover effects of disease eradication to children who were not directly targeted. The studies we summarize cover a wide range of settings, from impoverished areas of developing countries, to the historical United States, to modern Denmark.

The studies by Baird et al. (2016) and Ozier (2014) build on the famous "worms" paper of Miguel and Kremer (2004) in which the authors investigated the effect of giving children deworming medication on school attendance and on whether neighboring children were infected with parasites. The new studies ask how deworming affects outcomes of treated children ten years later, and whether other children benefited from the deworming of their neighbors. Significant and positive effects of deworming are found on virtually all outcomes examined. Unfortunately Ozier does not examine exactly the same outcomes as Baird et al., so it is hard to compare the effects on index children to those on their neighbors, but in keeping with the original paper, deworming initiatives definitely appear to be very cost effective.

Bhalotra and Venkataramani (2013) and Beach et al. (2016) focus on waterborne diseases in Mexico in the 1990s, and in early twentieth century America, respectively. The former examine the effect of a clean water reform in Mexico in 1991, which reduced the incidence of waterborne diseases including diarrhea, one of the most common causes of mortality and morbidity among infants. Beach et al. (2016) use typhoid mortality rates as a proxy for water quality. Bhalotra and Venkataramani find significantly positive but quite small effects of the reduction in waterborne diseases on test scores at ages 9–15. These estimates may understate the effect of clean water, given improved survival of the weakest infants, who may end up with low test scores for reasons unrelated to waterborne disease. The Beach et al. estimates appear to be larger: they estimate that moving from the top of the typhoid distribution to eradication would increase educational attainment in surviving children by one-third of a year and increase earnings by 4 percent. This larger effect is unsurprising, given that typhoid is at the extreme end of potential severity of waterborne contaminants and many of the contaminants addressed by the water campaigns studied by Bhalotra and Venkataramani would have caused less severe disease. Thus, a possible interpretation is that more severe shocks have a greater impact than less severe shocks, but with only two data points it is impossible to say much more about the shape of this relationship.

Venkataramani (2012) builds on work by Bleakley (2010) and others on the long-term effects of malaria. He finds large effects of malaria eradication in the birth year, consistent with those previous studies. Currie and Schwandt (2013) focus on a much milder and currently more common disease: seasonal influenza. While Almond (2006) showed that the Spanish flu epidemic of 1918 had long-lasting effects, it was a killer disease. Currie and Schwandt show that even a relatively mild disease such as seasonal influenza can have negative long-term effects if a fetus is exposed at the wrong time during pregnancy. They show that in the contemporary northeastern United States, infants conceived in May have a much higher probability of preterm delivery (and hence, low birth weight) than infants conceived at other times because they come to term at the height of the flu season. Moreover, the H1N1 flu season of 2009 was earlier and more virulent than usual and the spike in prematurity was correspondingly earlier and larger that year.

Schwandt (2017) and Ward and Phipps (2014) follow up on these observations by examining the long-term effects of exposure to flu in utero in Denmark and Canada, respectively. Schwandt examines rich individual longitudinal Danish registry data about women who were hospitalized with influenza and follows their children into adulthood. He finds that earnings are 9 percent lower for affected individuals, and that they are much more likely than others to be dependent on welfare. These long-term outcomes are driven by maternal admissions during the second and third trimester. Ward and Phipps (2014) exploit province-level data on influenza rates to identify the effects of exposure. They do not find any overall effect of an additional week of flu exposure during the pregnancy, but do find a small effect of additional weeks of exposure during the first trimester on test scores and on the probability of having a chronic condition. Given the richness of the Schwandt data, it seems that for now, the presumption should be that his conclusions about the timing of the impacts are more likely to be correct. However, the larger message is that millions of children may be harmed in utero by exposure to relatively mild diseases, even in rich countries.

Bhalotra and Venkataramani (2015) examine the long-term impact of the introduction of sulfa drugs in 1937, which reduced pneumonia mortality but presumably also had positive effects reducing morbidity.[9] Combining historical data with the US population census, cohorts who were exposed to sulfa drugs in their infancy attained 0.1 more years of schooling, were 1.5 percent more likely to graduate from high school, more likely to be employed (0.4 percent), and earned higher wages (1.5 percent). Long-term benefits varied for African American men who were exposed to different levels of segregation in their state of birth, suggesting that despite a strong economic climate (better early life conditions), institutional environment affects the rewards to investments in human capital.

3.4 *Pollution Exposure*

The last few years have seen an explosion of research on the effects of pollution in early life, much of which is summarized in panel D of table 1. Certain pollutants are well measured in developed countries, exhibit variation over time and across small areas, and have published thresholds that lend themselves to asking whether pollution below the threshold can also be shown to have an adverse effect. Moreover, many sources and types of pollution have been increasingly well documented in recent years, and have discrete beginning and ending dates (such as pollution due to industrial plant openings or closings) that assist identification.

Relative to the literature discussed in our earlier reviews, much of the newest literature focuses on documenting the long-term effects of fetal or early-childhood exposures, often relying on newly available large-scale administrative data sources to track children over time. For example, Isen, Rossin-Slater, and Walker (2017) look at the effects of reductions in air pollution due to the Clean Air Acts of 1970 on the employment and earnings of adults who were affected in very early childhood. The Clean Air Acts (CAA) mandated that pollution reduction measures be implemented in counties that were above thresholds for target pollutants. Counties just below these thresholds were not required to clean up. The legislation thus lends itself to analysis using a regression discontinuity framework. In order, however, to examine outcomes, it is necessary to merge data from

[9] In an earlier paper Jayachandran, Lleras-Muney, and Smith (2010) established that the introduction of these drugs did indeed lead to large declines in mortality from causes such as infections after childbirth and pneumonia. Bhalotra and Venkataramani (2015) focus on the effects of the introduction on cohorts of children at older ages.

several large administrative data sets, some of which are held in census data centers.

Specifically, they start with the Census Bureau's Longitudinal Employer Household Dynamics (LEHD) file, which records a worker's unemployment insurance covered earnings each quarter. The authors focus on twenty-four states that appear continuously in the LEHD and on individuals who were born in these states. The payoff to all this careful data work is that the authors are able for the first time to link air pollution changes around the time of birth to adult earnings and employment. They find an estimated gain of $4,300 in earnings per person for a total of $6.5 billion (2008 dollars) in gains.

Another focus of the literature on pollution and early childhood is to ask whether there is heterogeneity in the effects of pollution. There are many reasons to expect disparate impacts of the same potential exposures. For example, more educated people may be more knowledgeable about ways to protect themselves (i.e., have access to a different production function), or may be more likely to take measures that compensate for the harmful effects of pollution (perhaps because of looser budget constraints). They may even be more likely to move away from known pollution sources while the child is still young (Currie 2011). Richer people may live in housing that insulates them from the effects of pollution, for example, by having houses that are more airtight, or houses that are physically located slightly farther from sources such as freeways or factories.

The literature does generally find more negative effects of pollution on more disadvantaged people, whether disadvantage is defined in terms of minority race, income, or education. The only study in table 1 that finds the opposite is Black et al. (2014), who study the effect of radioactive fallout from nuclear tests on Norwegians born in the 1950s and early 1960s. In this one case, they find that the effects of potential exposure are greater for the more educated, perhaps because people were unaware of the danger and more educated people were more likely to spend time out of doors (echoing earlier findings by Lleras-Muney for ozone 2010).

Billings and Schnepel (2018) offer some evidence that the negative effects of early-life pollution exposure might actually be reversed with appropriate interventions, which can be interpreted as evidence about the substitutability of investments in different life periods. The authors show that children who were lead poisoned in Charlotte, North Carolina, and who also received an intense intervention comprising education for caregivers, lead remediation services, nutritional and medical assessments, and other nutritional benefits from the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), experienced reductions in antisocial behavior and substantial improvements in school performance relative to peers who did not receive these services because they had slightly lower blood lead levels. Since we know that the physical effects of lead are irreversible (once deposited in the brain, for example, lead tends to stay there), this result offers hope that compensation for early life insults is possible even when the physiological effects of such insults cannot be reversed.

3.5 *Weather and Climate Change*

With increasing scientific consensus about the reality of human-induced global warming, economists have responded to concerns about the short- and long-term effects of climate change on young children. These studies generally extrapolate from what is known about the effects of short-term variations in weather, including periods of high temperature, variations in the amount of sunlight, drought, or flooding. These studies are summarized in panel E of table 1. Of these papers, only the one by Wernerfelt, Slusky, and Zeckhauser (2017) is arguably really about weather effects per se. The authors find that exposure to sunlight in utero is associated with lower incidence of asthma in affected US cohorts, a result that they attribute to the effect of vitamin D on lung development in utero.

The remaining papers find effects that may work through economic mechanisms as well as through biological pathways. In terms of the section 2 framework, these papers are implicitly considering the optimized response of h to ΔY (changes in parental income). Given the budget constraint in section 2, a negative income shock would reduce investments in children in both period 1 and period 2, so as to equate marginal utilities of parental consumption and investing in children (at a higher level). If the marginal utility of consumption increases substantially with reduced consumption, child investments will need to be reduced even more. This may be particularly true at low baseline levels of consumption.

Several studies focus on weather shocks in rural populations where conditions outside the norm may lead to income losses by affecting crop yields; this may be a major pathway through which weather affects child outcomes. For example, Agüero (2014) examines the effect of high temperatures in a nationally representative sample of Mexicans, and find that higher temperatures during early childhood are associated with lower adult height. The effects are greater in poorer districts, which could be either because people in those areas are less able to shield themselves through, for example, air conditioning (i.e., a biological effect working through the production function), or because many poorer parts of Mexico are agricultural and heat may cause crop losses (an economic effect working through the budget constraint). One limitation of the work to date is that it is often impossible to distinguish between these pathways.

The remaining papers in panel E deal with fluctuations in rainfall, which are probably even more likely to lead to crop loss, and thus to affect outcomes primarily through economic channels. The Shah and Steinberg (2017) study is interesting in that it finds that drought has a positive effect on children's educational attainment in India. They explain this finding by arguing that in India, developments that prevent children from working in the fields may benefit their education. In the context of the model sketched above, one would have to add children's potential earnings to the budget constraint and allow weather to affect the market wage for children's labor (and thereby the opportunity cost of schooling investments) in order to capture this effect.

3.6 *Effects of Alcohol and Tobacco on Fetal Development*

Finally, panel F of table 1 considers three recent papers discussing the effects of alcohol and tobacco control policies on fetal development. While it is well known that alcohol and tobacco can harm the developing fetus, these studies focus on heterogeneity in the effects of policy, and on longer-term effects. Von Hinke et al. (2014) find long-term effects of maternal alcohol consumption during pregnancy on children's test scores up to age sixteen in data from the Avon Longitudinal Study. This study uses genetic variation in the mother as an instrument for alcohol consumption. Causal interpretation of an alcohol effect requires the assumption that the genetic variation in question has no effect other than through maternal alcohol consumption, which is questionable since scientists currently have relatively little understanding of the multiple pathways through which an observed genetic variation may impact a person. That is, even if we knew with certainty that a particular gene was associated with alcoholism, it might also be independently associated with cognitive problems in the offspring. And genes might also be correlated with environmental factors related to the child's upbringing. An additional concern about the use of genetic data as instrumental variables is that genetic effect sizes are often very small and therefore raise possible concerns about weak instruments.

Using register data from Sweden, Nilsson (2017) investigates the long-term effects of a policy that permitted strong beer sales in grocery stores, which resulted in a temporary and sharp increase in access to alcohol among young people. He finds that cohorts affected in utero early in pregnancy had 24 percent lower earnings at age thirty, as well as lower cognitive, noncognitive, and educational outcomes. Effects were particularly concentrated on males and among children from low-income families. Boys were also more likely to be premature or spontaneously aborted than girls. In terms of equation (1), Nilsson (2017) floats the possibility that boys and girls have different values for ϕ.

Bharadwaj, Johnsen, and Løken (2014) study the effect of smoking bans in Norway. The authors are able to identify mothers who worked in bars and restaurants while pregnant. They find significant effects on health at birth and also on adult income at age twenty-eight, but the effect of the reform is much stronger for mothers who were smoking at the start of the pregnancy, suggesting nonlinear effects of tobacco exposure.

Simon (2016) examines the effects of changes in state-level tobacco taxes in the United States on maternal smoking and child health and finds that higher taxes were associated with fewer days absent from school, and reductions in the utilization of medical care, as well as with 16 percent fewer asthma attacks. These effects are much greater for the least educated mothers. Barreca and Page (2015) use a similar design to consider state-level changes in minimum legal drinking age laws and find improvements in birth outcomes among affected cohorts of women. Their estimates are also suggestive of improvements in the survival of black infants to term.

An economic model of a parent's choice to use alcohol or tobacco while pregnant is complicated by the fact that while in the short-term the parent trades off utility from their own consumption against the investment in a child's health, their actions also directly affect the return to future investment in child health. That is, future investments are likely to be less productive if the child is damaged by fetal alcohol syndrome, for example.

4. *Parental Investments*

The evidence in section 3 shows that relatively mild shocks can, if delivered at the right or wrong time, have lasting positive or negative impacts on the developing fetus and young child. The question arises, then, as to whether there are parental investments that can mitigate the effects of negative shocks. Conceptually, this question centers on the parameters of the CES production function ϕ and γ.[10] Knowing that period 1 investments have a large effect on h per se tells us relatively little about the effectiveness of period 2 investments, including whether damage from a period 1 shock can be remediated by additional period 2 investments (whereas knowing ϕ and γ would take us closer).

A related question is how parents respond to positive or negative shocks to one of their children: does I_2^* change in response to μ_{1g}? Framed this way, the question does not require assumptions about the production technology for h or parental preferences. That said, various underlying concepts from the model will govern any observed investment response. These include parents' preferences (for instance, does the parent wish

[10] Additionally, it depends on the relative sizes of $\overline{I}_1$ and $\overline{I}_2$. See section 2.1.1 in Almond and Currie (2011a).

to equalize outcomes or to maximize the total productivity of their offspring) and the constraints that they face.[11] For instance, if a parent cannot afford the cost of intervening to help a disabled child, but can afford basic investment in a non-disabled sibling, then their choice may well be obvious. If many parents are constrained in their investments, then social investments may have an important impact on parent's choices by changing the productivity and cost of their own investments. Thus, distinguishing between behavior due to preferences and behavior due to constraints can be a key input to intelligent policy responses. Moreover, as Heckman (2008) points out, it may be the case that timing matters. The productivity of current investments may depend in important ways on whether past investments have taken place.

Table 2 summarizes some of the recent literature on parental investments. Hsin (2012) was one of the first to consider that parental investments in their young children may reflect not only preferences, but also constraints. Using sibling fixed-effects models and employing data from the Panel Study of Income Dynamics (PSID), she showed that college-educated mothers compensate low birth weight children (i.e., invest in order to try to equalize outcomes), while less educated mothers tended to concentrate resources (such as reading, playing, and doing hobbies) on higher birth weight children. A limitation of her study is that the number of low birth weight children with low birth weight siblings is quite small in the PSID, so the results are suggestive, rather than definitive, about the behavior of US parents.

Breining et al. (2015) find evidence consistent with parents trying to equalize outcomes between siblings. They use Danish registry data and examine children whose siblings were either just above the 1,500 gram threshold used to classify children as very low birth weight or just below it. Children just below the threshold were found to receive more care and be healthier subsequently (as in Almond et al. 2010). The novel finding is that their siblings also do better in school, which suggests that medical intervention for the very low birth weight child benefited all the children in the family. One interpretation of this result is that parents would otherwise have sacrificed the well-being of the healthy children in order to focus on the more vulnerable child. Alternatively, however, shocks to one child may work through the budget constraint to affect other children even in a rich country like Denmark, where most medical care would be paid for by the state.

Akee et al. (2015) investigate the effects of a casino opening on the Eastern Cherokee reservation, which resulted in an exogenous income transfer to tribal households. They find that parents reacted to the transfer by investing more in children who had lower levels of mental health and "worse" personality traits. This result seems to reflect preferences for equal outcomes—although the mechanism is a change in the budget constraint, the parent has a choice about which child to spend the "extra" money on. On the other hand, several studies in developing countries (Yi et al. 2015; Adhvaryu and Nyshadham 2016) find evidence consistent with parents reinforcing initial differences between children, which could reflect either preferences, ϕ, or budgetary realities.

Two studies of gender differences in investments also find opposite results for developing and developed countries.

[11] The returns to investment are governed by the elasticity of substitution of investment made at different stages of childhood. These returns have an impact on whether parents compensate versus reinforce, whatever their preferences are. For example, if a parent wants to compensate, but there are no suitable investments available or their return is low, then he or she will might well choose to invest in another child, which would have the effect of reinforcing differences.

TABLE 2
PARENTAL INVESTMENTS

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/effects
Adhvaryu and Nyshadham (2016). Impact of iodine supplementation in Tanzania on parental investments in children 0–5.	DHS 1999; representative of women of reproductive age. $N = 456$ children 0–5 (and their mothers).	Exploit the variation in in utero exposure to a large-scale iodine supplementation program across districts. Linear prob. models include rich controls & district & child's age FE. To test for resource allocation spillovers across siblings, authors regress health investments on own and sibs' accumulated treatment.	A 1 SD increase in treatment exposure: Vaccination: +0.2 SD (polio 0.16pp, measles 4.5pp). Breast feeding $\geq$6 months: +0.1 SD (3.5pp) (parents reinforce investments). Siblings of treated children were more likely to be immunized (no effects on breast feeding.)	Vaccinations highly responsive to parental observed benefits from the program… even when treated child is younger/older, younger/older siblings are more likely to receive additional investments (i.e., vaccination.)
Baker and Milligan (2016). Ask how differences in parental time investments are related to gender gaps in reading and math scores in Canada, the United States, and the United Kingdom at school entry.	1) Canada: National Longitudinal Survey of Children and Youth (NLSCY); children born between 1999–2004; 2) US: Early Childhood Longitudinal Survey-Birth Cohort (ECLS-B); children born in 2001; 3) UK: Millennium Cohort Study (MCS); children born in 2000/2001; $N =$ was not reported. 4) US data from: i) American Time Use Survey (ATUS); waves 2003–2011; ii) National Survey of Family Growth (NSFG); waves: 2002 & 2006–08; and Canadian data from the Maternity Experiences Survey (MES).	Authors assume sex of firstborn child is exogenous. Model regressions include demographic + SES controls and a dummy variable for firstborn male child. The authors investigate how parental investments change with child's age. Twin FE: authors test the hypothesis that parents treat opposite sex twins with greater similarity than parents generally treat sons and daughters (time inputs were asked separately for each twin in the UK data).	Controlling for parental time inputs in early life (ages 0–3) in baseline regressions reduces: Gender gap (boy/girl) in reading scores: −23% in United States, −16% in United Kingdom, −33% in Canada. Gender gap in Math scores: −25% in United States, −23% in United Kingdom, and −33% in Canada.	Boys have lower reading and math scores at school entry. Authors argue that this may be explained by parental time inputs.
Bharadwaj and Lakdawala (2013). Investigate gender differences in prenatal care, neonatal and early childhood mortality among mothers who had an ultrasound in India, Bangladesh, and China.	1) India: National Fertility and Health Survey (NFHS), waves: 1998–99, 2005–06. 2) Bangladesh: Demography & Health Survey (DHS), waves: 1996–97, 1999–2000, 2004, 2007. 3) China: Health and Nutrition Survey (CHNS), waves: 1991, 1993, 1997, 2000, 2004, 2006. Authors also use DHS data for other countries: Pakistan (2006–07), Ghana (1993, 1998, 2003, 2008), Sri Lanka (1987), & Thailand (1987). $N = 32{,}012$.	Exploit the fact that some mothers had ultrasounds (so could discriminate prenatally), while others did not. If mother did not have ultrasound can only discriminate postnatally. Also expect larger effects in places where sex discimination is more severe (e.g. Northern India). Models (linear & logit) include a dummy for gender of fetus, mother/child controls (that includes birth order, family size, etc.), state FE & year of birth FE	Mother pregnant with a boy: Attended prenatal care at least twice per week (India): +1.8pp (3%) (+4.6% in Northern India where sex discrimination is higher) Tenanus: +3% (only sign. for Northern India). Results are only significant in the sample of mothers who had an ultrasound. No evidence of sex-selective prenatal care in countries with weak or no son preference (i.e., Ghana, Sri Lanka). Tetanus shots can explain 2.6–7.2% of the excess female neonatal mortality.	Larger effects in northern India.

TABLE 2
Parental Investments (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Breining et al. and Trandafir (2015). Spillover effects of medical treatments received by VLBW children on their siblings.	1) Birth register data from Denmark since 1970. 2) Emergency room visits data (available between 1995 and 2011), provides inpatient hospital admissions & mortality. 3) Data on academic achievement including 9th grade test scores (available from 2002), high school enrollment by age 19. Final sample = 3,677 observations.	RD that exploits changes in medical treatment around the VLBW threshold (as in Almond et al. 2010). Treatment group: siblings of a child with BW just below 1,500 grams & with 32 or more weeks of gestation Control group: siblings of a child with BW just above 1,500 grams & with 32 or more weeks of gestation.	A child with a VLBW sibling (with 32 weeks or more gestational length) who received medical treatment due to this condition, experiences: Math test score (@age 15): +0.36 SD Language test score (@age 15): +0.31 SD High-school enrollment (@age 15): +9.5pp (+30%) Mortality (28-day & 1-year mortality) (ages 0–15): no effect Diagnosis of intellectual disability < age 5: no effect.	Heterogeneity in the spillover effects on sibling academic achievement varies by sibship characteristics that are most closely tied to the quality of peer interactions (gender of sibling, gender composition of the sibling pair, and birth order).
Del Bono, Ermisch, and Francesconi (2012). Ask how smoking and maternal work stoppage before birth affect outcomes in the United States and United Kingdom, and whether parents respond to idiosyncratic changes in one child's endowments by altering investments in a later child.	Three large representative samples: 1) UK: British Household Panel Survey, longitudinal, 1991–2005, N = 1,339 singletons 2) UK: Millennium Cohort Study, longitudinal, years of birth: 2000 & 2001, N = 17,483 singletons 3) US: National Survey of Family Growth, authors use the fifth cycle (1995), data is retrospective on children who were born in 1970–95, N = 12,166 singletons.	To address endogeneity of choice of birth inputs, use method of moments estimator (similar to an IV-FE that uses prenatal inputs during earlier pregnancies as instruments for differences in inputs between pregnancies). Identification assumption is that prenatal inputs associated with a specific pregnancy are uncorrelated w/the idiosyncratic child endowments. Authors estimate the direct effect of inputs on birth outcomes (structural parameters) & the reduced form parental responses to realized child endowments when choosing the inputs in successive pregnancies.	1) Maternal smoking during preg: BW: −190 to −200 grams (−5.6% = −0.34 SD) (BHPS & MCS datasets); −139 grams (NSFG) (−4.2% = −0.24 SD). Fetal growth: −5.4% (−0.36 SD) (BHPS); −4.1% (−0.26 SD) (NSFG). 2) Three month-work stoppage in late preg: BW: 5.2% (0.3 SD)(BHPS); 1.8% (0.10 SD) (NSFG). Fetal growth: 3.5% (0.23 SD) (BHPS); 1.3% (0.08 SD) (NSFG). "Parents respond to idiosyncratic endowment heterogeneity in a way that is easier to reconcile with inequity aversion."	More educated women are less likely to smoke and more likely to stop working three months before birth during their first three pregnancies.
Dizon-Ross (2018). Investigates the effect of providing parents with information about their children's true achievement on parental investments.	1) Author conducted a sibling census during January–March of 2012, based on information on children participating in 39 schools in two districts in central Malawi (the Machinga and Balaka districts) 2) Test data were gathered for all periodic exams administered at school N = 3,464 households with at least 2 children enrolled in grades 2–6	Randomly assigned half of the households to a treatment group that received information about their children's recent achievement test results in school, and half to a control group, which did not receive information	The information delivered to parents about their children's academic abilities: (1) Parents' perceptions of their children's achievement diverges from children's true achievement: the gap is 1 SD. (2) Parents reallocate educational investments: Willingness-to-pay for remedial math and English textbooks: +1.3pp in subjects in which children were doing worse than expected. Free subject-specific workbooks (remedial, average, advanced): parents shifted their choices toward workbooks that corresponded more closely to their children's true achievement level.	Poorer, less-educated parents have less accurate perceptions about their children's academic abilities than richer, more-educated parents, and update their beliefs more in response to improved information.

(*Continued*)

TABLE 2
Parental Investments (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Cunha, Elo, and Culhane (2015). What would happen to investments & child development if a policy that moved expectations from the median to objective estimates from the CNLSY/79 data was implemented?	1) Children of the National Longitudinal Survey of Youth/1979 (CNLSY/79); authors employ the Motor-Social Development Scale; $N = 335$ African American mothers.	Formulate a model of early childhood development in which mothers have subjective expectations about the tech. of skill formation. Empirically, the identification of the model poses a problem: preferences and beliefs are confounded. To solve this problem, authors create a survey instrument to elicit maternal expectations about the tech. of skill formation. Mothers are asked: "what is the youngest and oldest age at which your baby will learn how to do task X or Y?" (the tasks are taken from the Motor-Social Development Scale of the CNLSY/79 and NHANES). Authors exploit within-family variation to estimate the parameters of the technology of skill formation.	1) Mothers underestimate the elasticity of child development with respect to investments: Mothers' subjective expectation about the elasticity of their child's developmt with respect to investments is btw 4–19%, but authors estimate ndicates elasticities between 21–36%. 2) A policy that moved expectations from the median to objective estimates would increase investment by 4% to 24% and stocks of cognitive skills 24 months would increase by 1% to 5%. The impacts of such a policy would be even higher for mothers whose expectations were < the median.	NA
Fryer, Levitt, and List (2015). Effect of parental incentives on early childhood cognitive and noncognitive achievement.	Longitudinal data collected for the study includes pretest characteristics of the sample of children & families (year of data collection is 2011), children's test scores in the middle of the treatment year (January 2012) & at the end of treatment (May 2012) $N = 260$ families.	Randomized field experiment. Families were randomly assigned to three groups: 1. parents paid in cash or via direct deposits for attendance at early-childhood sessions; $N = 74$; Treatment 2. parents paid for attendance in early-childhood program attendance via deposits into a trust that can only be accessed when the child enrolls in college; $N = 84$; Control group: parents not paid & did not attend early-childhood sessions; $N = 99$.	Children of parents who participate in the intervention: Cognitive (PPVT; Woodcock Johnson III Test of Achievement scores): no effect. Noncognitive (Blair and Willoughby Executive Function scores, Preschool Self-Regulation Assessment score): +0.23 SD.	Positive effects only among whites and Hispanics (little impact on black children). Students who started below the median noncognitive skills, experienced no benefits in cognitive or noncognitive outcomes, while those who started with above the median noncognitive skills, experienced increases on both cognitive & noncognitive skills.

(*Continued*)

TABLE 2
PARENTAL INVESTMENTS (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/effects
Hsin (2012). Ask whether maternal time investments from 0–12 compensate or reinforce birth weight differences and whether effects differ by SES.	1) Time diaries from the PSID-CDS; time diaries are child-specific, the PSID collected time diaries & child info for up to two randomly selected children within each family; time-diaries sample weekdays & weekends for 24 hours; $N = 1{,}516$ children, or 758 sibling pairs.	Sibling FE estimates of the effect of birth endowments on parental investments & include interactions between child endowment & characteristics such as mother's education or family income. Models include rich controls, interactions between birth endowments × SES, and splines to measure family SES.	Overall effect of birth endowments on parental time investments & the interaction between BW × mother's characteristics: Total hours per week: no effect Hours devoted to activities that develop the child's human capital (reading, playing, doing hobbies, etc): no effect.	By mother's educ.: College educated mothers compensate by investing more in LBW children: children receive +0.65 SD (total time), +1 SD (educational time). Mothers with ≤12 years of education concentrate resources on higher BW children: non-LBW children receive +0.17 SD total time & −0.10 SD educational time than LBW siblings.
Yi et al. (2015). Asks how Chinese parents alter investments in twins at ages 6–18 in response to the serious illness of one twin at age 0–3.	Chinese Child Twins Survey (CCTS); includes detailed info on family health & educ. investments for e/child; conducted in 2002 to 2003 in the province of Kunming, China; $N = 1{,}694$ households with twins.	Early health shocks affect children both biologically and by affecting parental responses. Assume that "the within-twin variation in early health shocks is random and exogenous." To estimate effects of health shocks on child's outcomes and address the possibility that family investments may be endogenous, authors use an IV based on within-twin variations in BW, gender, and HH level variables (rural indicator, maternal working sector, age, ethnicity, and schooling).	When a twin child suffered from a serious disease at ages 0–3: Parental investments: Health investments in the sick twin ($ spent on medical treatment, medicine, health products): + RMB 305 (+$49 US) (+35% = +0.39 SD). Educational investments in the sick twin (tuition + $ spent on books, stationery, home tutors, tutoring class): RMB −182 (−$30 US) (−20% = −0.15 SD). Child outcome results suggest that parental investments equalize health but increase disparities in education in favor of the healthier twin.	Rural areas: increase in health expenditures in favor of the sick twin is not accompanied by a decrease in educational expenditures. Urban areas: the fall in educational expenditures on the sick child offsets the cost of medical expenses. Compensating investments and reinforcing educational investments are more precisely determined among high education mothers and in female twins. Wealthier households have more reinforcing educational investments.

Note: Acronyms used in this table and not previously specified are defined as follows: BHPS, British Household Panel Study; CCT, conditional cash transfer; DHS, Demographic and Health Surveys; MCS, Millennium Cohort Study; RD, regression discontinuity; RMB, renminbi (Chinese currency).

Bharadwaj and Lakdawala (2013) focus on India, China, and Bangladesh and find that mothers pregnant with a boy get more prenatal care and boys are more likely to receive tetanus shots after birth. One only sees the difference in prenatal care among mothers who had an ultrasound, and so presumably know that they are carrying boys. However, in Canada, the United States, and the United Kingdom, Baker and Milligan (2016) find that parents of children aged zero to three put more time into girls and that this time investment can explain as much as a third of the gender gap in reading scores in the early grades. It is possible that this pattern reflects mother's preferences for girls, if mothers are the primary caregivers.

From this brief description of a number of studies, it should be apparent that there is no simple answer to the question of whether or why parents compensate or reinforce differences between their children.[12] It does seem that parents are more likely to reinforce differences in low-resource settings, suggesting that the observed behaviors are at least partially a response to binding budget constraints in many instances.

The discussion above assumes that parents are making informed choices about investments in their children. Dizon-Ross (2018) investigates how parental investments responded to better information about children's academic performance using a field experiment in Malawi that targeted parents with young children. Results show that providing parents with information about how each child is doing causes them to reallocate their educational investments across children so that investments correspond more closely to their children's true achievement level.

Similarly, Cunha, Elo, and Culhane (2015) argue that US mothers have poor information on the return to early-childhood investments. They speculate that if the government could implement a policy that moved expectations from the median current belief to the true median return, parental investments would go up by 4–24 percent and the stocks of cognitive skills at age 24 months would increase by 1–5 percent. If parents lack information about the likely impact of investments in their children, then once again their behavior cannot be said to reflect their underlying preferences; perhaps information could be modeled as an input into child health production such that parents with incorrect information end up optimizing with respect to the wrong production function.

Perhaps an overall takeaway is that economists have been too quick to interpret parent's choices as revealed preference when even a simple economic model suggests that factors such as available production technologies and budgets, not to mention information, are likely to be tremendously important.

5. *Sometimes Lightning Strikes Twice*

In this section (and in table 3), we consider a handful of studies that attempt to examine dynamic complementarities empirically using cases where there were two shocks. These studies are often reminiscent of the first generation of fetal origin studies in their reliance on quirky and exotic instruments (which is why we characterize them as akin to being struck twice by lightning), and in the fact that it may be difficult to generalize

[12] Fryer, Levitt, and List (2015) focus on a different but related question, which is whether we can incentivize parents to invest more in their young children. They organized a randomized trial in Chicago in which parents were rewarded for activities such as attending educational sessions about early childhood, completing homework assignments with their children, and for their child's demonstration of mastery on interim assessments. These tasks were chosen to improve cognition and executive function. They found that the intervention benefited white and Hispanic children, but not African American children. Moreover, effects were bigger for children with better cognitive skills to begin with. This study may illustrate some of the limits of trying to improve children's outcomes by working to improve parenting skills.

TABLE 3
Two-Shock Studies

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Adhvaryu et al. (2015). Examine the effect of a conditional cash transfer program on the impacts of rainfall shocks in Mexico. Outcomes measured at 12–21 years.	1) Baseline and follow-up surveys of HHs in Progresa; 1997, follow-ups every six months for the first three years of the program (1998–2000). 2) ENCEL 2003; a HH survey of the 506 localities that were part of the original evaluation. 3) Mexico's National Meteorological Service provides rainfall data, 1975–2003. Data were matched using GPS coordinates, $N = 14{,}464$.	Exploit two orthogonal sources of exogenous variation: 1) Parents' resources at the time of a child's year of birth & state of residence (proxied by local rainfall) & 2) The returns to investing in education during adolescence (via the RCT program *Progresa*). Model includes dummy for rainfall shock, *Progresa* exposure, the interaction between rainfall shock and *Progresa*, state FE, birth year FE, & rich controls.	Exposure to adverse rainfall in the YOB: Years of educ.: −0.57. Mitigating impact of *Progresa*: +0.1 yrs for each year in the program. On average, *Progresa* mitigated 60–80% of the effect of the shock. Woodcock-Munoz tests (letter–word identification, applied problems, & dictation): −0.22 to −0.25 SD.	Effects of *Progresa* are larger for children with lower endowments (i.e., those who were affected by the rainfall shock).
Aguilar and Vicarelli (2015). Exposure to extreme precipitation in Mexico due to El Nino and outcomes at age 2–6.	1) 3 waves of longitudinal household data from Mexico's *Progresa* conditional cash transfer program: 1997, 2000, 2003; $N = 6{,}264$ children. Data NOT nationally representative.	1) DD model: Compare children in villages that experienced rainfall shocks versus children in regions that did not. Model includes individual controls + village and year of child's birth FE. 2) Mitigating impacts of *Progresa*: Use random selection of villages into *Progresa* to estimate the effect of early versus late (two yrs difference) allocation to treatment. Use the administrative selection rule for *Progresa* recepients to estimate an RD.	Exposure to El Nino: Height: −0.43 to −0.71 inches (~−2% = −0.2 SD). Stunting: +13pp (0.3 SD). Weight: −0.84 pounds (−2.5% = −0.13 SD). PPVT = −15% (−0.34 SD). Working memory = −18% (−0.44 SD). Visual-spatial thinking = −13% (−0.5 SD). Gross motor skills: no effects. Effects were not mitigated by *Progresa.*	1) Effects were more pronounced for children affected in the first two years of life versus prior to birth: Height: −0.71 inches versus −0.56 inches. PPVT = −21% versus −15%. Working memory = −19% versus −15%. Visual-spatial thinking = −13% versus −12%.
Gunnsteinsson et al. (2016). Effect of nutritional supplements in Bangladesh in mitigating the effects of tornadoes on infants.	1) RCT took place in 2001–07, $N = 18{,}767$ infants, 41 sectors (20 received supplements, 20 placebo). 2) Survey on the effects of the tornado 2005; collected data on damages, deaths (the tornado affected 17 of the 41 sectors).	Exploit data from an RCT of a nutritional supplementation program for newborns & mothers. A tornado occurred on March 20, 2005. Authors exploit 3 sources of variation: 1) RCT of vitamin A suppl.; 2) spatial variation in tornado exposure; 3) variation in trimester of pregnancy exposed to tornado. DDD: compare babies born at different times (within & outside of a window around the tornado), across sectors affected by & unaffected by the tornado.	Tornado exposure in early pregnancy: BW: −14pp (−0.6% = −0.03 SD). Height: −0.54cm (−1.2% = −0.23 SD). Mid-upper arm circumference: −0.29 cm (−0.31% = −0.35 SD.) Head circumference (HC): −0.54cm (−1.7% = 0.33 SD). Chest circumference (CC): −0.34cm (−1.1% = −0.16 SD).	Those treated with vitamin A at birth through the RCT were effectively protected from the shock in terms of antropometric outcomes at six months. There was little protective effect of maternal supplementation during pregnancy.

(*Continued*)

TABLE 3
Two-Shock Studies (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/effects
Rossin, Slater and Wust (2015). Explore main effects and interactions between high-quality preschool childcare and a nurse home-visiting program. Examine effects on children and children's children.	1) Digital atlas of the Danish Historical–Admin. Geography: includes individual & municipal-level data; source of outcomes data for second generation. 2) Historical data on state-regulated CC centers: address, year established, number of children (collapsed to municipality × year × gender cells) (N = 3,600 cells). 3) Nurse Home Visiting Program (NHV): Date program approval for all minicipalities over 1937–49 from the Danish National Archives. 4) Inpatient records, 1994–2010. N = 869,273 observations.	DD model: Exploit the municipality × year variation in CC center approvals & in the NHV program rollout. Identifying assumptions: (1) the timing of approvals is uncorrelated w/other municipal time-varying characteristics that also predict outcomes; (2) the timing of approvals is uncorrelated with the NHV program rollout.	LT impacts of the CC program: Years of schooling: +2% Only compulsory education: −11% Labor mkt: +1.6% wages (males) Mortality: −10% (females). Intergenerational effects of CC: Years of schooling (at age 25): +0.4% Only compulsory educ at age 25: −6%. But interactions of CC and NHV program are negative, suggesting substitution: Most positive effects of child care reduced by 80% suggesting that subsidized child care much less effective when NHV is already in place.	Interaction effects on education and on income were mostly driven by males (even persistent on the second generation), while effects on mortality were larger for females.

Note: Acronym used in this table (not previously defined): RCT, randomized controlled trial.

some of their conclusions to other settings. Nevertheless, they represent the frontier in terms of trying to apply insights from the theory outlined in section 1 to applied work in this area.

Aguilar and Vicarelli (2015) overlay variation from Mexico's conditional cash transfer *Progresa* program on top of rainfall shocks induced by El Niño. They consider shocks that affected children both prenatally and up to age two and examine anthropometric and cognitive outcomes at ages two to six. They did not find that *Progresa* mitigated any of the negative effects of weather shocks. In contrast, Adhvaryu et al. (2015) use a very similar design and ask whether *Progresa* mitigated the effects of rainfall shocks on cognitive test scores and years of education, measured at ages 12–21. They estimate that *Progresa* offset 60–80 percent of the negative effects of rainfall shocks on child development. It is unclear whether these conflicting results are caused by subtle differences in the approaches taken, or whether it is really the case that one can see positive long-term effects even in cases where the immediate short-term effects appear to be negligible. Certainly much of the literature on early intervention programs has this flavor, finding initial effects that "fade out" by age eight or nine but then reappear in adulthood (Almond and Currie 2011a).

Gunnsteinsson et al. (2016) examine data from a randomized controlled trial of vitamin A supplementation in Bangladesh that took place between 2001 and 2007. In 2005, parts of the study area were devastated by a tornado. The authors find that tornado exposure in early pregnancy and early infancy had significant negative effects on birth weight and infant anthropometrics. However, they also find that infants treated with vitamin A at birth were effectively protected from the effects of experiencing a tornado shock at zero to three months of age, in that there did not appear to be any effect of the tornado on anthropometrics at six months. An unusual feature of this paper is the authors' care in trying to disentangle the optimal timing of the protective investment relative to the timing of the shock.

One difference between Gunnsteinsson et al. (2016) and Adhvaryu et al. (2015) is the amount of time that occurs between the negative shock and the human capital investment. While in the case of the tornado in Bangladesh the interval between the shock and the vitamin A supplementation was only a few months, and the outcome was measured a few months after that, in the *Progresa* paper, the interval between the transfer and the weather shock was at least a decade. The temporal gap between the first and the second event may be relevant to identifying these interactions, as there may be behavioral responses from parents or teachers that could either reinforce or undo the impacts of the first or the second event, or both.

Rossin-Slater and Wust (2015) consider a somewhat different, but related and very important question of how different types of common public early interventions interact. They use Danish registry data to study the interaction of a nurse home-visiting program that supplies visits shortly after birth, and a child-care program for three-year-old children. Both programs rolled out beginning in the 1930s and ending in the 1950s. They find that the child-care program had large and persistent effects on educational attainment and income, and reduced adult mortality. In an innovative twist, they also find that the benefits extended intergenerationally to the children of the originally treated children.

A surprising finding, however, given the dynamic complementarities hypothesis, is that the effects of child-care programs were largest for children who had not had exposure to the nurse home-visiting program as newborns. At first blush, this finding seems the opposite of the "skills beget skills" concept that children who got off to a good start due to the home visitors would be better able to benefit from the child-care program. A possible explanation is that the programs actually provide similar but complementary services. For instance, home visiting often focuses on training parents about health and safety, as well as teaching them what they can expect developmentally from children of various ages. To the extent that a successful program trained parents to give better care at home, that might lessen the benefit of having better care in another setting. We are not aware of other studies of this type, so it is impossible to know how much the complementarities depend on the type of intervention, though it is reasonable to suppose that they would. Regardless, this handful of early two-shock studies establishes that estimating dynamic complementarities in a well-identified way is feasible with enough creativity and luck.

6. *How Do Resources Mediate the Effect of Early Life Events?*

Broadly considered, there are two types of resources that can be expected to benefit children: material resources (Y) and time inputs (I_t), which might be an argument in the production of child investments. In addition, parents of higher "quality" may be expected to make better use, on average, of the resources at their disposal (indeed, perhaps this should be considered as part of a definition of parent quality along with evidence of altruistic preferences towards the child). In equation (1), the productivity parameter A might be indexed by parental type, with $A^H > A^L$ where H represents "high" quality and L represents "low" quality. At the same levels of income, type "H" parents could achieve better child outcomes (and higher consumption) than type "L" parents. As we discussed above, one might think of higher quality parents as having access to a different production function than other parents. Accordingly, in this section we focus on policies that affect parental education as well as income and in-kind support and parental leave policy.

6.1 *Effects of Material Resources*

Many recent papers examine the effects of cash transfers on child outcomes in a range of settings. We can think of these policies as exogenously increasing Y, which according to (3), would increase both childhood investments and consumption. Aizer, Eli, Ferrie, and Lleras-Muney (2016) assemble unique historical administrative data about the US Mothers' Pension program (a precursor to modern welfare programs). They ask whether being accepted into the program affected outcomes observable on WWII enlistment records or mortality risk (measured using age of death on death certificates). They find that being accepted increased longevity by 1.5 years on average, with larger effects in the poorest families.

Two papers, by Hoynes, Miller, and Simon (2015) and Dahl and Lochner (2012) examine the effect of the US Earned Income Tax Credit Program (EITC). Although it is administered through the tax system, these refundable tax credits function rather like a conditional cash transfer (CCT) program in that they are mainly available to families who work and file a tax return, that is, they are conditional on working. Both papers exploit variation stemming from a significant increase in the generosity of the program in the mid-90s. The first study finds reductions in the incidence of low birth weight among mothers who benefited from the expansion while pregnant, while the second finds increases in a range of cognitive test scores, which are larger for children from the most disadvantaged families. One possible mechanism contributing to these effects is the positive link between EITC and mother's health (Evans and Garthwaite 2014).

Black et al. (2014) and Milligan and Stabile (2011) consider cash transfers that are targeted to children (a child-care subsidy and a child allowance, respectively). Like Dahl and Lochner (2012), both also find significant improvements in a range of cognitive test scores. Milligan and Stabile find that these effects are mainly driven by boys.

Set against these generally positive findings is the paper by Del Boca, Flinn, and Wiswall (2014) which estimates a structural model based on observational data from a variety of data sets. Their estimates suggest that monetary transfers will likely have only small effects on children because most of the transfer is likely to be spent on other types of consumption, or on parental leisure. However, they are not measuring the effects of an actual transfer policy using design-based variation in that policy.

A second group of papers looks at "near cash" programs supplying food aid. If the amount of an in-kind transfer is small relative to the household's budget for that item, then in-kind transfers are likely to have much the same impact as cash. The studies of the US Food Stamp program (now known as the Supplemental Nutrition Assistance Program (SNAP)) by Almond, Hoynes, and Schanzenbach (2011) and Hoynes, Schanzenbach, and Almond (2016) find (respectively) that the rollout of the program increased birth weights, especially among African Americans, and that in the long term the rollout reduced the incidence of metabolic syndrome (i.e., obesity, high blood pressure, diabetes, etc.), and likewise increased the economic self-sufficiency.

Rossin-Slater (2013) examines the opposite type of policy, which is closures of clinics providing Supplemental Nutrition for Women, Infants, and Children (WIC) in Texas in the late 2000s. WIC closures reduced WIC participation, the probability that a mother gained an adequate amount of weight during pregnancy, and birth weight. Similarly, Meckel (2015) finds that crackdowns on WIC fraud caused small retailers to exit the program and reduced mothers' prenatal participation in WIC with negative effects on birth outcomes.

A number of studies look at the broader effects of economic circumstances on child outcomes. Arguably, good economic times may have effects not only through increasing family resources, but also through increasing employment (with either positive or negative effects for children depending on the range of child-care options available) and social resources. For example, more money may flow to schools and social services in good times. Hence, studies of the effects of business cycles may not tell us about precise mechanisms, though they do once again suggest the vulnerability of young children. The studies by Løken, Mogstad, and Wiswall (2012) and Adhvaryu et al. (2016) examine the oil boom in Norway and a cocoa price boom in Ghana, respectively. These find positive effects of good times, with the impacts being felt disproportionately in low-income households.

Lindo (2011) and Carlson (2015) examine the effects of job displacement during pregnancy on health-at-birth outcomes. Lindo focuses on the father's job loss using data from the Panel Study of Income Dynamics and controlling for mother fixed effects. Carlson uses data from notices filed under the Worker Adjustment and Retraining Notification Act aggregated at the county-month data to examine the effect of anticipated job losses. Both studies find negative effects on birth weight. Golberstein, Gonzales, and Meara (2016) go beyond examining effects on health at birth and examine children's mental health. The paper finds that a one standard deviation increase in the state unemployment rate has a negative impact on a child's mental health (assessed using the Child Strengths and Difficulties Questionnaire) and is associated with a 5.7 percent increase in the use of special education services for emotional problems. Given the nature of the shock examined (i.e., the Great Recession) and the magnitude of the effects on clinically meaningful outcomes, it would be interesting to know whether these impacts will persist over time.

Bharadwaj, Lundborg, and Rooth (2014) ask how low birth weight affects vulnerability to economic shocks later in life using Swedish administrative data and models with twin fixed effects. Their estimates suggest that a 10 percent increase in birth weight results in a 1 percent decline in the probability of using unemployment insurance during a recession as an adult. Conversely, using Dutch data, Scholte, van den Berg, and Lindeboom (2015) find that individuals subjected to economic downturns early in life are more likely to have chronic diseases and functional limitations in old age.

Two studies by Gould, Lavy, and Paserman (2011) and Lavy, Schlosser, and Shany (2016) study the children of Ethiopian Jews who were airlifted to Israel either as young children or while in utero. Those children airlifted to Israel experienced large differences in material conditions depending on where their families were assigned, and families had little say in this decision. Children who had running water, sanitation, and electricity in early childhood obtained more education, were more likely to be employed, and were less likely to have health problems in later life. Children airlifted while in utero faced different conditions during their mother's pregnancy, compared to children airlifted shortly after birth. Those children who experienced Israel's better conditions prior to eight weeks of gestation did better on standardized tests and obtained more education. Perhaps curiously, these studies both find that the effects were concentrated mainly among girls. They attribute this finding to gender discrimination, particularly in Ethiopia and the more backward parts of Israel. The idea is that parents would have been more likely to stint girls, so girls are particularly benefited by relaxation of resource constraints. If this explanation is correct, then the result highlights the fact that the effects of a shock reflect both "biological" effects and the influence of social conditions, and that it is difficult to disentangle the two.

Rossin-Slater (2017) highlights a very different type of policy that also had the capacity to change many aspects of a child's living situation: changes in US laws governing paternity establishment. Many states adopted policies aimed at making it easier to establish paternity in the hospital. A goal of these changes was to encourage parents to marry. Since married families are generally better off than single-parent households, such a policy might be expected to increase the resources available to children (both in terms of income and possibly father's time). However, Rossin-Slater argues that any positive effect on marriage rates was offset by the fact that the law also made it easier for some mothers to gain child support without marrying the father. Overall, she finds little effect on measures of paternal involvement or child health, but some negative effect on children's health insurance coverage and utilization of medical care, which may be a result of losing access to paternal employer-sponsored health insurance coverage. This is one of very few studies to explicitly consider the role of fathers in providing resources to households, something that it would be useful to see more of.

Chetty, Hendren, and Katz (2016) focus on the Moving-to-Opportunity (MTO) experiment that randomly offered families living in housing projects vouchers that enabled them to move. Combining MTO experimental data with administrative data from federal tax returns, the authors find significant differences in the later-life outcomes of children who moved when they were less than thirteen years old. Moving to a lower-poverty neighborhood improved college attendance rates by 15 percent and earnings by 14 percent. Treated children were also 4 percent more likely to live in better neighborhoods as adults and 15 percent less likely to become single parents.

These results contrast with an earlier literature on MTO, which did not separate children out by the age at which they moved to the new lower-poverty neighborhood (Ludwig et al. 2008; 2013). These earlier studies found little effect on the schooling attainment or physical health of children; some positive effects on mental health for girls; but negative effects for boys, especially in terms of their probability of being involved with property crime. Chetty, Hendren, and Katz (2016) also find that children who moved later in their adolescence either did not benefit or actually faced negative long-term impacts, so that their results are not inconsistent with the earlier literature but show the importance of distinguishing between early and later childhood.

One potential explanation for these differential effects by age is that moving to a very different environment as an adolescent could disrupt social networks and have other adverse effects on child development. The authors discuss potential intergenerational gains to providing access to better neighborhoods to families in public housing, which ultimately could generate positive effects of these policies in terms of returns for taxpayers.

6.2 *Policies to Promote Maternity Leave*

If childhood investments are an increasing function of parental time, then maternity leave policies may increase investments at key developmental stages. Such policies appear to be predicated on the belief that the elasticity of child investments in (1) with respect to parental time is large in very early childhood. The key policy question is when specifically maternal (or paternal) time is most important. Recent studies focusing on the effects of maternity leave policy on child outcomes are summarized in panel B of table 4. At first glance, it is difficult to see any consistent picture in these estimates. However, on closer examination, a story emerges in which facilitating short maternity leaves is highly beneficial, but extended maternity leaves do not have a positive effect. This pattern seems plausible if child investments are an increasing but concave function of maternal time or if the return to childhood investments is diminishing in the investment level.

Rossin-Slater (2011) studies the implementation of the Family and Medical Leave Act (FMLA) in the United States, a federal law allowing women to take up to twelve weeks of unpaid maternity leave. The law superseded a patchwork of state laws, creating a good deal of variation, which she exploits. She finds a positive effect on the birth outcomes of college educated women. These women are more likely than less-educated women to have been able to afford to take unpaid leave. Similarly, Carneiro, Løken, and Salvanes (2015) study the effect of a 1977 Norwegian law that replaced a legal right to twelve weeks of unpaid leave with four months of paid leave and an additional right to take twelve months of unpaid leave. They find that children of affected mothers got more education and had higher wages at age thirty. Thus, it appears that allowing some maternity leave in the first months of life was associated with better outcomes in these two examples.

In contrast, Baker and Milligan (2015), Danzer and Lavy (2018), and Dahl et al. (2016) study expansions of paid leave from twenty-five weeks to fifty weeks, twelve months to twenty-four months, and eighteen weeks to thirty-five weeks, respectively. Baker and Milligan (2015) actually find some evidence of negative effects on

TABLE 4
POLICIES THAT AFFECT HOUSEHOLD RESOURCES

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity
Panel A. Policies to increase material household resources				
Adhvaryu, Fenske, and Nyshadham (forthcoming). Effects of cocoa price shocks in Ghana in year of birth on mental and physical adult health.	1) Cocoa prices time series. 2) EGC-ISSER Socioeconomic Panel; baseline data on cocoa production Nov. 2009 to April 2010; plots of land & type of crops, 10 regions; data also includes Kessler Psychological Distress scale—10 questions. $N = 7{,}741$ individuals. 3) Demographic and Health Survey; waves: 1988, 1993, 1998, 2003, 2008; nationally representative cross-sections women 15–49.	HHs the cocoa-producing regions of Ghana experience changes in the real producer price of cocoa as income shocks, while HHs in regions that do not produce cocoa are unaffected by these fluctuations. Linear models include region r and year of birth t FE and individual and HH controls; some specifications include region linear & quadratic time trends, rainfall & temperature controls, as well as household FE.	A 1 SD rise in the cocoa price in the year of birth: Kessler Psychological Distress scale: −2pp (−0.08 SD; −1.0%). Severe distress (Kessler scale>10): −3pp (−0.13 SD; −4.5%). Physical health: Height: +1.23cm (no avg. height provided in descriptive stats) BMI, savings, occupation: no effect.	By gender: very mild differences across males and females. By timing of exposure: shocks in the first four years of life have significant effects, though effects are largest in the YOB.
Almond, Hoynes, and Schanzenbach (2011). Effects of introduction of the US Food Stamp program (FSP) on birth weight and fertility.	Vital statistics—Natality & death records 1959–77; $N \approx$ 2million observations per year. SEER population data (to construct fertility rates).	Use the county-by-county rollout of FSP. Model regressions include county level controls, county and year of birth FE, state × year FE, interactions of pretreatment county characteristics with time trends. Event time study: authors do not have information about FSP participation or data to impute eligibility (e.g., income), so they use the 1980 CPS to calculate FSP participation rates for women with a child <5.	Food stamps during pregnancy increase BW by: Whites +2.04 gr (effect size = 0.06%) Blacks +3.45 gr (effect size = 0.08%). Estimate of TOT effect (after adjusting by participation rate) on BW: Whites: +15 to 20 gr (effect size: 0. 5–0.6%) Blacks: +13 to 42 gr (0.4–1.4%). No statistically significant effects on fertility or neonatal mortality.	Largest impacts at lower BWs. LBW: −7% for whites, −5% to −11% for blacks. Poor counties face +3.41 g BW, no effect in wealthier counties. Larger effects in the South and in urban counties. Larger impacts for older mothers. Black single mothers experienced larger impacts than all black women.

(*Continued*)

TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity
Aizer et al. (2016). Examines the long run effects of the US Mothers' Pension (MP) program on child survival by comparing mothers who were accepted and those who were rejected from the program.	1) Individual-level administrative records of applicants to the Mothers' Pension program: N = 16,000 children from 11 states who were born 1900–1925. 2) WWII enlistment records. 3) 1940 census records. 4) Social Security Death Master File (DMF); name, date of birth, date of death, SSN for 88 million deaths reported from 1965–2012. Authors matched administrative data to census, WWII, & death records. Able to match 48% of sample to a unique death record. Females could not be matched due to name changes.	Compare children of mothers who applied to the MP transfers & were given the receipt, to the children of mothers who applied for transfers but were denied. Rejected mothers were on average slightly better-off based on observable characteristics. Hence, the effects of the program are likely to understate the benefits of the program. Models include state-level, time-varying characteristics (i.e., ratio of state manufacturing earnings to national manufacturing earnings, laws governing school attendance, expenditures on social programs, education, & charitable institutions, hospitals & prisons); county-level characteristics in 1910, county & cohort FE.	Effect of access to the Mothers' Pension program: Longevity: +1.5 years (+2.1%) (no standard deviations provided in descriptives). Prob(of survival past age 70): +10–20%. Prob(of survival past age 80): 9–15%.	Effects are driven by the poorest families in the sample.
Akee et al. (2015). The effect of a permanent increase in unearned household income on children's emotional, behavioral, health, and personality traits.	The Great Smoky Mountains Study of youth: longitudinal survey of 1,420 children aged 9, 11, 13 years at the survey intake, who were recruited from 11 counties in western NC; follow-ups occur annually until ages 16, 19, 21 N = 6,050 children.	A casino opened on the Eastern Cherokee reservation and part of profits were distributed per capita to all adult tribal members (Transfer = $4,000 annually; amount comparable to TANF or SNAP). DD: Compare outcomes for adolescents who resided in households with extra income (youngest and middle-age cohorts of Native American children) to adolescents who were not exposed to the extra income by age 16 (the oldest age cohort). Models include individual FE, age FE, age × race FE	Child resides in a household that receives the unearned income transfers due to the casino revenues: Behavioral disorders: −0.27 SD Emotional disorders: −0.36 SD Personality traits: Conscientiousness: −0.43 SD Agreeableness: −0.31 SD Neuroticism: no effect	Income transfer improved child outcomes through better parent–child relations and not necessarily through more parental time investments "parents who receive the $ provide investments in their children with lower than avg. personality traits and lower than avg. amounts of behavioral and emotional problems" (i.e., compensatory responses)

(*Continued*)

TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity
Barham, Macours, and Maluccio (2013). Examine the effect of CCTs received in utero to age 2 versus ages 2–5 in Nicaragua on cognitive and health outcomes.	1) Household data from the phase-in & follow-up of the randomized CCT experiment; years 2000 & 2010; $N = 171$ boys in the "early treatment" group + $N = 197$ boys in the "late treatment group" born up to 1 year after CCT started (Oct., 2001).	42 localities in 6 municipalities were randomized into early treatment (21) versus late treatment (21); groups were stratified by their poverty level Treatment group—"early-treatment" boys were exposed to the program from in utero to age 2. Control group "late treatment" boys were exposed from ages 2 to 5. Models include birth month FE, stratification dummies to account for the stratification in the randomization (i.e., poverty).	Boys exposed to the program in utero up to age 2 versus ages 2–5: Cognitive outcomes: +0.15 SD Anthropometrics: no effect.	NA
Bharadwaj, Lundborg, and Rooth (2014). Explore whether low birth weight affects how one is affected during economic downturns.	1) Swedish registry data on births: data on all twins born in 1929–56; $N = 5{,}000$ twins. 2) UREG: data on individual years of schooling, 1990–2007. 3) Income data: equivalent of W2 records in the United States, 1981–2005. 4) Statistics Sweden: provides info on occupation for 1985 and 1990.	Compare cohorts who were born years before the economic crisis (1985–90) with cohorts born few years after the crisis (1993–98); Include twin FE. Assumptions: Post-birth investments within twin pairs are not correlated to birth weight.	A 10% increase in BW: Receives unemployment insurance: −1% (no SD available) Years receiving UI: −0.4 years (−80%) "a 10% increase in BW (approx. 260 grams) results in a 0.008pp lower prob. of being on unemployment insurance."	One potential mechanism driving the effects is "occupational sorting in the precrisis years." Affected cohorts were less likely to be employed in the public sector and less likely to enter a white collar job.
Black et al. (2014). Effect of a 1-year childcare subsidy at age 5 on parental behavior and teen GPA.	1) Administ. data covering the entire population of Norway, cohorts: 1986–1992; authors link individuals to their parents through unique identifiers. $N = 367{,}836$ obs. 2) Municipality-level data on childcare prices and family income cutoffs in the 1990s.	Exploit sharp discontinuities in the price of CC by income. Compare outcomes of children whose HH income was just less than a cutoff to those of children whose HH income was just above a cutoff. Also estimate a parametric specification that controls for indiv./HH charact. & cohort by municipality FE, as well as sibling FE.	Being eligible for lower CC prices at age 5: No change in use of child care, so subsidy only increased income. GPA: +0.30 SD Oral exam grade: +0.30 SD Main result: A 1% increase in family income at age 5: would increase scores by about 0.04 SD Sibling FE: similar by less precise.	NA

(*Continued*)

TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity
Chetty, Hendren, and Katz (2016). Examine two hypotheses: 1) moving to a lower-poverty neighborhood improves LT outc. for children who moved young? 2) the gains decline with child's age at move?	1) MTO data includes demographic, SES, school data, criminal victimization, income, transfer receipt; there are 11,276 children in the MTO data, of whom 8,603 (76%) were born $\leq$ 1991. i) annual data on residential neighborhood (census tract) using 1990 & 2000 Censuses; 2005–09 American Community Surveys. 2) Federal income tax returns data, 1996–2012. *MTO records were linked to the tax data by SSN (86% success).	Experiment: families were randomly assigned to three groups. 1) Experimental grp: was offered subsidized housing voucher + requirement to move to a census tract w/poverty rate $<$10%. 2) Section 8 voucher grp: was offered a standard subsidized housing voucher w/no additional contingencies. 3) Control grp: was not offered a voucher (but retained access to public housing). *Authors replicate ITT models as in Kling et al. (2007). Models also include interactions of age at RA $\times$ treatment indicators.	Effects on children $<$age 13: 1) Voucher (experimental) group income: $1,624 (+14%). Attends college: +2.5pp (+15%) Prob(live in a poor neighborhood as an adult): −4% Prob(single parent): −15% (only for females) 2) Section 8 income: no effect. Attends college: no effect Prob(live in a poor neighborhood as an adult): −7% Prob(single parent): no effect Effects on children $\geq$age 13 Little (or sometimes negative) effects on older children.	Gains from moving to lower-poverty areas decline with child's age at move. The extra federal income taxes that young children in the experimental group would obtain during their mid-twenties, would offset the incremental cost of providing voucher treatment relative to providing public housing
Dahl and Lochner (2012). Effects of changes in US EITC on child test scores, mean age = 11 at testing.	1) Child Supplements of the NLSY, longitudinal data, N = 4,500 children. Includes PIAT scores for children 5+ from 1988 to 2000 (biannually). (Children took each individual test at most five times.) N = 4,412 children born to 2,401 mothers.	Identification comes primarily from the substantial expansion of the EITC schedule between 1993 and 1995. Child FE + IV (instrument for HH income: predicted EITC income due to regulatory changes & not due to changes in family structure). Models include year FE, controls for other state-level policies, a fifth-order polynomial in lagged pretax income & an indicator for positive lagged pretax income as a baseline "control function," national trends.	A $1,000 increase in income: PIAT score (combined math & reading test scores): +0.06 SD. Reading recognition: +0.04 SD. Reading comprehension: +0.06 SD. Math: 0.06 SD. First stage coefficient: 1.270** Overall effect: from 1987–99, the median EITC payment for eligible two-child families increased by $1,670 (2000 dollars), implying a test score increase of 0.010 of an SD for this group.	Test gains are larger for children from disadvantaged families (minorities: +0.08 SD, children in unmarried families: +0.08 SD, children of mothers with HS or less educ.: +0.05 SD), for younger children (ages$<$12 the effect is: +0.08 SD), and for boys (+0.09 SD).
Del Boca, Flinn, and Wiswall (2014). Asks how cash transfers affect parental investments in children in the United States	1) Longitudinal data from Child Development Supplement of the PSID; first 2 waves (CDS-I & CD-II) 1997 & 2002–3, include child time diaries & rich demographic and SES HH data, N = 3,500 children residing in 2,400 HH (authors also use the PSID waves 1997, 1999, 2001, 2003).	Authors estimate the parameters of a production function for child outputs using a Cobb–Douglas production function & simulation methods (using PSID-CDS data).	Estimates suggest that parental time inputs are more valuable than monetary inputs in producing child quality. Time is relatively most valuable when children are young. Suggests that monetary transfers may have small impacts on child quality because a significant fraction of the transfer is spent on other HH consumption and the leisure of the parents.	NA

(*Continued*)

TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity
Hoynes, Miller, and Simon (2015). Effects of changes in US EITC on incidence of low birth weight.	1) Vital Statistics micro data, 1984–99, collapsed to cells defined by state, month-year, parity of birth, mother's education, marital status, race, age; N = 47,687 cells. 2) March Current Population Survey combined with the NBER TAXSIM model to compute average EITC benefits.	Exploit tax-reform (1986, 1990, 1993) induced variation in the federal EITC across time & family size. 1) DD: Compare second & higher order births (treatment) to first births (control). Models include effective tax year FE, state FE, & rich demographic controls. 2) Event study. 3) Panel FE model to measure the generosity of the EITC using the maximum EITC credit.	Second parity or higher births, relative to first births: LBW: −3.5% for the full sample (no SD available) (effects are larger for third or higher order births than second births). An increase of $1,000 treatment on the treated (TOT): LBW: −6.7%.	LBW: larger effects (−10.8%) for infants of single and less educated mothers. By race: African American infants largest reduction in LBW (−5.1% versus whites −1.6%). Effects on Hispanics are small (−1.9%).
Hoynes, Schanzenbach, and Almond (2016). Effect of exposure to the US FSP from 0–5 years on adult health (age 25 plus).	PSID; 3,000 HHs; use waves until 2009. The Survey of Economic Opportunity subsample; N = 1,900 low-income & minority HHs selected from an existing sample (adjust for nonrandom sample using PSID weights).	DD model: Exploit variation in roll-out of FSP across counties & over birth cohorts in exposure to the FSP. DDD: use variation across subgroups w/varying propensities to use FSP. Models include controls for county, year of birth, interview FE, state linear time trends, county-year of birth controls.	Increasing the share from no FSP exposure to full exposure in utero to age 5): Metabolic syndrome Z-score (obesity, high blood pressure, diabetes, heart attack): −0.3 SD (TOT: −0.24 SD) (largest effects on males 0.5 SD). Weak improvements in other health outcomes: diabetes, health status, disability, smoking. Gains from FSP are large and increasing with exposure up to age 5.	Largest effects on males: 0.5 of an SD. Economic self-sufficiency: +0.3 of an SD for women only. Adult health impacts of FSP are minimal if child is exposed only after age 5.
Gould, Lavy, and Paserman (2011). Effects of material resources such as running water, electricity, and sanitation during childhood on outcomes at age 56–61 of Yemenite immigrants to Israel.	1) Authors conducted a survey in 2006 of the entire population of immigrants who were born in Yemen between 1945 and 1950 and arrived in Israel during 1949 and 1950. N = 2,927 individuals who were sorted into 233 different locations. 2) Census data for 1961.	Authors exploit quasi-random variation in the living conditions experienced by Yemenite children after being airlifted to Israel in 1949. Models regress a person's outcome on the conditions experienced in childhood and on family/indiv. background.	Running water, sanitation, and electricity in early childhood. Results for girls and women only: HS matriculation: +9pp (+33%) (no SD provided). Postsecondary: +6pp (4.7%). Years of schooling: +0.6 (5.3%). Age at First marriage: +0.6pp (2.7%). Fertility (N_children): −0.2pp (−5%). Employed: +7.2pp (11.3%). Self-reported health problems: −6.2pp (−15.5%). No effect on disability. Second-generation effects in the full sample: HS matriculation: 3.2pp; College degree: 3.3pp (baseline means not provided).	By gender: Effects are mainly for women, which could be due to: i) gender discrimination in the allocation of scarce resources or ii) a stricter enforcement of traditional norms in rural areas. By age: Authors include an interaction between treatment variables and YOB & find that older women, experience much larger impacts (results not shown).

(*Continued*)

TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, *N*	Identification strategy and specification	Effects of the shock	Heterogeneity
Lindo (2011). Health effects of parental job displacement on child's birth weight.	1) PSID; waves: 1968–97 (author stops in 1997 due to concerns in how job displacement is measured). Author uses the PSID's Childbirth & Adoption History Supp. (CAHS) to measure children's outcomes, i.e., birth weight in ounces is available for children born in 1985+; $N = 1{,}607$ births.	Compare the outcomes of children born after a displacement to the outcomes of those born before. Mother FE. Models also include education-group trends and industry trends.	Child was born after his/her father's job displacement: Birth weight: −4.8% (approx. 5 ounces decline).	Mother's with >HS have higher percent declines in family income, are more likely to work, and to work for more hours. Potential mechanisms: Husbands' earnings: −22% Family income: −13%. Men's work activity: no change. Mother's employment status: no change. Food spending: no change.
Carlson (2015). Examine the direct consequences of job loss on birth outcomes, isolating anticipatory effects.	1) Dates of major job losses & information on the warnings given to the local community using notices filed under the Worker Adjustment & Retraining Notification (WARN) Act. 2) Natality data, 1999–2008. *The author constructs a county-month panel data set including all 422 counties in AL, NY, TX, & WA; $N = 7{,}113{,}083$ births & 2,626 WARN notices.	Exploit county-month variation in the occurrence of job losses through announced notices. Models include county-specific quadratic time trends, county of birth, year of birth, & calendar month of birth FE.	Being exposed to anticipatory dislocations during pregnancy: Birth weight: −15 to −20 grams (−0.4% to −0.06%). Gestational age: −0.5 to −0.8 days (−0.2% to −0.3%). LBW = +1pp (+16.4%) Strongest effects are associated with exposure to notices in third trimester.	Potential mechanisms: physiological stress responses or increased levels of unhealthful behavior.
Golberstein, Gonzales, and Meara (2016). Effects of economic recessions (measured by UR and HPI) on child and adolescent mental health.	1) National Health Interview Survey (NHIS), years 2001–13; nat. The child's mental health questionnaire (SDQ score) has five domains: emotional symptoms, conduct pb's, hyperactivity-inattention, peer problems, prosocial behavior. Mental health treatment & medication use are only available for 2005–07. 2) Economic variables are obtained from the BLS & from the Freddie Mac Housing Price Index (HPI).	Exploit the state and quarter variation in the unemployment rate (UR). Models include state & quarter FE, individual and family covariates, & state linear time trends.	A 1 SD increase in the UR: SDQ score (index of mental health severity; higher index, worse mental health): +2.3% in the "mental health severity 1/10 scale" and +11% in the "likely psychological problem." Emotional difficulty score: +4.8% in the "mental health severity 1/10 scale" and +10.4% in the "likely psychological problem." Use of special education services for children's emotional problems: +5.7%.	Parental unemployment, reduced family income, & higher family stress are likely to influence child mental health. The impacts were stronger among households where parents have < college, are nonwhite, or are in the bottom income quintiles. Authors also find little differences by child's gender or by child's age (comparing children versus adolescents).

(*Continued*)

TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity
Gutierrez (2014). Effect of birth during economic crisis in Peru on infant mortality, education, and employment at 15–18 years.	1) National Household Survey (Encuesta Nacional de Hogares, ENAHO), eight waves: 2004–2011; data on educational & health outcomes at later ages; $N = 39{,}846$ children. 2) DHS data, three waves: 1991, 1996 & 2000; data on mother's health & child's mortality; $N = 11{,}275$ children.	Estimate a two-sample instrumental variable model: 1) Regress child mortality in first year of life on dummy for YOB interacted by mom's education. 2) Regress outcome at age 15 on dummy for YOB interacted by mom's education. 3) Ratio of coefficients of interest in 1) & 2) shows the effect of early-life health shocks on future outcomes. Models include rich controls and some specifications include trends.	Exposure to the crisis and being born to less-educated mothers: Prob(dying in the first year of life): 1% (no table 1 available). Chronic illness: +2.36pp (no table 1 available). Complete primary education (ages 15–18): −1.7pp. Employment (ages 15–18): no effects. Calculates upper and lower bounds on the effects by assuming: i) there is no selection; ii) there is no scarring effect.	Mother's education: the increase in infant mortality during the crisis was particularly severe for children born to less-educated mothers.
Lavy, Schlosser, and Shany (2016). Children conceived in Ethiopia and born in Israel after their parents migrated. Effects of early childhood conditions on outcomes at 18–20.	1) High school administrative data linked to demographic records for all Ethiopian children born June 1991 to February 1992; data include student's birth date, date of immigration, country of origin of students & parents, student demographics (parental education and number of siblings), current schooling status; data collected in 2007–11; $N = 1{,}951$ students.	Exploit the timing of the immigration shock of Ethiopian Jews to Israel in May 1991. DD: Three groups by the gestational age at the time of the immigration: 1) Children whose mothers arrived after conception but before week 8 of gestation. 2) Children whose mothers arrived at 8–24 weeks of gestation; 3) Children whose mothers arrived after week 25 of gestation but before birth. Models include cohort & month of birth FE and rich controls.	Exposure to Israel's better conditions before week 8 of gestation: Matriculation diploma: 12.2% (0.07 SD). Quality of matriculation diploma (more challenging study programs during high school): +33% (0.39 SD). Math credits: +39.6% (0.32 SD). English credits: +33% (0.37 SD). No effect on high school completion. All effects are driven by exposure in the first 8 weeks of gestation (i.e., no effect of exposure after week 8).	By gender: Effects are only significant among girls. By parental education: Effects are stronger for children from families with higher parental education. (Though most immigrants had low levels of education.)
Løken, Mogstad, and Wiswall (2012). Effects of Norwegian oil boom on family income and child outcomes at 29 plus.	Administrative registers for the entire population, provide information on educational attainment, IQ, & family income during childhood, 1967–2006; control variables: sex, birth year, marital status, N of children, SES (years of education, IQ, income, etc.), personal identifiers for one's parents, family identifiers, geographic identifiers for county of birth; $N = 202{,}000$ children.	1) Show that the linear FE estimator identifies a weighted average of the marginal causal effects. 2) Use a Blinder–Oaxaca decomposition to measure the contribution of different weights to the differences between linear OLS, FE, & IV estimates. IV: instrument for family income using the regional & time variation in the economic boom after the oil discovery. Also include sibling FE.	A 1 SD increase in family income: Years of education - Models without income squared: No effects in IV or FE. Models including income squared: IV: +0.74 (child in poor family), +0.05 (child in rich family). FE: +0.22 (child in poor family), +0.02 (child in rich family).	Effects are larger in the lower part of the income distribution.

(*Continued*)

TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity
Meckel (2015). Examines the effects of antifraud efforts in the WIC program, which resulted in the shutdown of some small operators.	1) Administrative data about WIC vendors in Texas. 2) Prices from Nielsen Homescan data: representative panel of consumers w/product-level data on all purchases; includes product type, date & location of purchase, & on the purchaser; $N = 430{,}000$ purchases (11,400 stores). 3) Individual birth records that provides information on WIC participation of pregnant women and on ZIP code of residence of the mother, 2005–09; $N = 1$ million mothers on WIC.	Exploit the staggered county-level rollout of a fraud reduction program in Texas through the introduction of the Electronic Benefit Transfer (EBT) that replaced paper vouchers. DDD model: exploit variation in the exact timing of EBT rollout across counties, years, and months, and WIC product and WIC store. Assumption: the exact timing of EBT rollout is uncorrelated with endogenous trends.	The antifraud reform: (1) Eliminated most preexisting fraud among stores (violations declined 15%) (2) Caused 10–26% of single outlets to drop out of WIC (no change for chains) (3) Reduced WIC participation among eligible mothers by 3–5% (4) Reduced the likelihood that a mother has at least one WIC store in her ZIP code (a fall of 10–25%) (5) Increased the prices on WIC products within single outlet WIC stores by 9% (6) Reduced welfare by 3–4% of the value of benefits received	The largest declines in WIC participation among stores and women occur in high-poverty ZIP codes. Only fraudulent stores select into the program in high-poverty areas, suggesting that fraud implicitly subsidizes program access in these areas.
Milligan and Stabile (2011). Effects of child benefit payments in Canada on child outcomes from 0–10.	1) NLSCY provides family income & demographics; 6 biannual cycles: 1994–95 to 2004–05; followed children aged 0–11 to age 10-21; $N = 108{,}000$ children. 2) Survey of Labour & Income Dynamics (SLID) used to simulate the aggregate benefits (instruments).	Exploit the variation in child benefits across province, year, and family type (N of children in a household) due to changes in legislation. Instrument: actual child benefit level in a given year, province, family size is instrumented with a simulated tax benefit computed using a tax & benefit calculator. Models include a set of individual/family characteristics and control variables for time and province effects.	An increase of $1,000 in child benefits: Education: repeating a school grade: no effect; math score: +0.069 SD (+1.6%); PPVT: no effect Prob (not been diagnosed with a learning disability): +2.8pp (+1.0% = 0.16 SD) Emotional/behavioral well-being: Physical aggression: −0.106 SD (−14%)	Most significant effects are driven by boys, not girls. For girls, there is a significant effect on physical aggression (−0.14 SD for boys; −0.22 SD for girls).
Scholte, van den Berg, and Lindeboom (2015). Influence of economic conditions early in life on the impact of adverse life events and on physical health later in life.	1) Longitudinal Aging Study Amsterdam (LASA); five waves: 1992–1993, 1995–1996, 1998–1999, 2001–2002, 2005–2006, ($N = 2{,}869$, 2,001, 1,571, 1,132, 799 persons). Data includes info on: functional limitations, heart disease, stroke, cancer, respiratory diseases, peripheral artery disease, diabetes and arthritis.	Ask how shocks in later life affect functional limitations in later life AND whether individuals exposed to recessions early in life respond differently to later-life shocks than other adults. Strategy: IV + individual FE. Instrument: Business cycle at birth (boom or recession). Regressions include interactions between: (indicator for a recession at birth) × (adverse later life events).	N of functional limitations later in life: Chronic disease: +8.6% (Chronic disease) × (early-life recessions): +10.5% This result indicates that the effects of chronic diseases on functional limitations are exacerbated by adverse early-life conditions.	Effects of chronic disease and (Chronic disease) × (early-life recessions) are only positive & significant among males.

(*Continued*)

TABLE 4
POLICIES THAT AFFECT HOUSEHOLD RESOURCES (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity
Rossin-Slater (2013). Effect of closures of WIC clinics in Texas on birth outcomes.	1) Texas Birth & admin. records 2005–09; data includes mothers' maiden name, DOB, counties of birth, ZIP codes of residence; allows linking of siblings & determining whether mothers had an operating WIC clinic in their ZIP code during pregnancy; N = 1,937,003 births (612,694 siblings). 2) WIC clinic locations come from TX Dept. of State Health Services; includes names, address/ZIP codes, & opening/ losing dates in 2005–10 (N = 578 ZIP codes; 114 experienced openings/closures).	Exploit the within-ZIP-code variation in WIC clinic openings/closings. Compare births by mothers who did & did not have a WIC clinic in their ZIP code during pregnancy & control for mother-FE with IV (to account for migration, measurement error, & the mechanical correlation between gestation & WIC participation) (instrument: dummy for whether mother would have had an open WIC clinic during her current pregnancy in the ZIP code of her first pregnancy assuming 39 weeks gestation). Models include individual controls, YOB & MOB FE, ZIP code-FE, county linear time trends.	The presence of a WIC clinic in a mother's ZIP code of residence, during her pregnancy: Food benefit take-up: +6% Pregnancy weight gain: too little weight (<7.3 kg): −2pp; too much weight (>18 kg): +3pp (among those with ≤HS educ.) Diabetes: +1.3pp (among those with ≤HS educ.) Gestational hypertension: +1.3pp (among those with ≤HS educ.) Birth weight: +27gr (+0.8%) (full sample)	Strongest effects for mothers with high school or less, who are most likely eligible for WIC services (0.74% WIC take-up vs. 0.07% among other moms). The increase in BW is concentrated in the middle of the BW distribution.
Rossin-Slater (2017). How did changes in paternity establishment laws affect young children's access to resources and health outcomes in the United States?	1) Paternity establishments in hospital, N = 601 state-year observations. 2) CPS-CSS & March CPS, 1994–2008 child support supplements (CSS); N = 8,974 who respond to CSS); 3) NHIS data 1997–2010 restricted sample of child files; provides info on child mental & physical health. 4) Fragile Families & Child Wellbeing Study.	Exploit variation in the timing of in hospital paternity establishment across states. Models regress a child outcome on the in hospital paternity establishment dummy, rich individual controls, state & child birth year FE, & state-specific time trends. Author imputes birth year = survey year − child age − 1 since interview year are in March.	Paternity establishment no effects on time spent father & child. Child private health insurance: −2.65pp (−3.89%). Child physical health (asthma, ear infection): no effects. Any well-visits: −1.99pp (−2.53%). Any doctor visits: −1.48pp (−1.78%). Child mental health: no effects. Income, poverty status, or welfare benefit receipt: no effects.	No differences by mother's race.

(*Continued*)

TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/effects
Panel B. Maternity leave policy				
Baker and Milligan (2015). Expansion of paid maternity leave in Canada on children's outcomes at age 4–5.	1) National Longitudinal Survey of Children and Youth (NLSCY), 1994/5 to 2008/09. $N \sim 10{,}000$ observations. Authors sample multiple cohorts before and after the reform so that any age effects average out. 2) Labour Force Survey (LFS) that includes data on labor force status.	Exploit the variation in time at home post-birth induced by the maternity leave reform extending maximum length of paid leave from 25 to 50 weeks. IV (instrument for time at home: dummy for whether child was born after the law change (i.e., December 31, 2000)). Models include time trends & rich individual controls.	A one month increase in maternal care: Cognitive: PPVT: −5.7% of a standard deviation; "Who am I? test": −5.1% of a standard deviation Behavioral outcomes (hyperactivity, anxiety, physical aggression, & indirect aggression): no effect	By child's gender: negative & significant effects only for boys. By mother's educ. (HS or less versus >HS): effects seem to be only negative & significant for children of more educated mothers.
Carneiro, Løken, and Salvanes (2015). Effect of an unexpected extension of paid maternity leave in Norway on the education and wages of children at age 30.	Norwegian Registry data: covering the population of Norwegians up to 2007 and a providing month and year of birth, education, labor market status, earnings, age, gender, data on families. Authors are able to link data on individuals with parents. $N \sim 42{,}600$ observations.	Two strategies: 1) RD: comparing children of eligible mothers born just before and just after July 1, 1977 when maternity leave expanded from 12 weeks unpaid to 4 months paid plus up to 12 months unpaid. 2) DD: Treatment: difference between mothers who had a child in June and those who had a child in July 1977. Control: difference between mothers who had a child in June and those who had a child in July of 1975, 1977, and 1978.	Children of mothers who benefited from PAID maternity leave: HS drop-out (refers to a 3 yr HS diploma): −2pp (−7% = −0.04 SD). Ever started college (at age 30): +2pp (+5% = 0.04 SD). Wages (at age 30): +5% to +6.2%.	Children of less educated moms experienced a higher decline in HS drop out: (−3.6pp versus −1.8pp), more college attendence (+3pp versus no effect), BUT no effect on earnings by age 30 (children of more educated moms had 5.7% increase in earnings). Effects of the reform are larger for mothers who would have taken little unpaid leave.
Dahl et al. (2016). Effect of an unexpected change in paid maternity leave in Norway on parental earning, fertility, LFP, and child test scores.	1) Social security registers, 1992 onward. Multiple years merged using individual identifiers. Authors do not observe actual eligibility, therefore, predict eligibility using labor earnings the year before birth. $N = 21{,}838$.	RD: exploit the discontinuity from the reform being contingent on the birthdate of the child. A series of reforms extended paid maternity leave from 18 weeks to 35 weeks. Authors exploit this type of variation from six different maternity leave reforms in Norway. Since take-up is very high ITT ~ATE. Models include time trends & rich individual controls; also include quadratic trends on each side of the discontinuity.	The expansion of the paid ML: 1) Did not crowd out unpaid leave 2) Effects on individual outcomes: No effects on test scores, school drop-out, parental earnings, mother's LFP after birth (rate of returning to work two years after the birth), completed fertility, marriage, or divorce: no effects. 3) Cost–benefit analysis "Paid maternity leave is regressive."	NA

(*Continued*)

TABLE 4
POLICIES THAT AFFECT HOUSEHOLD RESOURCES (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Danzer and Lavy (2018). Effect of an Austrian maternity leave reform extending leave from 12 to 24 months on test scores at age 15.	1) OECD's PISA data, 2003 & 2006; includes student-reported background information (e.g., gender, birth year, month, nationality, attitudes), parents (education, nationality, occupation), & school (e.g., school program, location, school size, resources); Not included: DOB, maternal labor market participation at the time of birth, duration of leave taking of mothers. $N = 764$.	Exploit an amendment to parental leave legislation that came in effect on July 1, 1990 which extended paid leave from 12 to 24 months. Identification strategy uses: 1) RD 2) DD - RD Treatment group: children born after July 1, 1990 and before December 31, 1990. Control group: children born in the First half of 1990 (& in 1987). Models include rich mother controls & month of chld's birth FE. Estimates are ITT since actual leave taking is not observed.	No effects on PISA test scores in the full sample.	Mothers with postsecondary: +0.20 SD (math), +0.22 SD (reading), +0.21 of an SD (science), Boys: +0.33 SD (reading), +0.40 (science). Mothers with less than postsecondary education: −0.14 SD (reading). Boys −0.27 SD (reading), −0.23 SD (science). Girls no effect.
Rossin-Slater (2011). Effects of extensions of unpaid maternity leave on birth outcomes and fertility in the United States.	1) Vital Statistics natality & mortality 1989–97 collapsed into birth-year/ birth-month/county/ mother-education/mother-race/mother-age/ mother marital-status cells; $N = 5{,}806{,}669$ cells. 2) County Business Patterns (CBP), 1989–97, to estimate the likelihood that a resident of a county is employed in a firm with 50 or > employees/ year. 3) Quarterly Workforce Indicators (QWI) to check the firm-size procedure. 4) 1990 Census by county of birth to construct county-level controls. Link datasets by county & year (>98% of cases matched).	Exploit variation in pre-FMLA maternity leave policies across states & variation in which firms are covered by FMLA provisions. DD & DDD: Compare the likely eligible & likely ineligible groups before & after FMLA, & across states. Likely eligible group: those employed by a firm with ≥ 50 employees. Models control for rich county-level & mother controls, month-of-birth, year-of-birth, state FE, state specific time trend. Estimates are ITT given that author does not observe leave-taking.	DDD results: BW: +6.5 gr (+0.2% = +0.01 SD). Gestation length: +0.04% (0.008 SD). LBW: −0.2% (0.01 SD). Prob(preterm): −3% (0.1 SD). Infant mortality: −2.5% (−0.017 SD). Risk factors or complications at birth: no effects. Overall fertility: no effects. Parity at birth: increase in first parity births and a decrease in later parity births. Laws encouraged some previously childless women to give birth.	By mother's education & marital status: Married college mothers versus single mothers without college: BW: +9.2 gr (+0.3% = +0.02 SD) vs. 7.1 gr (0.2% = 0.016 SD). Gestation length: +0.06% (0.012 SD) vs. no effect. LBW: −0.2% (0.01 SD) vs. −0.3% (0.012 SD). Prob(preterm): −2.7% (0.1 SD) vs. no effect. Infant mortality: −10% vs. no effect. Changes in parity at birth driven by single, less than college mothers.

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TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/effects
Panel C. Child care				
Aizer and Cunha (2014). Head Start effects on outcomes measured at age 7.	National Collaborative Perinatal Project (NCPP); children & parents were followed before birth up to age 7; waves: 8 mths, 1, 4, 7 years after birth; years of birth: 1959–65, 12 cities. $N = 10{,}157$ observations. Sample includes 8-month Bayley score; authors argue that the Bayley is more predictive of later human capital than birth weight.	Exploit the introduction of Head Start in 1966 in a model with sibling FE. Older siblings had no access to HS. Focus on the ability of initial endowments to predict parental investments at age 8 months & at age 7. Regression models include an interaction between HS_enrollment × investments_8mths and controls for HS_enrollment, investments at 8mths, individual covariates, & family-FE.	The effect of HS × Bayley score at 8mths (Sibling-FE): Child IQ (age 4): 16.5% SD. Cogn. Achievement age 7 (ONLY signi. for those w/high initial HK): IQ: 10.4% SD. Reading: no effect. Math score: 16.0% SD. Parents invest more in highly endowed children. Preschool invest. & early HK are complements in the prod. of late HK. Degree of reinforcement increases w/family size.	The impact of HS is largest for those w/higher early cognitive development at age 8 mths. By age 7, the effect of HS on IQ & achievement have faded except for those with the highest endowments.
Attanasio, Di Maro, and Vera-Hernandez (2013). Impact of a preschool program in Colombia (*Hogares Comunitarios*, HC) on children's nutrition at age 2–6.	1) Survey of *Familias en Accion* (CCT program in Colombia): representative of poor individuals in rural areas; focus on 65 towns where preschool program was not implemented; years 2002, 2003, & 2005-6; $N = 2{,}413$ children. 2) ENDS: a more complete version of the DHS 2005; basic household demographics, children anthropometrics, & participation in HC; urban areas, includes poor and less poor; $N = 6{,}179$ children.	To address the endogeneity of HC participation authors instrument using: i) distance from the residence to the nearest nursery, ii) the median fee in the town, iii) the capacity of the HC programme in the town (filled + vacant HC slots/N of eligible children in the town). Model covariates include the N of children aged 2–6 in the town, the distance to other amenities (school, health centre, and town hall), mother & head's ages & education levels and mother's height, as well as town-level variables.	Exposure to HC: Height-for-age: +0.88 SD (FeA sample); +1.23 SD (ENDS sample). Atendance to HC: Height-for-age: +0.4 SD (FeA sample); +0.83 SD (ENDS sample). "A 60-month-old child that has spent 24 months in an HC would be 0.35 SD (FeA) or 0.49 SD (ENDS) taller."	The impact of the program is considerably higher for lower quantiles & almost zero for the top quantiles.

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TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/effects
Attanasio et al. (2014). Effects of a psychosocial and nutritional intervention in Colombia on outcomes at 12–24 months.	Baseline was collected in Feb–May 2010 & follow-up in Sept–Dec 2011; duration of the program was 18 months. Data collection includes rich measures of child cognitive tests & physical health, HH characteristics, at ages 1–2. $N = 1{,}420$ children in 96 municipalities (out of the 1,100 in Colombia). Sample sizes: Control ($n = 318$) Stimulation ($n = 318$) Supplementation ($n = 308$) Both interventions ($n = 319$).	RCT in 96 towns in Colombia using a 2×2 factorial design There were 4 interventions: i) psychosocial stimulation alone ($n = 318$), ii) micronutrient supp. alone ($n = 308$), iii) both combined ($n = 319$), iv) control ($n = 318$). Models include tester effects (two for each region), baseline level of the outcomes, sex, and a second order polynomial in age.	Psychological stimulation: Cognitive scores (Bayley-III): +0.26 SD (3.7%) Receptive language: +0.22 SD (5.4%) No effects on expressive language, fine motor skills, height, weight, hemoglobin. Micronutrient supplementation had no effect on any outcomes. Interactions between psychosocial & nutritional interventions had no effects on any outcomes.	NA
Baker, Gruber, and Milligan (2015). What are the long-run impacts of interventions that foster a deterioration in noncognitive skills?	1) Canadian National Longitudinal Study of Children and Youth; biannual between 1994–51 & 2008–09; focus on children 0–9; $N \sim 2{,}000$ observations. 2) Test Scores: School Achievement Indicators Program (SAIP); Pan Canadian Assessment Program (PCAP); PISA scores; 1993–2012. 3) Health and well-being data: Canadian Community Health Survey (CCHS) and Canadian Health Measures Survey (CHMS); 2001–13. 4) Criminal Behavior: Stats Canada's Uniform Crime Reporting Survey (UCRS); years: 2006–13.	In 1997, Quebec introduced a very low cost universal child care program for children aged 0–4. This program increased maternal labor supply and use of CC in Quebec (Baker, Gruber, and Milligan 2008). DD: compare the pre- and post-program outcomes of children/teenagers in Quebec, to the corresponding outcomes of child/teenagers in the rest of Canada. Models include province dummies, year dummies, and individual controls.	Children enrolled in child care at ages 0–4 in Quebec: Self-reported (worse) health: +0.07 SD (+3.4%) (a positive effect means worse health). Life satisfaction: +0.30 SD (+14.0%) (a positive effect means worse). Quality of life: +0.35 SD (+14.6%) (a positive effect means worse). Criminal behavior: rates of accusations: +3.7% rates of convictions: +4.6% Test scores: no effects/opposing effects across math/science "There is no strong evidence that the Quebec Family Plan had a lasting impact on children's cognitive development."	By gender: "effects on criminal behavior, aggression, and hyperactivity are concentrated in boys, who also see the largest deterioration in non-cognitive skills."

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TABLE 4
POLICIES THAT AFFECT HOUSEHOLD RESOURCES (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Campbell et al. (2014). Effect of Carolina Abecedarian Project on health outcomes at age 30.	Surveys of children, parents, teachers include data on cognition, personality, health, achievement, & behavior; participants followed at ages 12, 15, 21, 30, mid-30s. Collected biomedical data (e.g., blood samples). $N = 111$ children (57 treat, 54 control).	Randomization of children into control & treatment groups. Due to VERY small samples ($N = 111$), authors use estimation methods that involve exact (small-sample) block permutation tests + boostrapping of standard errors.	Disadvantaged children randomly assigned to treatment at 0–5 have: 1) Fewer risk factors for cardiovascular & metabolic diseases in their mid-30s (stronger effects on males): systolic blood press.: −17mm Hg; metabolic syndrome (males): −25%; prehypertensive (females): −0.24; obesity & hypertension: difference of 38.9% between treatments & controls. 2) More health care utilization at age 30 (males): +22.8%. 3) Lower risk of overweight in early life (males): −40%. Those who are obese at age 30s were already obese at ages 0–5.	Larger impacts on overweight, obesity, & hypertension, healthcare utilization for males.
Carneiro and Ginja (2014). Effect of US Head Start program on outcomes observed in teens and young adults.	CNLSY; annual survey from 1979 until 1994 and biannual since then; authors use until 2008. Nationally representative. $N = 5{,}433$ children 3–5.	RD: exploit selection criteria on HH income (& on family size) Main regressions include Head Start participation, HH income (measured at age 4), & a parametric but flexible function of year, state, family size, family structure, HH income (measured at age 4) Discontinuity in the prob(take-up of HS) around income eligibility threshold is not sharp so authors instrument using determinants of eligibility. First stage only significant for males (F-stat = 17).	Effects only estimated for boys (first stage regression only significant for boys) Participation in HS (IV results): Overweight: −29% (0.74 SD) Needs special health equipment: −29% (1.29 SD) Behavioral problems: −0.6 SD (not given as a %) Engagement in criminal act.: −22% (young adults) (0.56 SD)	No first stage for girls.

(*Continued*)

TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Conti, Heckman, and Pinto (2015). The impacts of two early-life US programs (Perry Preschool Project (PPP) & Carolina Abecedarian Project (ABC)) on LT health and health behaviors.	1) PPP longitudinal data: follow-ups collected annually from age 3 until fourth grade; includes measures of intelligence, academic aptitude, achievement tests, assessments of socio-emotional development, school records starting at kindergarten through secondary education. 2) ABC longitudinal data: follow-ups collected at ages 12, 15, 21, 30. $N = 7{,}400$.	Treatment randomization with long-term follow-up: The paper accounts for small sample sizes, multiple hypothesis testing, and nonrandom panel attrition. Effects are estimated by gender due to both biological and behavioral considerations.	Participating in an early-childhood program: 1) PPP (outcome observed at ages 27 and 40): Prob(having a healthy diet): +15pp (males) (no SD available). Prob(engaging in regular physical activity): +33pp (females). Prob(of being a daily smoker): −20pp (males) Avg. N of cigarettes/day: falls from 8.7 at age 27 to 6.5 at at 40 (males). 2) ABC (outcome observed at age 34): Obesity: no effects Overweight: no effects Prob(Diastolic blood pressure): −15% (males) Prob(Systolic blood pressure): −12% (males) Hypertension I: −76% (males) Hypertension II: −62% (males) Prob(ever been hospitalized): +35pp (males).	Both programs improved the health outcomes and healthy behaviors of males only. Externalizing behavior in early life is a key mediator of the effect of PPP on smoking among males, while enhancements in cognitive skills are a key mediator of PPP on physical activity. Task orientation and child's BMI are important mediators for high blood pressure and hypertension in later-life (males) in ABC.
Gelber and Isen (2013). Effects of Head Start on parental investments in children.	The Head Start Impact Study was an experiment in which some children were treated with Head Start while the controls were not. Many controls were in other preschools. Outcomes were measured in the fall of 2002 (after their enrollment in HS) & in the Spring of 2003, 2004, 2005, 2006 ($N = 4{,}061$ children).	Exploit the random selection of first-time applicants (ages 3 & 4) to HS for the fall of 2002. HS experiment: children on waiting lists for 84 nationally representative HS programs (353 HS centers) were selected into: Treatment: group enrolled in HS ($N = 2{,}479$ children) Control: group that was not granted access to HS ($N = 1{,}582$ children).	While enrolled in HS: Parental involvement w/child (includes all activities): +0.15 SD. Reading & writing: +0.19 SD. Math: +0.19 SD. Qualitative parenting: +0.07 SD. Rules & routines: 0.12 SD. Tracking child learning: 0.23 SD. After child was enrolled in HS: Parental investment in children: +0.06 SD. Reading & writing: no effect. Math: +0.10 SD. Qualitative parenting: +0.07 SD. Rules & routines: +0.09 SD. No effect on father involvement or parent–school involvement in either condition.	Across HS programs, programs that raised children's cognitive test scores more also raised parents' involvement w/children. No evidence of differential impacts across: i) father present; ii) gender; iii) fall 2002 income of the parents; iv) number of siblings; v) whether child entered HS at age 3 or 4.

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TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Gertler et al. (2014). Effect of psychosocial stimulation and nutrition in Jamaica on child outcomes at age 20–22.	The Jaimaican Study: Longitudinal data that follows (N = 129; 64 treatment + 65 control) poor & stunted children and a comparison group (N = 84) of non-stunted. Urban representative data were used to compare samples: i) the 1992 Jamaican Survey of Living Conditions; ii) the 2008 Jamaica Labor Force.	Randomized intervention: treated/control groups were all stunted, lived in same neighborhoods, had same age/sex. The two groups differ in terms of: mother's education & weight-for-height (treated group was more disadvantaged) & mother's employment (treated group higher than control). The comparison NON-stunted group is a more advantaged group of children (although not as advantaged as the average population in urban Jamaica).	Psychological stimulation treatment: Earnings: +42% (effect sizes: NA) Employment or LFP: no effect. Compared w/the NON-stunted group, treated children catchup in earnings, while the control group (stunted children w/o intervention) lag behind in earnings. Nutrition supplementation treatment: NO effects on ANY of the outcomes.	Treated males are more likely to be enrolled in school & to be enrolled full time. Have a higher cognitive factor & are more likely to be expelled from school. Females are more likely to increase their years of schooling, have any college education, have higher exam grades, & better externalizing & internalizing behaviors.
Havnes and Mogstad (2011). Effect of being born after a child care reform in Norway on outcomes at age 30.	1) Longitudinal database that covers every resident from 1967 to 2009, includes rich data on all HH members; N = 341,170 children. 2) Administrative register that covers all child care institutions eligible for public subsidies from 1972 to 2009. Datasets are merged using unique identifiers for each individual.	Exploit temporal & spatial variation in child care availability induced by the staged expansion. Compare adult outcomes for 3 to 6 year olds before/after the reform, from municipalities where CC expanded a lot & municipalities little increase. Nonlinear DD methods to estimate quantile treatment effects & local linear regression estimates of the program effects by family income. Order the municipalities by the pp increase in CC coverage rates from 1976 to 1997, divide sample at the median, the upper half are treatment municipalities & lower half are the controls.	The child care reform: Earnings (age 30): +9,000 NOK peaks at the 11th percentile (+2.5% = +0.06 SD); +5,000 NOK between the 15th–60th percentile (+1.4% = 0.03 SD); & then fade out. Gini coefficient: declined from 0.306 to 0.296 "universal child care has a small but non-negligible equalizing effect." Intergenerational income elasticity: −2.5pp.	Results show substantial heterogeneity in child care effects by family income. Children from high-income households suffer a mean loss of 8,000 NOK while children from low-income households experience a gain of 9,000 NOK. No differences by gender.

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TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/effects
Heckman, Pinto, and Savelyev (2013). Effect of Perry Preschool on outcomes up to age 40.	1) Data on the Perry Preschool randomized experiment: $N = 123$ children (51 females (25 treatment & 26 control) & 72 males (33 treatment & 39 control)); follow-ups: ages 3–15, 19, 27, and 40.	1) Exploit the randomized controlled trial design of the program to identify the causal effect of the treatment on measured skills and on adult outcomes. 2) Use an econometric model that estimates the relationship between outcomes & experimentally induced changes in measured skills. Three stage procedure: 1) estimate the measurement system; 2) from the theoretical equations in 1), estimate the skills for each participant; 3) estimate the relationship between participant skills and lifetime outcomes.	1) Program effects on cognition and personality skills (kernel density graphs): Cognition (Stanford–Binet Intelligence Test): increases only in the right tail of the distrib (and for females). Externalizing behavior: strong reductions for males (at all levels of the distrib.) and females (left tail). Academic motivation: increases at all levels of the distrib. except at right tail (and for females only). 2) Effect of cognition and personality skills on outcomes: Cognition: increases achievement tests and certain labor market outcomes. Externalizing behavior: affects crime, labor market, and health behaviors. Academic motivation: boosts education and reduces long-term unemployment.	By gender: there are significant differences.
Kline and Walters (2016). Reexamine the Head Start Impact Study. Account for participation of controls in other preschool programs.	The Head Start Impact Study was an experiment in which some children were treated with Head Start while the controls were not. Many controls were in other preschools. Outcomes were measured in the fall of 2002 (after their enrollment in HS) and in the spring of 2003, 2004, 2005, 2006 ($N = 4{,}061$ children).	Conduct a calibration exercise that accounts for the fact that ~1/3 of Head Start children were drawn from another public preschool setting. Thus, the cost of providing preschool to these children is overestimated if we ignore this. Also assumes that the short-run impacts of Head Start on test scores are the best predictors of future outcomes, in line with previous studies which have shown initial “fade out” followed by long-term effects.	Head Start is about as cost effective as other publicly funded preschools, and under reasonable assumptions, has positive rates of return. Ignoring the fact that Head Start draws from other preschools substantially overstates its cost.	The children who are most likely to benefit from Head Start are least likely to participate. Hence, an expansion that brought these children into the program would have even higher payoffs.

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TABLE 4
POLICIES THAT AFFECT HOUSEHOLD RESOURCES (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/effects
Panel D. Medical care and insurance				
Bharadwaj, Løken, and Neilson (2013). Examine the effect of additional medical care for infants over 1,500g on infant mortality and test scores in Norway and Chile.	Chile: 1) Health: Vital statistics and death records 1992–2007. $N = 6{,}109$ births in the bandwith of VLBW. 2) Education records: 2002–10 Universe of students 1st–8th grades. 95% cases matched. Norway: 3) Health: Medical Birth Registry, 1967–93; universe, twins. 4) Education: Norwegian Registry Data, covers population, ages 16–74 in 1986–2008. Includes basic SES data (educ., age, labor mkt., family info, etc.). $N = 2{,}477$ births in window. Test scores measures at age 6–8. 72% cases are matched.	RD: Exploit variation in birth weight around the cutoff of VLBW (1,500gr) or less than 32 weeks gestation to identify effect of neonatal health care on mortality/education. Compare children just under and over 1,500 grams to examine difference in outcomes as a result of extra medical treatments.	Being VLBW compared to children just above 1,500gr: Infant mortality: −4.4pp (Chile; avg. infant mortality = 10.9%),. −3.1pp (Norway; avg. infant mortality = 4%). Test scores: +0.15 SD (Chile; math score); 0.22 of an SD (Norway; national exam). Introduction of surfactant therapy helped improve educational outcomes for VLBW. Predicted effects on wages: +2.7% (0.15 SD) (Chile); 1.8% (Norway).	NA
Daysal, Trandafir, and van Ewijk (2015). Effects of home delivery on newborn deaths in the Netherlands.	1) Perinatal Registry of the Netherlands, 2000–2008, annual dataset that links three datasets of individual birth records collected by midwives (LVR-1), obstetricians (LVR-2), & pediatricians (LNR), covers 99% of the primary care & 100% of the secondary care provided during pregnancy & delivery in the Netherlands, $N = 356{,}412$ births. 2) Statistics Netherlands data on income & educ. at the postal code level. 3) 2005 Dutch National Atlas of Public Health for exact address and the availability of obstetric wards for each hospital.	Use the variation in distance from a mother's residence to the closest hospital with an obstetric ward (exogeneity?) as an IV for a hospital delivery. Models include year, month, & day of the week of the birth FE, rich maternal controls, and avg. HH income in the postal code of residence of the mother.	Giving birth in a hospital versus at home (IV results): A 10.81pp increase in the share of hospital births reduced 7-day (28-day) mortality by 49% (46%) between 1980–2009). 5-minute Apgar score: no effects first stage: distance is a strong predictor of whether she gives birth in a hospital or at home (F-stat ∼ 28): 7.5pp (11% at the mean).	By income: baseline results are driven entirely by births to mothers residing in postal codes with less than the median of the average monthly HH income in the postal code (1,929 euros). TSLS estimates are similar when the sample is split by maternal ethnicity, median age (29 years), median gestational age (280 days) or median birth weight (3,410 grams).

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TABLE 4
POLICIES THAT AFFECT HOUSEHOLD RESOURCES (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Sievertsen and Wust (2015). Effects of longer post partum hospitalizations on mother and child readmission and children's schooling achievement at age 7 in Denmark.	1) Danish National Birth Cohort (hospital admissions), 1985–2006, $N = 714{,}562$ births. 2) Survey data: Danish National Birth Cohort, 1997–2003; pregnant women were invited to participate in 2 pre-birth & up to 4 post-birth surveys (at 6 & 18 months, 7 years & 11 yrs); includes maternal health behaviors, investments in children's health & development, & mother-reported child health; $N = 100{,}000$ births. 3) Data on the 9th-grade GPA are available for cohorts who completed 9th-grade in 2002–12 (cohorts born 1987–97).	Exploit county-by-county introduction of mandatory same-day discharge on the day of birth in a difference-in-differences framework. Models include county and year FE, as well as county-specific quadratic trends in birth year.	Same-day discharged newborns: Prob(1st-month hospital readmission): +75% (+0.15 SD). Readmission after first month: no change N of contacts mother & child with general practitioner in first month of child: +0.48 (+126% = 0.54 SD). N of contacts mother & child with general practitioner up to age 3: no effect. Children's ninth grade GPA: −0.1 SD. Test score in Danish: −0.12 SD.	Long term effects are strongest for at-risk children: "Children of at-risk mothers (defined by their age, education, income) appear to drive the negative effect of same-day discharge on schooling outcomes at age 15." GPA: declines by 0.19 SD in the at-risk group.
Wherry and Meyer (2016) examine the effect of the Medicaid expansions on mortality in affected cohorts.	1) Admin data: mortality records from the National Vital Statistics System (NVSS) Multiple Cause of Death files for the years 1979 to 2011. 2) March Supplements to the Current Population Survey (CPS): use a random sample of 500 children of ages 0–17 from each year of the 1981–88 CPS and estimate the childhood eligibility for this pooled sample for each birth month. $N = 864$ children (ages 4–23)	RD: exploit the discontinuity induced by Medicaid expansions that extended eligibility only to children born after Sept. 30, 1983. Poor children gained five additional years of eligibility if they were born in October 1983 rather than just one month before. Control group: cohorts of children born just before the birthdate cutoff.	Children born after September 30, 1983: Internal-cause mortality rate: Ages 4–7, 8–14, 19–23: no effect. Outcome at ages 15–18: −19% (blacks only). External-cause mortality rate: Outcome at ages 4–7: no effect. Outcome at ages 8–14: −13% (blacks only). Outcome at ages 15–18: +8% (whites only). Outcome at ages 19–23: −10% (blacks only).	By race: Medicaid expansions had a sizable decrease in the internal mortality rate of older black teens.

(*Continued*)

TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/effects
Miller and Wherry (2014). Effects of Medicaid expansions to older children on health status in young adulthood.	1) National Health Interview Survey (NHIS), years 1998 to 2012 $N = 95{,}855$ individuals. 2) Administrative data on hospitalizations from the Nationwide Inpatient Sample (NIS) provided by the Healthcare Cost & Utilization Project, includes data on 46 states, $N = 3$ million hospital visits (excluding pregnancy).	Exploit variation in the timing & generosity of Medicaid and CHIP eligibility for pregnant women & children across states. Construct a simulated eligibility measure of the generosity of state eligibility rules to instrument for the fraction of individuals eligible for Medicaid coverage. Authors construct Medicaid coverage measures by age groups: prenatal period, ages 1–4, 5–9, 10–14, 15–18. Model: outcome regressed on Medicaid eligibility in prenatal period, ages 1–4, 5–9, 10–14, 15–18, & on individual & state-level control variables, state of residence, year of birth (age), & survey year dummies.	A 10 pp increase in eligibility during the prenatal period (or during childhood): Obesity: −1.4pp (−7%) (no SD) (in utero). BMI: −1.5 kg/m2 (−7% = −0.25 SD) (in utero). Adult hospitalizations (excluding pregnancy): −2.7% (no SD) (ages 1–4). Preventable hospitalizations: −7% (in utero). Hospitalizations related to endocrine, nutritional, metabolic, & immunity disorders: −8% (in utero). No effects on health status, on any health limitation, or on psychological distress (Kessler scale).	Larger effects of coverage in utero.
Wherry et al. (2015). Effects of Medicaid expansions to older children on health status in young adulthood.	Uses data from the Healthcare Cost and Utlization Project (individual level hospital discharge and Emergency Department records from participating states) to examine exposure to Medicaid expansions given state and year of birth on number of visits as adults. $N \sim 58{,}000$.	RD: exploit the discontinuity induced by several early Medicaid expansions that extended eligibility only to children born after September 30, 1983. Treatment group: children in families with incomes at or just below the poverty line gained five additional years of eligibility if they were born in October 1983 rather than just one month before. Control group: cohorts of children born just before the birthdate cutoff.	Children born after September 30, 1983: At age 15: Hospital visits: no effect. Emergency department visits: no effect. At age 25: Hospital visits: no effect (for nonblacks) Emergency department visits: no effect (for nonblacks).	Effects were concentrated among blacks: Hospital visits: −7% to −15% (blacks only). Emergency department visits: −2 to −5% (blacks only). No effects were observed on nonblacks.

(*Continued*)

TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, *N*	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/effects
Brown, Kowalski, and Lurie (2015). Expansions of Medicaid coverage to older children and effects on labor force participation and income at age 28–31.	1) IRS Compliance Data Warehouse (CDW), 1996–2012; allows individuals + parents to be followed; $N = 4{,}911{,}040$ females and 5,129,194 males. Authors link children to parents in 1997, & follow the parents in all other years. 2) Medicaid Statistical Information System (MSIS). 3) Social Security Administration data on mortality.	Exploit the variation in public insurance eligibility by cohort & state due to the Medicaid & CHIP expansions in the 1980s & 90s. Authors exploit variation in total years of eligibility during childhood. Variation is at the state, month, and age group level. Models include FE for each birth month cohort, & each state at age 15, plus individual/HH controls. IV (instrument: simulated eligibility based on the fraction of the sample eligible for Medicaid at state & cohort year, at each age from ages 0 to 18).	For each additional year of simulated Medicaid eligibility: Cumulative income and payroll tax payments (at age 31): +$1,561 (of a base of $35,268) (+4.4%) (no standard deviations provided). Income: +$186 (on a base year of 20,623) (+0.9%). Years of education: +0.9 years (no avg. years of schooling provided).	By gender: "Females earned more in cumulative wages by age 28."
Cohodes et al. (2016). Effects of Medicaid expansions to older children on high school and college education of 22–29 year olds.	1) American Community Survey (ACS) 2005–2012, provides educational variables; allows matching each repondent to the state of birth. 2) March Current Population Survey (CPS), used to calculate Medicaid eligibility by age, state, year, & race. 3) Youth Risk Behavior Surveillance System (YRBSS) to explore mechanisms (i.e., teen health behaviors). $N = 5{,}494$ observations.	Exploit the state-level expansions of Medicaid and the CHIP that took place in the 1980s & 1990s. IV (instrument for actual eligibility using Medicaid eligibility of a fixed population in each age, state, year, & race). Identification assumption: Medicaid rules are not changing due to unobserved cross-cohort trends that also affect educational attainment. Models include rich aggregate-level controls, state-of-birth FE & calendar year FE.	A 10pp increase in avg. Medicaid eligibility between the ages of 0–17: IV results High school drop-out: −0.5pp (−5%) (−0.10 SD). College attendance: +0.7 to 1.0pp (1 to 1.5%) (0.08 SD). College completion: 0.9 to 1.0pp (3.3 to 3.7%) (0.08 SD).	By race: An interaction between Medicaid Xad nonwhite shows that: "Medicaid expansions helped to reduce the racial gap in HS completion..." By age: Authors show results of health insurance access by age: ages 0–1 versus ages 2–17. Find larger effects on older children.

(*Continued*)

TABLE 4
Policies that Affect Household Resources (*Continued*)

Study	Micro-data, N	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Panel E. Policies to increase maternal education				
Carneiro, Meghir, and Parey (2013). Effect of changes in maternal education on health and test scores at ages 7–8 and 12–14 in the United States.	National Longitudinal Survey of Youth 1979 (NLSY79), women and their children only; annual survey from 1979 to 1994 and biannual since. Authors use data until 2008. $N = 7{,}555$ children from 3,191 mothers.	IV approach: instrument for materal education is variation in schooling costs during the mom's adolescence (IVs: local tuition fees, distance to college, local labor market variables). Since IVs may be weak, authors also use a limited information maximum likelihood. Models include county & cohort FE, & aggregate trends as well rich controls for mother's ability.	A year of mother education (IV estimates): Whites: cognition (PIAT): +9.4% of 1 SD (math), +5.5% (reading) (ages 7–8); +6.0% of 1 SD (math), +5.2% (reading) (ages 12–14). Behavioral problems index: −6.6% (ages 7–8), −7.7% (ages 12–14). Grade repetition: −1.5% (ages 7–8), −2.1% (ages 12–14). Health (overweight/obesity): no effect. Blacks: cognition (PIAT): +10.3% of 1 SD (math), +7.3% (reading) (ages 7–8); +8.3% of 1 SD (math), +7.2% (reading) (ages 12–14). Behavioral problems index: −6.8% (ages 7–8), −4.9% (ages 12–14). Grade repetition: −1.7% (ages 12–14). Health (overweight/obesity): weak effects.	The effect of maternal education persists into adolescence. Heterogeneity across races.
McCrary and Royer (2011). Effect of mother's high school education on fertility and infant health in California and Texas.	1) Administrative (confidential) data set on all births in CA & TX with data on mother's date of birth, education, infant health, pregnancy behaviors (e.g., smoking, drink), paternal characteristics; N = 800,000 births per year. 2) Public-use Natality Detail Files, 1969–88, (only years for which daily birth counts by state are available).	Exploit age-at-school-entry policies to identify the effect of female education on fertility & infant health (i.e., exploit the fact that the year in which a person starts school is a discontinuous function of exact date of birth and determines when they can legally drop out). Compare women born just before & after the school entry date. Authors claim that school entry policies do not affect fertility.	Mother was born after the school entry date: Education at motherhood: −0.14 years (−1.3%) in CA and −0.24 years (−2.1%) in TX (no standard deviations provided). No effects on Infant health (LBW, gestation, infant mortality). Risky maternal behaviors: Maternal smoking: +13% (no SD). Drinking: −20% (no SD). Mother has STDs: no effect.	By race/ethnicity: "For black women, the effect on LBW is consistent with education improving well-being, while for white women is of the opposite sign."

Note: Acronyms used in this table and not previously specified are defined as follows: ATE, average treatment effect; BMI, body mass index; CHIP, Children's Health Insurance Program; CPS, Current Population Survey; CPS–CSS, Current Population Survey–Child Support Supplement; ENDS, Encuesta Nacional de Demografia y Salud; HPI, house price index; MOB, month of birth; NLSY, National Longitudinal Survey of Youth; NOK, Norwegian currency; PIAT, Peabody Individual Achievement Test; PISA, Programme for International Student Assessment; SEER, Surveillance, Epidemiology, and End Results program; TSLS, two-stage least squares; TANF, Temporary Assistance for Needy Families; UR, unemployment rate; UREG, Swedish education registry data.

children's test scores among boys and children of more-educated mothers. Dahl et al. (2016) find no effects on adult outcomes. Danzer and Lavy (2018) do not find any overall effect, but report that there was some benefit to the reform for children of more highly educated mothers, but negative effects among children of less-educated mothers. Thus, although there is some disagreement about the magnitude and direction of effects, there is little evidence in any of these studies that long maternal leaves have overall benefits for children. One possible interpretation is that mothers who go back to work after the first six months manage, on average, to find child care that approximates the care they would offer in their own homes.

6.3 *Policies to Promote Child Care*

Panel C of table 4 reviews recent work on the feasibility of investing in young children through organized child care. These studies are organized into three categories: Long-term follow-ups of small-scale demonstration programs; long-term follow-ups of large, publicly funded programs; and short-term results of more recent demonstration programs.

There is a good deal of previous work showing long-term effects of small-scale child care demonstration programs conducted using randomized controlled trials, including Perry Preschool and the Carolina Abcedarian Program. We have reviewed these programs extensively elsewhere.[13] Suffice it to say here, these studies involved interventions of medium and strong intensity (respectively) with groups of very disadvantaged preschool children. At the time these demonstrations took place, the alternative was generally no preschool, rather than some other type of preschool, which is the default today.

Studies by Heckman, Pinto, and Savelyev (2013), Campbell et al. (2014), and Conti, Heckman, and Pinto (2015) add to this literature by showing that the interventions had positive effects on a broader set of outcomes than had previously been considered. In particular, they find positive effects on personality traits, health behaviors, and health outcomes. All of these measures have been shown to have important impacts on employment and earnings, though the focus in evaluations of early-childhood interventions is often solely on test scores. These studies also take care to correct their estimates for complexities such as attrition and imperfect random assignment as well as multiple hypothesis testing (i.e., the problem that if you test twenty hypotheses, it is likely that one of them will fail to be rejected with 95 percent confidence even if there are, in fact, no underlying causal relationships). It is increasingly well understood that it can be difficult to interpret results from some randomized experiments given these sorts of problems.

A second set of studies extend the large literature on the effects of public preschool programs in various ways. Havnes and Mogstad (2015) examine the effect of a Norwegian reform that extended publicly funded preschools. The availability of preschool varied across space and time, and the authors exploit this variation to identify its effects. A striking finding is that the reform increased the eventual adult earnings of affected children in the poorest households, but *reduced* the earnings of affected children in the richest households. The paper is therefore a very nice demonstration of the fact that child care centers do not exist in a vacuum—hours in child care replace some other form of care for the child. If the care that is replaced is worse than the child care center, then one can expect improvements in child outcomes

[13] For instance, Almond and Currie (2011a) review some of the studies evaluating these programs in table 11, p. 1435.

and vice versa. Of course, income matters too. To the extent that child care allows women to work and earn more, their higher earnings may also benefit their children and could possibly offset a mild negative direct effect of child care. One would expect the marginal value of additional earnings to be higher in lower-income households, even though more educated women are likely to earn more per hour.

A recent study by Baker, Gruber, and Milligan (2015) showed that the introduction of a universal child care program in Quebec led to negative effects on children's noncognitive outcomes (with little gain in cognitive test scores), significant declines in long term self-reported health and life satisfaction, and behavioral problems and criminal activity among boys. These results are quite consistent with those of Havnes and Mogstad because the modal child who was brought into child care as a result of the reform was a middle class child who went into a low-quality, hurriedly created, child care facility.

Aizer and Cunha (2014), Gelber and Isen (2013), and Kline and Walters (2016) examine the US Head Start program, a publicly funded program that originally served three to five year old children, but has increasingly served younger children as well. Aizer and Cunha (2014) focus on the rollout of Head Start in the mid-1960s using data from the National Collaborative Perinatal Project and find that children who were able to participate in Head Start had test scores that were 0.1 to 0.2 standard deviations higher at age 7 than those of their older siblings. However, like the parenting intervention studied by Fryer, Levitt, and List (2015), the effect was greatest for the children with the highest initial endowments. Aizer and Cunha also examine the compensation versus reinforcement question, and find that in this low-resource setting, parents invested more in highly endowed children and parental investments complemented investments from Head Start. Gelber and Isen (2013) focus on parenting practices in Head Start cohorts from the early 2000s who were followed as part of the Head Start Impact Study, a randomized controlled trial intended to examine the short-run impacts of Head Start. They also find that Head Start enrollment tended to increase parental investments.

Kline and Walters (2016) offer a reexamination of data from the Head Start Impact Study. Original analyses found that Head Start had some positive effects on children in the short run, but that these effects quickly "faded out." Kline and Walters point out that about one-third of the children treated in the Head Start Impact Study were drawn from other publicly funded preschool programs, and that many of the controls attended other public preschools. One would not necessarily expect to see any difference between Head Start children and children in other similar public preschool programs. Ignoring this fact substantially overstates the cost of providing Head Start to the study children (since one-third of them would have been receiving preschool at public expense anyway), and also understates the positive effects of attending a public preschool of some sort; hence, naïve estimates substantially understate the cost effectiveness of the program. Using estimates from previous work showing that short-term boosts in test scores are associated with long-term gains in outcomes (e.g., Garces, Thomas, and Currie 2002; Chetty et al. 2011), they estimate that Head Start is likely to be a cost effective program. Interestingly, the eligible children who were not participating in the early 2000s were those with the highest potential benefits, suggesting that expansions that drew these children into care could be even more cost effective.

A common theme in these studies of public preschool programs in developed-country settings is that a failure to consider the available alternatives to child care programs leads analysts to understate the positive social returns to expanding these programs.

A third group of recent studies (all randomized controlled trials) examine preschool programs in developing countries. Attanasio et al. (2013) and Attanasio et al. (2014) examine the effects of two interventions, a home-based psychosocial intervention program and a center-based preschool program, which were implemented in poor Columbian towns. Both interventions find positive effects, though on different domains (cognitive test scores and height-for-age, respectively). Perhaps the main takeaway is that such publicly funded, large-scale programs can have positive effects even in very low resource settings. Gertler et al. (2014) examine the long-term effects of an intervention to provide psychosocial stimulation to impoverished Jamaican children. An ambitious aspect of this project is that they attempted to track migrants, pointing out that in Jamaica, many successful people emigrate and are lost to follow-up unless special care is taken to retain them in the study. This study finds large effects of the psychosocial intervention on adult earnings.

Taken as a whole, the studies summarized in panel C of table 4 add to the extensive literature on the potential for early intervention programs to improve children's short- and long-run outcomes. Both high quality center-based programs and home visiting interventions appear to be effective and have the potential to influence many domains, including education, income, employment, health, and future health behaviors (see Almond and Currie 2011a for a review of work on this topic before 2011).

6.4 *Policies to Promote Medical Care*

Much of the literature on the long-term effects of medical care in childhood exploits the revolutionary expansions of public health insurance (Medicaid) coverage to children in poor and near-poor families that occurred in the United States during the 1980s and 1990s. But other rich countries have also made efforts to improve medical care for young children, and some of these investments have also been evaluated. Recent studies of the issue are reviewed in panel D of table 4.

One noteworthy study by Sievertsen and Wust (2015) uses rich administrative registry data from Denmark and exploits county-by-county variation policies mandating same-day post-birth discharge. Same-day discharge following normal deliveries was apparently implemented as a cost-saving measure in a staggered way across Danish counties. They find that same-day discharge leads to a 75 percent increase in readmissions during the first month of life and also increases contacts with general practitioners. The largest effects are found for disadvantaged mothers (defined in terms of age, education, and income). The authors are able to link administrative data sets together in order to examine long-term effects of this policy change on ninth grade test scores. They find that the policy was associated with a 0.2 standard deviation decline in test scores in children born to disadvantaged mothers. While modest, this effect is in line with the effect sizes seen in many educational interventions and highlights the interrelationship of health and cognitive achievement.

Bharadwaj, Løken, and Neilson (2013) examine infants in Chile and Norway and exploit the fact that infants below the 1,500g threshold cutoff used to define very low birth weight received more intensive medical services than those just above this threshold. In addition to finding significant effects on infant mortality in each country, they also find that more intensive medical care increased adult wages by 2.7 percent in Chile and by 1.8 percent in Norway.

Studies of the US Medicaid expansions use a variety of methodologies and data sets, but generally rely on the fact that the Medicaid expansions were phased in at different rates across the states (although the expansions eventually became mandatory in every state). Brown, Kowalski, and Lurie (2015) use US Internal Revenue data from tax returns, which allows them to examine income and payroll taxes as well as college attendance as outcomes. Cohodes et al. (2016) use publicly available data from the census, the Current Population Survey, and the Youth Risk Behavior Surveillance System to examine effects on educational attainment. Wherry and Meyer (2016) and Miller and Wherry (2014) examine effects on mortality using Vital Statistics data and on obesity, body mass index, and hospitalizations for endocrine disorders using data from the NHIS, while Wherry et al. (2015) look at hospitalizations and emergency room visits using hospital discharge data.

All of these studies find positive long-term effects of having been eligible for health insurance coverage in childhood, suggesting that improved access to medical care in childhood increases the health and productivity of adults. These findings are significant, as Medicaid is possibly the largest US policy engaging "fetal origins" linkages and represents one of the largest social investments that has been made in US children. There is some heterogeneity in the estimated long-term effects. The effects are strongest for African Americans (who were most strongly affected by the expansions, given their lower average incomes and resulting higher eligibility for public insurance). Brown et al. do not see race in the tax data, but find stronger effects on earnings among women than among men. The take away from these studies is that even in rich countries where much of the morbidity is due to behavioral factors rather than infectious disease, improvements in access to medical care matter for long-term outcomes, especially among the disadvantaged.

6.5 *Maternal Education*

In Grossman (1972), more-educated individuals are more efficient producers of health. Analogously here, it may be the case that better-educated parents have $A = A^H > A^L$, which would yield higher child outcomes h, other things equal. As Currie and Moretti (2003) point out, maternal education is endogenously chosen, and has possible effects on many aspects of a woman's life,[14] including fertility choices. McCrary and Royer (2011) and Carneiro, Meghir, and Parey (2013) examine the effect of policies that affected the amount of maternal education. The first paper exploits discontinuities created by rules about age-at-school entry. The idea is that children who are slightly too young to enter school must wait a year and will be in lower grades when they reach the age at which they can legally leave school, causing the marginal children to end up with less education than children who were just above the age cutoff for school entry. McCrary and Royer find little overall effect of additional compulsory education on either fertility or infant health, though for African American women, they do find some reduction in the incidence of low birth weight.

This result contrasts with Currie and Moretti (2003), who examined the effect of additional years of college education induced by having a college open in the mother's county when she was seventeen years old. These openings were associated with large improvements in infant health, possibly through the mechanism of reducing

[14] There is no time budget in our stylized model. Were labor income a function of hours worked, then another margin for optimization would presumably be through the shadow price of parental time spent on investing in children. Increases in education could increase the return to work and shadow price of time spent investing in children, with ambiguous predictions on net investments given competing income and substitution effects.

maternal smoking. McCrary and Royer (2011) study a different margin (years of high school) and find no effect on smoking, so a possible explanation for these conflicting results is that the studies are looking at different margins, presumably affecting different parts of the distribution of potential mothers. Carneiro, Meghir, and Parey (2013) also focus on college education and instrument for education using variables such as tuition and distance to college. They find positive effects on child test scores, with slightly larger effects for African Americans.

In order to place these results in context, it is important to note that the fraction of US women with less than a high school degree has fallen by more than 50 percent in the last twenty-five years, and there is increasing evidence that high school dropouts and those with only a high school degree fare similarly in the labor market (Card 2009). Hence, college may be the key margin for maternal education to affect child health in the United States.

7. *The Missing Middle and Latent Effects*

In order to examine the long-term impact of policies experienced as young children, researchers must wait patiently to observe a "fully formed" measure of h. For example, Hoynes, Schanzenbach, and Almond (2016), Dahl et al. (2016), and Isen, Rossin-Slater, and Walker (2017) study the impact of policies that were rolled out thirty to forty years ago. In addition to the usual difficulties identifying policy effects, these studies must address the problems involved in tracking affected people or cohorts over decades. In the case of Hoynes, Schanzenbach, and Almond (2016), the problem was addressed by gaining restricted-access information on county of residence over time in the Panel Study of Income Dynamics, while the other two studies rely on administrative records that geocode county of birth.

Clearly, while long-term follow-up is the most reliable way to assess whether a policy is effective in the long term, it limits our ability to assess *current* or even recent policies within a reasonable amount of time. While economists may be particularly interested in adult productivity and earnings, skipping the middle years between early childhood and adulthood means that we have little idea about what typical developmental trajectories look like and how they are shaped by policies experienced over the life course. If we knew more about the relationship between early childhood, middle-childhood, and adulthood, it would aid us in making medium-term inferences about those early-childhood policies that are likely to successfully impact adults. Our lack of knowledge also means that we are largely shooting in the dark when trying to compare the efficacy of programs targeted at very young children to those targeting older children. While there is a widespread perception that it is more cost effective to focus on the very young, there is surprisingly little direct comparison of policies targeting different age groups.

An additional reason to be interested in the middle years is that the limited amount that we do know presents some real puzzles. For instance, a common finding in the literature evaluating early-childhood intervention programs is that there is an immediate gain in test scores, followed by "fade out" of test score gains in the early elementary school years (Almond and Currie 2011a; Currie and Thomas 1995). However, these same children tracked many years later often show positive effects of the intervention in terms of completed schooling attainment and other measures (Garces, Thomas, and Currie 2002). Are the initial test score effects a "red herring" in that the intervention is really affecting something else that matters for future development (such as noncognitive skills)? Or do the initial effects on cognition simply become latent for some period of time and reemerge?

In many cases, data on the "missing middle" is simply unavailable. For instance, Isen, Rossin-Slater, and Walker (2017) know where people were born, and link information about their birth counties to their adult earnings records. Their data has no information on movement patterns between birth and adulthood, which is perhaps something that could be examined using tax records, as in Chetty, Hendren, and Katz (2016). However, a few recent papers have begun to examine the effects of events in early childhood on outcomes during the school years.

A few of these papers have already been discussed. For example, in student register data for Pakistani and Bangladeshi families in England, Almond, Mazumder, and van Ewijk (2015) examined whether Ramadan's overlap with pregnancy affects subsequent academic outcomes at age seven. They find that test scores are 0.05 to 0.08 standard deviations lower for students exposed to Ramadan in early pregnancy.

A few additional studies focusing on middle childhood are summarized in table 5. Figlio et al. (2014) use the universe of births in Florida matched to data from standardized tests. They find that in models with twin fixed effects, increases in birth weight are associated with higher performance. The estimates are slightly smaller than those found in Black, Devereux, and Salvanes (2007) who conducted a similar investigation in Norway. Bharadwaj, Eberhard, and Neilson (2018) report very similar findings for Chile. A further interesting result is that the effects of low birth weight are largely stable between the ages of 9 and 14 in Florida, and between first and twelfth grade in Chile.

Another approach to the problem of measuring trajectories is to try to develop better measures of fetal damage, i.e., quantifying μ_{1g} and μ_{2g}. We know, for example, that low birth weight is an extremely crude measure of fetal damage, which while predictive, is certainly not dispositive. There are babies who were low birth weight who seem to be just fine ex post, and many babies who were not low birth weight but who nonetheless have developmental problems. Robinson (2012) attempts to distinguish between "brain sparing" forms of low birth weight, and low birth weight that is associated with evidence of brain damage. He does this largely by focusing on head circumference, which may feel uncomfortably close to the preoccupations of early eugenicists. His estimates suggest that there are no cognitive effects of low birth weight in the infants with brain sparing. However, his low birth weight infants were more likely than normal weight siblings to have congenital malformations and vision, hearing, or speech abnormalities regardless of head circumference. Biomedicine has proposed some intriguing alternative metrics to birth weight, e.g., telomere length, methylation patterns, etc., but none that have gained widespread acceptance as yet.

The multidimensional nature of both investments (I) and outcomes (h) (Heckman 2007) is one reason for the measurement problem. It is unclear whether any unidimensional metric will ever fully capture the effects of early-childhood policies and investments insofar as they will impact later life outcomes. At present, waiting until cohorts reach adulthood to observe effects remains useful, though it is severely limiting. For example, how do we know today whether policy A or B will have bigger long-term effects? Presumably this is where a structural, well-calibrated model of investments in early childhood and human capital formation could help to fill the gaps in our knowledge. In addition, a potential avenue of research could be the development of "sufficient statistics" to identify key reduced-form

TABLE 5
THE "MISSING MIDDLE" AND LATENT EFFECTS

Study	Micro-data, *N*	Identification strategy and specification	Effects of the shock	Heterogeneity in mechanisms/ effects
Bharadwaj, Eberhard, and Neilson (2018). Examines effects of BW on test scores from 1st to 12th grade in Chile.	1) Chile's birth records, 1992–2002. Twins/siblings are identified by using a mother ID; $N = 15{,}740$ twin pairs. 2) Education data comes from the RECH (National student registry) database, the SIMCE (Math, Science, & Language Arts), and the PSU data set (college entrance exam on math & language), that consists of administrative data on the grades/test scores of every student in the country, 2002–2008; database provided by the Ministry of Educ. of Chile. Approximately 4 million students observed ~4 times.	Over time, depending on parental preferences (compensatory or reinforcing), test score diff's within sibling or twin pairs will converge or diverge. Parents may find it harder to invest differentially in twins. Compare OLS, sibling, and twin FE estimates.	A 10% increase in BW: Math & language scores: +0.04 to 0.06 of an SD. Relationship is stable from first grade through HS. Being VLBW: Math & language scores: −0.1 to −0.2 SD. OLS & twins estimators are similar in 1st grade(~ 0.04 SD) but OLS estimates decline over time (e.g., in eighth grade the OLS estimate is 0.2 SD & the twins estimate is 0.5 SD). Authors claim this is explained by parental investment.	By mother's educ: The relationship between BW & test scores for children (twins) of mothers with & w/o a HS degree is statistically identical (0.04 SD due to a 10% increase in BW)—a possible explanation for this result is that inequality aversion does not vary by mom's education. By SES: similar relationships in low and high SES schools/families. Results show a nonlinear relationship between BW & academic outcomes.
Figlio et al. (2014). Examines effects of LBW on test scores in 3rd–8th grade in Florida.	Universe of births in Florida from 1992–2002 matched to subsequent universe of public school system records (includes children in third to eighth grade) based on first & last name, DOB, SS#. Nearly all potentially matchable children are matched. Sample is conditioned on: those remaining in the state of FL & attending public school. Authors select twins (sample of twins is followed from birth through middle school). $N = 14{,}000$ pairs of twins.	Authors estimate Twin FE models (to account for potential unobservable determinants of cognitive ability that could be correlated w/BW); neonatal health is measured using ln(BW); controlled for a gender dummy, and a dummy for within-twin-pair birth order. Authors hold gestation length constant. Estimates are identified by variation in fetal growth rates.	A 10% increase in BW: Cognitive test (Florida Comprehensive Assessment Test, FCAT): +0.045 SD (OLS: +0.031 SD). Math test: +0.050 SD. Reading: +0.039 SD. Predicted effects on wages are: 3/4 of those in Black, Devereux, and Salvanes (2007). Effects on cognition are 60%–88% of those found in Black, Devereux, and Salvanes (2007). These effects do not change between ages 9–14.	Authors estimate models by: same sex twins (versus opposite sex), gender, same sex composition (GG versus BB), mother's race, ethnicity, immigration status, education (<12, 12–15, >15), zip code median income (bottom, middle, top), marital status, age at birth (≤ 21, 22–29, 30–35, ≥ 36) and find: that a 10% increase in BW is associated with a 0.04 SD increase in cognitive tests for all. Slightly larger effect for more advantaged children.
Robinson (2012). Hypothesises that LBW infants with evidence of slower brain growth will have worse outcomes at age 4–7 than LBW infants with a brain sparing pattern of slower growth.	1) Collaborative Perinatal Project, longitudinal survey of newborns in one of 12 major US cities, 1959–74, waves: ages 4, 8, & 12 months of age, and at 4, 7, and 8 years of age; $N = 47{,}019$ individuals. 2) A 50% sample of all US births from 1968, reported by Hoffman et al. (1974); provides ability to get percentile data broken down by both gender/race.	Decompose LBW infants into: i) those whose head circumference is proportionate to their weight; ii) those with evidence of brain sparing. Hypothesis: "Human capital should be affected through decreased cognitive function caused by brain growth restriction in utero—a potential mechanism for the fetal origins hypothesis." Models regress child outcome on indicators for whether a child was AGR & SGR, and on rich individual controls and sibling FE.	Find no cognitive effects of LBW in group with brain sparing. In group with effects on brain size: Welsher IQ scores (ages 4 & 7): −3 to −4pp (−4.2% = 0.27 SD). Congenital malformations: 1.6 times higher. Prob(vision, hearing, & speech abnorm.): +1.5 to 2.3 times higher. Even with brain sparing: Congenital malformations: 1.3 times higher. Prob(vision, hearing, and speech abnorm.): +1.2 to 1.5 times higher.	NA

elasticities that summarize the human capital effects of early life shocks or investments.[15, 16]

8. *Discussion and Conclusions*

We now know that variegated shocks, some of them relatively mild and brief, can have lasting measurable impacts on child outcomes. Many authors start from the basic, scientific perspective of asking whether shock *X* has a causal effect on outcome *Y*. While that is an important question, it is reasonable to ask whether, given all of this research, we can say anything yet about the relative magnitudes of the effects and in particular, about which investments and interventions would be most cost effective in terms of improving young children's future outcomes. Answering this question is hampered by the wide range of both shocks and outcomes that have been considered. However, at this point a large number of studies have examined three types of outcomes: birth weight (and low birth weight), test scores, and wages—three outcomes that offer glimpses of an individual's well-being at birth, in childhood, and in adulthood.

Table 6 summarizes what some of these studies have found. These estimates do not lend themselves to comparative analysis of cost effectiveness. For one thing, we do not have estimates of what it would cost to prevent or ameliorate some types of shocks, such as stress due to a death in the family or domestic violence. Still, given what we know about interventions that are feasible and a rough idea about the likely costs of intervention, the table can serve as a starting point for a discussion about what interventions appear to be most promising.

Studies that focus on birth weight as an outcome are shown in panel A. Unfortunately, we don't know whether small changes in birth weight for babies well above the cutoff for low birth weight will have meaningful effects on future adult outcomes. Studies that focus on effects on mean birth weight can answer the rudimentary question of whether a given shock affects the fetus, but are not necessarily well suited to considering the cost effectiveness of intervention because we don't know how much a small change in the entire distribution of birth weight is likely to be worth.

On the other hand, we do know that low birth weight is associated in a meaningful way with future outcomes such as adult health, schooling attainment, and wages (see for example, Bharadwaj, Lundborg, and Rooth 2014; Bharadwaj, Eberhard, and Neilson 2018; Figlio et al. 2014). Table 6 suggests that there is low-hanging fruit in terms of potential for meaningful interventions to reduce the incidence of low birth weight. For example, Schwandt (2017) finds that reducing severe influenza cases among pregnant women would have a meaningful effect on the incidence of low birth weight (and on children's future wages). This goal could be accomplished quite cheaply by promoting immunization for influenza among women of child-bearing age.

Hoynes, Miller, and Simon (2015); Almond, Hoynes, and Schanzenbach (2011); and Rossin-Slater (2013) find that small increases in annual income (or equivalent in-kind transfers) have relatively large impacts on the incidence of low birth weight, which suggests that some sort of pregnancy bonus or mother's allowance might have

15 Bleakley (2010), for instance, showed that years of schooling is not a sufficient statistic for measuring the impact of early-life health on lifetime income, as it is possible that when health improves, lifetime income goes up, but years of schooling declines.

16 The use of sufficient statistics has been relatively common in other fields of economics, such as in public finance for welfare analysis. For instance, Chetty (2009) showed that in order to calculate the welfare impact of a tax policy, one only needs to estimate the elasticity of equilibrium quantity with respect to the tax rate and avoid estimating all the "primitive" parameters in a structural model.

TABLE 6
Summarizing the Effects of Shocks on Birth Weight, Test Scores, and Wages

Shock	Study	Elasticity
Panel A. Outcome = Birth weight		
Alcohol	Barreca and Page (2015)	A 1-month increase in the minimum legal drinking age leads to a 0.03% decline in LBW (or a statistically non-significant 1.2% decline on BW).
Disease	Schwandt (2017)	A 10% increase in maternal influenza hospitalizations in pregnancy leads to a 0.2% decline in BW (or a 7.2% increase in LBW).
Income	Almond, Hoynes, and Schanzenbach (2011)	A 10% increase in annual income leads to a 0.5% increase in BW (or a 6.0% decline in LBW).
Income	Hoynes, Miller, and Simon (2015)	A 10% increase in annual income leads to a 1.0% increase in BW (or a 11.0% decline in LBW).
Income	Rocha and Soares (2015)	A 10% increase in rainfall shocks during pregnancy leads to a 1.8% decline in BW (no LBW estimates are provided).
Income & stress	Lindo (2011)	Father's (own) unemployment leads to 4.8% decline in BW (or a statistically non-significant 2.5% increase on LBW).
Maternity leave	Rossin-Slater (2011)	A 1-month increase in maternity leave during pregnancy leads to a 0.16% increase in BW (or a –0.16% decline in LBW).
Nutrition	Almond and Mazumder (2011)	A 1-month increase in fetal nutritional disruption, leads to a 0.6% decline in BW (no LBW estimates are provided).
Nutrition	Rossin-Slater (2013)	A 10% increase in the availability of WIC clinics leads to a 0.4% increase in BW (or a 1.7% decline in LBW only for mothers with HS or less).
Pollution	Currie et al. (2013)	A 10% increase in pollution (the *N* of districts with water contamination) leads to a 7.5% increase in LBW (no BW estimates are provided).
Pollution	Currie and Walker (2011)	A 10% increase decline in NO_2 from cars (along with associated decreases in other pollutants leads to a 10% decline in LBW.
Smoking	Bharadwaj, Johnsen, and Løken (2014)	A 10% decrease in smoking (the proportion of women smoking) during pregnancy leads to a 1.3% decline in BW.
Stress	Carlson (2015)	A 10% increase in anticipated job losses in pregnancy leads to a 0.2% decline in BW (or a 16.0% increase in LBW).
Stress	Persson and Rossin-Slater (2018)	Exposure to the death of a close relative during pregnancy reduces BW by 0.5% (or a 20% increase in LBW).
Stress	Quintana-Domeque and Rodenas-Serrano (2017)	A 10% increase in violence (terrorist attacks) during pregnancy leads to a 0.2% decline in BW (no LBW estimates are provided).
Violence	Aizer (2011)	A 10% increase in violence (the probability of personal assault) during pregnancy leads to a 10.0% decline in BW (no LBW estimates are provided).
Panel B. Outcome = Test scores		
Alcohol	von Hinke Kessler Scholder et al. (2014)	A 10% increase in the probability of consuming alcohol during pregnancy leads to a 0.05 SD decline in test scores.
Disease	Bhalotra and Venkataramani (2013)	A 10% decrease in diarrhea mortality rates leads to a 0.14 SD increase in test scores.
Disease	Venkataramani (2012)	A 10% decline in the cases of malaria at the year of birth leads to a 0.2 SD increase in test scores.
Disease	Ward and Phipps (2014)	A 10 unit increase in the influenza rate leads to a 0.3 SD decrease in test scores.
Education (mother)	Carneiro, Meghir, and Parey (2013)	1-year increase in mother's education leads to a 0.1 SD increase in test scores.
Income	Black et al. (2014)	A 10% increase in annual income at age 5 leads to a 0.4 SD increase in test scores.
Income	Dahl and Lochner (2012)	A 10% increase in annual income at ages 5–11 leads to a 0.15 SD increase in test scores.
Income	Milligan and Stabile (2011)	A 10% increase in annual income at ages 0–5 leads to a 0.14 SD increase in test scores.

(*Continued*)

TABLE 6
Summarizing the Effects of Shocks on Birth Weight, Test Scores, and Wages (*Continued*)

Shock	Study	Elasticity
Maternity leave	Baker and Milligan (2016)	A 1-month increase in paid maternity leave at ages 6–12 months leads to a –0.057% SD decline in test scores.
Nutrition	Almond, Mazumder, and van Ewijk (2011)	A 1-month increase in fetal nutritional disruption (Ramadan exposure) reduces test scores by 0.07 SD.
Nutrition	Fitzsimons and Vera-Hernandez (2014)	A 1-month increase in breastfeeding leads to a 0.2 SD increase in test scores.
Nutrition	Greve, Schultz-Nielsen, and Tekin (2015)	A 1-month increase in fetal nutritional disruption (Ramadan exposure), reduces female (ONLY) test scores by 0.26 SD.
Pollution (radiation)	Black et al. (2017)	A 10-unit increase in pollution (air/ground radiation) in utero leads to a 0.3 SD decline in test scores.
Pollution	Bharadwaj et al. (2017)	A 10-unit increase in pollution (CO) in utero leads to a 0.4 SD decrease in test scores.
Pollution	Sanders (2012)	A 10-unit decline in pollution (TSP) at the year of birth leads to a 0.1 SD increase in test scores.
Stress	Aizer, Stroud, and Buka (2016)	A 10% increase in cortisol during pregnancy leads to a 0.12 SD decrease in test scores.
Weather	Shah and Steinberg (2017)	A 10% increase in the proportion of districts/year that experience a rainfall shock leads to a 0.02 SD decline in test scores.
Weather	Aguilar and Vicarelli (2015)	A 10% increase in rainfall shocks leads to a 0.02 SD decline in test scores.
Panel C. Outcome = Wages		
Alcohol	Nilsson (2017)	A 1-month increase in alcohol exposure during pregnancy leads to a 3.4% decrease in wages.
Child care	Gertler et al. (2014)	A 1-month increase in psychosocial stimulation in early-life leads to a 1.75% increase in wages.
Child care	Havnes and Mogstad (2011)	A 10% increase in child care subsidies leads to a 1.4% increase in wages.
Disease (worms)	Baird et al. (2016)	A 1-month increase in deworming school-aged children (age ~12) leads to a 0.15% decrease in wages.
Disease	Bhalotra and Venkataramani (2015)	A 10% decline in infant pneumonia death rates leads to a 7.0% increase in wages.
Disease	Beach et al. (2016)	A 10% decrease in typhoid mortality rate leads to a 5.0% increase in wages.
Disease	Schwandt (2017)	A 10% increase in maternal influenza hospitalizations in pregnancy leads to a 1.1% decline in wages.
Health care	Brown, Kowalski, and Lurie (2015)	A 1-year increase in Medicaid coverage eligibility at ages 0–18 leads to a 4.8% increase in wages.
Maternity leave	Carneiro, Løken, and Salvanes (2015)	A 1-month increase in paid maternity leave leads to a 1.4% increase in wages.
Nutrition	Adhvaryu et al. (2016)	A 10% increase in (the availability of) iodized salt in utero leads to a 0.4% increase in wages.
Pollution	Isen, Rossin-Slater, and Walker (2017)	A 10-unit decrease in pollution (TSP) in-utero leads to a 1.0% increase in wages.

Note: Acronym used in this table (not previously defined): TSP, total suspended particulates.

positive effects at a modest cost (compositional effects aside). Another policy that could accomplish the same thing, though perhaps at higher cost, is paid maternity leave, which would be particularly valuable if it covered some of the prenatal period (Rossin-Slater 2011).

Conversely, uncertainty about income seems to be extremely harmful (Carlson 2015). It isn't clear at this point how much this problem could be mitigated by expanding unemployment insurance, or at what cost. For example, we don't know how many pregnant women or their partners now qualify for unemployment insurance (UI) or how much they typically receive in benefits. Lindo (2011) finds extremely negative effects of paternal unemployment, though again, it is not clear what policy response could best prevent or address this. This result does point to the importance of fathers, a topic that has generally been neglected in the literature.

Currie and Walker (2011) and Currie et al. (2013) show that exposure to pollution during pregnancy has particularly negative effects on the developing fetus. The cost of pollution control varies greatly depending on exactly how it is done. One option that has not been explored a great deal to date is the potential role of zoning to keep residences, schools, and child care centers away from sources of pollution such as busy highways. Over time, zoning changes might accomplish a lot in terms of health protection at a relatively modest cost. Improvements in filtration by daycare and school HVAC systems are probably cheaper still.

The second panel of table 6 briefly summarizes shocks that have been shown to affect future test scores. Perhaps unsurprisingly, the same things that have an impact on low birth weight often have significant impacts on test scores. Black et al. (2014), Milligan and Stabile (2011), and Dahl and Lochner (2012) all show that small increases in annual income in childhood has measurable effects on children's test scores. Sanders (2012), Bharadwaj et al. (2017), and Black et al. (2017) further explore the effects of pollution, while Aizer, Stroud, and Buka (2016) highlight negative effects of maternal stress during pregnancy on test scores.

Almond, Mazumder, and van Ewikjk (2015) and Greve, Shultz-Nielsen, and Tekin (2015) focus particularly on mild nutritional deprivation during pregnancy and find large negative effects on test scores. It would be particularly interesting to tie this literature on mild nutritional deprivation together with the literature on nutritional supplementation (e.g., analyses of the US WIC program) to draw inferences about the potential effects of small variations in nutrition during pregnancy.

Turning to shocks in early childhood that have been shown to impact the wages of young adults, panel C of table 6 points, once again, to some of the same suspects. Policies to improve immunization for influenza (Schwandt 2017), reduce alcohol consumption in pregnant women (Nilsson 2017), and reduce exposure to pollution (Isen, Rossin-Slater, and Walker 2017) hold considerable promise. Maternity leave in very early childhood (Carneiro, Løken, and Salvanes 2015), child care subsidies (Havnes and Mogstad 2011), and health insurance coverage for young children (Brown, Kowalski, and Lurie 2015) all appear to have payoffs down the road. The Gertler et al. (2014) study of psychosocial stimulation applies to very disadvantaged children in a developing country. Yet there may be parallels to nurse home-visiting programs that target disadvantaged parents in the United States and many developed countries.

Clearly, we cannot pin down specific cost–benefit ratios without a lot more information. But arguably we have still learned quite a bit about the types of interventions that could be expected to make children healthier, smarter, and more productive as adults.

That said, there remains a great deal of room for future research. More progress could be achieved if some of the measurement problems could be addressed. Some of our most widely used measures, such as low birth weight, are at best only proxies for a whole range of subtle damages that a developing fetus may have suffered. Without sensitive and specific "real-time" measures of how someone has been harmed, and how interventions are affecting them, all we can do is wait and see what the eventual outcome will be. In addition to specific measures of harms, knowing more about how intermediate outcomes are affected could help us to identify individuals in need of assistance more quickly, and to target interventions more effectively.

Similarly, being able to identify sensitive or critical periods when particular shocks have their greatest impact, would be extremely helpful. To date, we have learned that the *in utero* period is itself an especially critical and sensitive period of an individual's life. But breaking this period down further and learning more about critical periods in early childhood would also be extremely useful. If the early stages of pregnancy matter most, does starting WIC a few weeks earlier have a high return? Does fostering earlier recognition of pregnancies help?

Another area that could benefit from more precise measurement concerns the development of noncognitive skills. A few of the studies discussed above focus on noncognitive skills, and there is growing evidence that such "soft" skills matter a great deal in terms of producing "hard" outcomes such as educational attainment and employment. Yet these skills are typically represented by a hodge-podge of different measures that happen to be available to researchers, and there is no consensus as yet on which measures are best or how to get a comprehensive overview of an individual's noncognitive skills.

We have emphasized that there is often considerable heterogeneity in the effects of a given shock. Most often, more disadvantaged people suffer greater harms, though not always. It is perfectly reasonable that there should be heterogeneous effects given differences in endowments, budget constraints, and available production technologies. Yet in many cases, effective interventions may depend on knowing the source of the heterogeneity, something we can largely only speculate about now. Moreover, as we have discussed, families may act either to magnify or mitigate the effects of initial shocks. Hence, a greater understanding of the way that shocks and disadvantage interact, and of the role of parents in responding to them, is highly desirable.

To date, most of the literature focuses on the role of mothers, largely because we have had much better information about mothers than about fathers in many data sets. As large administrative data sets have become increasingly available, it has become possible to explore the role of fathers, but this exploration is only just beginning.

Similarly, improvements in the availability of data are making it possible to explore intergenerational effects. Given evidence from animal models, it is highly likely that changes in the fetus or young child could be passed on to the next generation. This type of mechanism could offer an additional reason for the intergenerational persistence of poverty, and for the existence of poverty traps in some disadvantaged areas.

References

Adhvaryu, Achyuta, Steven Bednar, Teresa Molina, Quynh Nguyen, and Anant Nyshadham. 2016. "When It Rains It Pours: The Long-Run Economic Impacts of Salt Iodization in the United States." Working Paper.

Adhvaryu, Achyuta, James Fenske, and Anant Nyshadham. Forthcoming. "Early Life Circumstance and Adult Mental Health." *Journal of Political Economy*.

Adhvaryu, Achyuta, and Anant Nyshadham. 2016. "Endowments at Birth and Parents' Investments in

Children." *Economic Journal* 126 (593): 781–820.

Adhvaryu, Achyuta, Anant Nyshadham, Teresa Molina, and Jorge Tamayo. 2015. "Helping Children Catch Up: Early Life Shocks and the PROGRESA Experiment." Working Paper.

Agüero, Jorge M. 2014. "Long-Term Effect of Climate Change on Health: Evidence from Heat Waves in Mexico." Inter-American Development Bank Working Paper 481.

Aguilar, Arturo, and Marta Vicarelli. 2015. "El Nino and Mexican Children: Medium-Term Effects of Early-Life Weather Shocks on Cognitive and Health Outcomes." Working Paper.

Aizer, Anna. 2011. "Poverty, Violence, and Health: The Impact of Domestic Violence during Pregnancy on Newborn Health." *Journal of Human Resources* 46 (3): 518–38.

Aizer, Anna, and Flavio Cunha. 2014. "Child Endowments, Parental Investments and the Development of Human Capital." Unpublished.

Aizer, Anna, and Janet Currie. 2014. "The Intergenerational Transmission of Inequality: Maternal Disadvantage and Health at Birth." *Science* 344 (6186): 856–61.

Aizer, Anna, Janet Currie, Peter Simon, and Patrick Vivier. 2016. "Do Low Levels of Blood Lead Reduce Children's Future Test Scores?" National Bureau of Economic Research Working Paper 22558.

Aizer, Anna, Shari Eli, Joseph Ferrie, and Adriana Lleras-Muney. 2016. "The Long-Run Impact of Cash Transfers to Poor Families." *American Economic Review* 106 (4): 935–71.

Aizer, Anna, Laura Stroud, and Stephen Buka. 2016. "Maternal Stress and Child Outcomes: Evidence from Siblings." *Journal of Human Resources* 51 (3): 523–55.

Akee, Randall, Emilia Simeonova, E. Jane Costello, and William Copeland. 2015. "How Does Household Income Affect Child Personality Traits and Behaviors?" National Bureau of Economic Research Working Paper 21562.

Almond, Douglas. 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 (4): 672–712.

Almond, Douglas, and Janet Currie. 2011a. "Human Capital Development before Age Five." In *Handbook of Labor Economics: Volume 4B*, edited by David Card and Orley Ashenfelter, 1315–486. Amsterdam and Boston: Elsevier, North-Holland.

Almond, Douglas, and Janet Currie. 2011b. "Killing Me Softly: The Fetal Origins Hypothesis." *Journal of Economic Perspectives* 25 (3): 153–72.

Almond, Douglas, Janet Currie, and Mariesa Herrmann. 2012. "Front Infant to Mother: Early Disease Environment and Future Maternal Health." *Labour Economics* 19 (4): 475–83.

Almond, Douglas, Joseph J. Doyle, Jr., Amanda E. Kowalski, and Heidi Williams. 2010. "Estimating Marginal Returns to Medical Care: Evidence from At-Risk Newborns." *Quarterly Journal of Economics* 125 (2): 591–634.

Almond, Douglas, Lena Edlund, Michael Joffe, and Marten Palme. 2016. "An Adaptive Significance of Morning Sickness? Trivers–Willard and *Hyperemesis Gravidarum*." *Economics and Human Biology* 21: 167–71.

Almond, Douglas, Lena Edlund, and Marten Palme. 2009. "Chernobyl's Subclinical Legacy: Prenatal Exposure to Radioactive Fallout and School Outcomes in Sweden." *Quarterly Journal of Economics* 124 (4): 1729–72.

Almond, Douglas, Hilary W. Hoynes, and Diane Whitmore Schanzenbach. 2011. "Inside the War on Poverty: The Impact of Food Stamps on Birth Outcomes." *Review of Economics and Statistics* 93 (2): 387–403.

Almond, Douglas, and Bhashkar Mazumder. 2011. "Health Capital and the Prenatal Environment: The Effect of Ramadan Observance during Pregnancy." *American Economic Journal: Applied Economics* 3 (4): 56–85.

Almond, Douglas, Bhashkar Mazumder, and Reyn van Ewijk. 2015. "*In Utero* Ramadan Exposure and Children's Academic Performance." *Economic Journal* 125 (589): 1501–33.

Angrist, Joshua D., and Jorn-Steffen Pischke. 2010. "The Credibility Revolution in Empirical Economics: How Better Research Design Is Taking the Con Out of Econometrics." *Journal of Economic Perspectives* 24 (2): 3–30.

Anttila-Hughes, Jesse K., and Solomon M. Hsiang. 2013. "Destruction, Disinvestment, and Death: Economic and Human Losses following Environmental Disaster." University of California Berkeley Goldman School of Public Policy Working Paper.

Arceo, Eva, Rema Hanna, and Paulina Oliva. 2016. "Does the Effect of Pollution on Infant Mortality Differ between Developing and Developed Countries? Evidence from Mexico City." *Economic Journal* 126 (591): 257–80.

Attanasio, Orazio P., Vincenzo Di Maro, and Marcos Vera-Hernandez. 2013. "Community Nurseries and the Nutritional Status of Poor Children: Evidence from Colombia." *Economic Journal* 123 (571): 1025–58.

Attanasio, Orazio P., Camila Fernández, Emla O. A. Fitzsimons, Sally M. Grantham-McGregor, Costas Meghir, and Marta Rubio-Codina. 2014. "Using the Infrastructure of a Conditional Cash Transfer Program to Deliver a Scalable Integrated Early Child Development Program in Colombia: Cluster Randomized Controlled Trial." *British Medical Journal* 349: G5785.

Backhouse, Roger E., and Steven G. Medema. 2009. "Retrospectives: On the Definition of Economics." *Journal of Economic Perspectives* 23 (1): 221–33.

Baird, Sarah, Joan Hamory Hicks, Michael Kremer, and Edward Miguel. 2016. "Worms at Work: Long-Run Impacts of a Child Health Investment." *Quarterly Journal of Economics* 131 (4): 1637–80.

Baker, Michael, Jonathan Gruber, and Kevin Milligan.

2015. "Non-cognitive Deficits and Young Adult Outcomes: The Long-Run Impacts of a Universal Child Care Program." National Bureau of Economic Research Working Paper 21571.
Baker, Michael, and Kevin Milligan. 2015. "Maternity Leave and Children's Cognitive and Behavioral Development." *Journal of Population Economics* 28 (2): 373–91.
Baker, Michael, and Kevin Milligan. 2016. "Boy–Girl Differences in Parental Time Investments: Evidence from Three Countries." *Journal of Human Capital* 10 (4): 399–441.
Barham, Tania, Karen Macours, and John A. Maluccio. 2013. "Boys' Cognitive Skill Formation and Physical Growth: Long-Term Experimental Evidence on Critical Ages for Early Childhood Interventions." *American Economic Review* 103 (3): 467–71.
Barker, D. J. P. 1998. "*In Utero* Programming of Chronic Disease." *Clinical Science* 95 (2): 115–28.
Barreca, Alan, and Marianne Page. 2015. "A Pint for a Pound? Minimum Drinking Age Laws and Birth Outcomes." *Health Economics* 24 (4): 400–418.
Beach, Brian, Joseph Ferrie, Martin Saavedra, and Werner Troesken. 2016. "Typhoid Dever, Water Quality, and Human Capital Formation." *Journal of Economic History* 76 (1): 41–75.
Bhalotra, Sonia, and Atheendar Venkataramani. 2013. "Cognitive Development and Infectious Disease: Gender Differences in Investments and Outcomes." Working Paper.
Bhalotra, Sonia, and Atheendar Venkataramani. 2015. "Shadows of the Captain of the Men of Death: Health Innovation, Human Capital Investment, and Institutions." Unpublished.
Bharadwaj, Prashant, Juan Pedro Eberhard, and Christopher A. Neilson. 2018. "Health at Birth, Parental Investments, and Academic Outcomes." *Journal of Labor Economics* 36 (2): 349–94.
Bharadwaj, Prashant, Matthew Gibson, Joshua Graff Zivin, and Christopher Neilson. 2017. "Gray Matters: Fetal Pollution Exposure and Human Capital Formation." *Journal of the Association of Environmental and Resource Economists* 4 (2): 505–42.
Bharadwaj, Prashant, Julian V. Johnsen, and Katrine Vellesen Løken. 2014. "Smoking Bans, Maternal Smoking and Birth Outcomes." *Journal of Public Economics* 115: 72–93.
Bharadwaj, Prashant, and Leah K. Lakdawala. 2013. "Discrimination Begins in the Womb: Evidence of Sex-Selective Prenatal Investments." *Journal of Human Resources* 48 (1): 71–113.
Bharadwaj, Prashant, Katrine Vellesen Løken, and Christopher Neilson. 2013. "Early Life Health Interventions and Academic Achievement." *American Economic Review* 103 (5): 1862–91.
Bharadwaj, Prashant, Petter Lundborg, and Dan-Olof Rooth. 2014. "The Effects of Birth Weight over the Life Cycle." Working Paper.
Billings, Stephen B., and Kevin T. Schnepel. 2018. "Life after Lead: Effects of Early Interventions for Children Exposed to Lead." *American Economic Journal: Applied Economics* 10 (3): 315–44.
Black, Sandra E., Aline Bütikofer, Paul J. Devereux, and Kjell G. Salvanes. 2017. "This Is Only a Test? Long-Run Impacts of Prenatal Exposure to Radioactive Fallout." National Bureau of Economic Research Working Paper 18987.
Black, Sandra E., Paul J. Devereux, Katrine V. Løken, and Kjell G. Salvanes. 2014. "Care or Cash? The Effect of Child Care Subsidies on Student Performance." *Review of Economics and Statistics* 96 (5): 824–37.
Black, Sandra E., Paul J. Devereux, and Kjell G. Salvanes. 2007. "From the Cradle to the Labor Market? The Effect of Birth Weight on Adult Outcomes." *Quarterly Journal of Economics* 122 (1): 409–39.
Bleakley, Hoyt. 2007. "Disease and Development: Evidence from Hookworm Eradication in the American South." *Quarterly Journal of Economics* 122 (1): 73–117.
Bleakley, Hoyt. 2010. "Malaria Eradication in the Americas: A Retrospective Analysis of Childhood Exposure." *American Economic Journal: Applied Economics* 2 (2): 1–45.
Breining, Sanni, N. Meltem Daysal, Marianne Simonsen, and Mircea Trandafir. 2015. "Spillover Effects of Early-Life Medical Interventions." Institute for the Study of Labor Discussion Paper 9086.
Brown, David W., Amanda E. Kowalski, and Ithai Z. Lurie. 2015. "Medicaid as an Investment in Children: What Is the Long-Term Impact on Tax Receipts?" National Bureau of Economic Research Working Paper 20835.
Campbell, Frances, et al. 2014. "Early Childhood Investments Substantially Boost Adult Health." *Science* 343 (6178): 1478–85.
Card, David. 1999. "The Causal Effect of Education on Earnings." In *Handbook of Labor Economics: Volume 3A*, edited by Orley C. Ashenfelter and David Card, 1801–63. Amsterdam and Lausanne: Elsevier, North-Holland.
Card, David. 2009. "Immigration and Inequality." *American Economic Review* 99 (2): 1–21.
Carlson, Kyle. 2015. "Fear Itself: The Effects of Distressing Economic News on Birth Outcomes." *Journal of Health Economics* 41: 117–32.
Carneiro, Pedro, and Rita Ginja. 2014. "Long-Term Impacts of Compensatory Preschool on Health and Behavior: Evidence from Head Start." *American Economic Journal: Economic Policy* 6 (4): 135–73.
Carneiro, Pedro, Katrine V. Løken, and Kjell G. Salvanes. 2015. "A Flying Start? Maternity Leave Benefits and Long-Run Outcomes of Children." *Journal of Political Economy* 123 (2): 365–412.
Carneiro, Pedro, Costas Meghir, and Matthias Parey. 2013. "Maternal Education, Home Environments, and the Development of Children and Adolescents." *Journal of the European Economic Association* 11 (S1): 123–60.
Chetty, Raj. 2009. "Sufficient Statistics for Welfare Analysis: A Bridge between Structural and Reduced-Form Methods." *Annual Review of Economics* 1:

451–88.
Chetty, Raj, John N. Friedman, Nathaniel Hilger, Emmanuel Saez, Diane Whitmore Schanzenbach, and Danny Yagan. 2011. "How Does Your Kindergarten Classroom Affect Your Earnings? Evidence from Project STAR." *Quarterly Journal of Economics* 126 (4): 1593–660.
Chetty, Raj, Nathaniel Hendren, and Lawrence F. Katz. 2016. "The Effects of Exposure to Better Neighborhoods on Children: New Evidence from the Moving to Opportunity Experiment." *American Economic Review* 106 (4): 855–902.
Cohodes, Sarah R., Daniel S. Grossman, Samuel A. Kleiner, and Michael F. Lovenheim. 2016. "The Effect of Child Health Insurance Access on Schooling: Evidence from Public Insurance Expansions." *Journal of Human Resources* 51 (3): 727–59.
Conti, Gabriella, James J. Heckman, and Rodrigo Pinto. 2015. "The Effects of Two Influential Early Childhood Interventions on Health and Healthy Behaviors." National Bureau of Economic Research Working Paper 21454.
Costa, Dora L. 2000. "Understanding the Twentieth-Century Decline in Chronic Conditions among Older Men." *Demography* 37 (1): 53–72.
Cunha, Flavio, Irma Elo, and Jennifer Culhane. 2015. "Eliciting Maternal Subjective Beliefs about the Technology of Skill Formation." Unpublished.
Cunha, Flavio, and James J. Heckman. 2008. "Formulating, Identifying and Estimating the Technology of Cognitive and Noncognitive Skill Formation." *Journal of Human Resources* 43 (4): 738–82.
Cunha, Flavio, James J. Heckman, and Susanne M. Schennach. 2010. "Estimating the Technology of Cognitive and Noncognitive Skill Formation." *Econometrica* 78 (3): 883–931.
Currie, Janet. 2009. "Healthy, Wealthy, and Wise: Socioeconomic Status, Poor Health in Childhood, and Human Capital Development." *Journal of Economic Literature* 47 (1): 87–122.
Currie, Janet. 2011. "Inequality at Birth: Some Causes and Consequences." *American Economic Review* 101 (3): 1–22.
Currie, Janet, Joshua Graff Zivin, Katherine Meckel, Matthew Neidell, and Wolfram Schlenker. 2013. "Something in the Water: Contaminated Drinking Water and Infant Health." *Canadian Journal of Economics* 46 (3): 791–810.
Currie, Janet, and Rosemary Hyson. 1999. "Is the Impact of Health Shocks Cushioned By Socioeconomic Status? The Case of Low Birthweight." *American Economic Review* 89 (2): 245–50.
Currie, Janet, and Enrico Moretti. 2003. "Mother's Education and the Intergenerational Transmission of Human Capital: Evidence from College Openings." *Quarterly Journal of Economics* 118 (4): 1495–532.
Currie, Janet, and Maya Rossin-Slater. 2013. "Weathering the Storm: Hurricanes and Birth Outcomes." *Journal of Health Economics* 32 (3): 487–503.
Currie, Janet, and Hannes Schwandt. 2013. "Within-Mother Analysis of Seasonal Patterns in Health at Birth." *Proceedings of the National Academy of Sciences* 110 (30): 12265–70.
Currie, Janet, and Duncan Thomas. 1995. "Does Head Start Make a Difference?" *American Economic Review* 85 (3): 341–64.
Currie, Janet, and Reed Walker. 2011. "Traffic Congestion and Infant Health: Evidence from E-ZPass." *American Economic Journal: Applied Economics* 3 (1): 65–90.
Dahl, Gordon B., and Lance Lochner. 2012. "The Impact of Family Income on Child Achievement: Evidence from the Earned Income Tax Credit." *American Economic Review* 102 (5): 1927–56.
Dahl, Gordon B., Katrine V. Løken, Magne Mogstad, and Kari Vea Salvanes. 2016. "What Is the Case for Paid Maternity Leave?" *Review of Economics and Statistics* 98 (4): 655–70.
Danzer, Natalia, and Victor Lavy. 2018. "Paid Parental Leave and Children's Schooling Outcomes." *Economic Journal* 128 (608): 81–117.
Daysal, N. Meltem, Mircea Trandafir, and Reyn van Ewijk. 2015. "Saving Lives at Birth: The Impact of Home Births on Infant Outcomes." *American Economic Journal: Applied Economics* 7 (3): 28–50.
Del Boca, Daniela, Christopher Flinn, and Matthew Wiswall. 2014. "Household Choices and Child Development." *Review of Economic Studies* 81 (1): 137–85.
Del Bono, Emilia, John Ermisch, and Marco Francesconi. 2012. "Intrafamily Resource Allocations: A Dynamic Structural Model of Birth Weight." *Journal of Labor Economics* 30 (3): 657–706.
DiNardo, John. 2007. "Interesting Questions in *Freakonomics*." *Journal of Economic Literature* 45 (4): 973–1000.
Dizon-Ross, Rebecca. 2018. "Parents' Beliefs about Their Children's Academic Ability: Implications for Educational Investments." Unpublished.
Evans, William N., and Craig L. Garthwaite. 2014. "Giving Mom a Break: The Impact of Higher EITC Payments on Maternal Health." *American Economic Journal: Economic Policy* 6 (2): 258–90.
Ferrie, Joseph P., Karen Rolf, and Werner Troesken. 2014. "Lead Exposure and the Perpetuation of Low Socioeconomic Status." Unpublished.
Feyrer, James, Dimitra Politi, and David N. Weil. 2013. "The Cognitive Effects of Micronutrient Deficiency: Evidence from Salt Iodization in the United States." National Bureau of Economic Research Working Paper 19233.
Field, Erica, Omar Robles, and Maximo Torero. 2009. "Iodine Deficiency and Schooling Attainment in Tanzania." *American Economic Journal: Applied Economics* 1 (4): 140–69.
Figlio, David, Jonathan Guryan, Krzysztof Karbownik, and Jeffrey Roth. 2014. "The Effects of Poor Neonatal Health on Children's Cognitive Development." *American Economic Review* 104 (12): 3921–55.
Fiszbein, Ariel, and Norbert Schady. 2009. *Conditional Cash Transfers: Reducing Present and Future Poverty*. Washington, DC: World Bank.

Fitzsimons, Emla, and Marcos Vera-Hernandez. 2014. "Food for Thought? Breastfeeding and Child Development." University of London Department of Quantitative Social Science Working Paper 14-04.
Fryer, Roland G., Jr., Steven D. Levitt, and John A. List. 2015. "Parental Incentives and Early Childhood Achievement: A Field Experiment in Chicago Heights." National Bureau of Economic Research Working Paper 21477.
Garces, Eliana, Duncan Thomas, and Janet Currie. 2002. "Longer-Term Effects of Head Start." *American Economic Review* 92 (4): 999–1012.
Gelber, Alexander, and Adam Isen. 2013. "Children's Schooling and Parents' Behavior: Evidence from the Head Start Impact Study." *Journal of Public Economics* 101: 25–38.
Gertler, Paul, et al. 2014. "Labor Market Returns to an Early Childhood Stimulation Intervention in Jamaica." *Science* 344 (6187): 998–1001.
Golberstein, Ezra, Gilbert Gonzales, and Ellen Meara. 2016. "Economic Conditions and Children's Mental Health." National Bureau of Economic Research Working Paper 22459.
Gould, Eric D., Victor Lavy, and M. Daniele Paserman. 2011. "Sixty Years after the Magic Carpet Ride: The Long-Run Effect of the Early Childhood Environment on Social and Economic Outcomes." *Review of Economic Studies* 78 (3): 938–73.
Greve, Jane, Marie Louise Schultz-Nielsen, and Erdal Tekin. 2015. "Fetal Malnutrition and Academic Success: Evidence from Muslim Immigrants in Denmark." National Bureau of Economic Research Working Paper 21545.
Grossman, Michael. 1972. "On the Concept of Health Capital and the Demand for Health." *Journal of Political Economy* 80 (2): 223–55.
Gunnsteinsson, Snaebjorn, et al. 2016. "Resilience to Early Life Shocks: Evidence from the Interaction of a Natural Experiment and a Randomized Control Trial." Unpublished.
Gutierrez, Federico H. 2014. "Long-Term Consequences of Early Life Health Shocks: Evidence from the 1980s Peruvian Crisis." Unpublished.
Havnes, Tarjei, and Magne Mogstad. 2011. "No Child Left Behind: Subsidized Child Care and Children's Long-Run Outcomes." *American Economic Journal: Economic Policy* 3 (2): 97–129.
Havnes, Tarjei, and Magne Mogstad. 2015. "Is Universal Child Care Leveling the Playing Field?" *Journal of Public Economics* 127: 100–114.
Heckman, James J. 2007. "The Economics, Technology, and Neuroscience of Human Capability Formation." *Proceedings of the National Academy of Sciences* 104 (33): 13250–55.
Heckman, James J. 2008. "Schools, Skills, and Synapses." *Economic Inquiry* 46 (3): 289–324.
Heckman, James J., Rodrigo Pinto, and Peter Savelyev. 2013. "Understanding the Mechanisms through Which an Influential Early Childhood Program Boosted Adult Outcomes." *American Economic Review* 103 (6): 2052–86.
Hoffmann, Anne Brenøe. 2014. "Adverse In Utero Experiences and Distortions of the Sex Ratio: Evidence from Prenatal Fasting." Working Paper.
Hoynes, Hilary, Doug Miller, and David Simon. 2015. "Income, the Earned Income Tax Credit, and Infant Health." *American Economic Journal: Economic Policy* 7 (1): 172–211.
Hoynes, Hilary, Diane Whitmore Schanzenbach, and Douglas Almond. 2016. "Long-Run Impacts of Childhood Access to the Safety Net." *American Economic Review* 106 (4): 903–34.
Hsin, Amy. 2012. "Is Biology Destiny? Birth Weight and Differential Parental Treatment." *Demography* 49 (4): 1385–405.
Isen, Adam, Maya Rossin-Slater, and W. Reed Walker. 2017. "Every Breath You Take—Every Dollar You'll Make: The Long-Term Consequences of the Clean Air Act of 1970." *Journal of Political Economy* 125 (3): 848–902.
Jayachandran, Seema, Adriana Lleras-Muney, and Kimberly V. Smith. 2010. "Modern Medicine and the Twentieth Century Decline in Mortality: Evidence on the Impact of Sulfa Drugs." *American Economic Journal: Applied Economics* 2 (2): 118–46.
Kline, Patrick, and Christopher R. Walters. 2016. "Evaluating Public Programs with Close Substitutes: The Case of Head Start." *Quarterly Journal of Economics* 131 (4): 1795–848.
Knittel, Christopher R., Douglas L. Miller, and Nicholas J. Sanders. 2016. "Caution, Drivers! Children Present: Traffic, Pollution, and Infant Health." *Review of Economics and Statistics* 98 (2): 350–66.
Krutikova, Sonya, and Helene Bie Lilleor. 2015. "Fetal Origins of Personality: Effects of Early Life Circumstances on Adult Personality Traits." Working Paper.
Lavy, Victor, Analia Schlosser, and Adi Shany. 2016. "Out of Africa: Human Capital Consequences of In Utero Conditions." National Bureau of Economic Research Working Paper 21894.
Lee, Chulhee. 2014. "Intergenerational Health Consequences of *In Utero* Exposure to Maternal Stress: Evidence from the 1980 Kwangju Uprising." *Social Science and Medicine* 119: 284–91.
Lindo, Jason M. 2011. "Parental Job Loss and Infant Health." *Journal of Health Economics* 30 (5): 869–79.
Linnemayr, Sebastian, and Harold Alderman. 2011. "Almost Random: Evaluating a Large-Scale Randomized Nutrition Program in the Presence of Crossover." *Journal of Development Economics* 96 (1): 106–14.
Lleras-Muney, Adriana. 2010. "The Needs of the Army: Using Compulsory Relocation in the Military to Estimate the Effect of Air Pollutants on Children's Health." *Journal of Human Resources* 45 (3): 549–90.
Løken, Katrine V., Magne Mogstad, and Matthew Wiswall. 2012. "What Linear Estimators Miss: The Effects of Family Income on Child Outcomes." *American Economic Journal: Applied Economics* 4 (2): 1–35.
Ludwig, David S., Heather L. Rouse, and Janet Currie. 2013. "Pregnancy Weight Gain and Childhood Body

Weight: A Within-Family Comparison." *PloS Medicine* 10 (10).

Ludwig, Jens, et al. 2008. "What Can We Learn about Neighborhood Effects from the Moving to Opportunity Experiment?" *American Journal of Sociology* 114 (1): 144–88.

Ludwig, Jens, et al. 2013. "Long-Term Neighborhood Effects on Low-Income Families: Evidence from Moving to Opportunity." *American Economic Review* 103 (3): 226–31.

Malamud, Ofer, Cristian Pop-Eleches, and Miguel Urquiola. 2016. "Interactions between Family and School Environments: Evidence on Dynamic Complementarities?" National Bureau of Economic Research Working Paper 22112.

Manski, Charles F. 2011. "Genes, Eyeglasses, and Social Policy." *Journal of Economic Perspectives* 25 (4): 83–94.

McCrary, Justin, and Heather Royer. 2011. "The Effect of Female Education on Fertility and Infant Health: Evidence from School Entry Policies Using Exact Date of Birth." *American Economic Review* 101 (1): 158–95.

Meckel, Katherine. 2015. "Is the Cure Worse than the Disease? Unintended Consequences of Fraud Reduction in Transfer Programs." Unpublished.

Miguel, Edward, and Michael Kremer. 2004. "Worms: Identifying Impacts on Education and Health in the Presence of Treatment Externalities." *Econometrica* 72 (1): 159–217.

Miller, Sarah, and Laura R. Wherry. 2014. "The Long-Term Effects of Early Life Medicaid Coverage." Working Paper.

Milligan, Kevin, and Mark Stabile. 2011. "Do Child Tax Benefits Affect the Well-Being of Children? Evidence from Canadian Child Benefit Expansions." *American Economic Journal: Economic Policy* 3 (3): 175–205.

Nilsson, J. Peter. 2017. "Alcohol Availability, Prenatal Conditions, and Long-Term Economic Outcomes." *Journal of Political Economy* 125 (4): 1149–207.

Ozier, Owen. 2014. "Exploiting Externalities to Estimate the Long-Term Effects of Early Childhood Deworming." World Bank Policy Research Working Paper 7052.

Persson, Petra, and Maya Rossin-Slater. 2018. "Family Ruptures, Stress, and the Mental Health of the Next Generation." *American Economic Review* 108 (4–5): 1214–52.

Quintana-Domeque, Climent, and Pedro Rodenas-Serrano. 2017. "The Hidden Costs of Terrorism: The Effects on Health at Birth." *Journal of Health Economics* 56: 47–60.

Robinson, Joshua J. 2012. "The Effects of Asymmetric and Symmetric Fetal Growth Restriction on Human Capital Development." Working Paper.

Rocha, Rudi, and Rodrigo R. Soares. 2015. "Water Scarcity and Birth Outcomes in the Brazilian Semiarid." *Journal of Development Economics* 112: 72–91.

Rosales-Rueda, Maria. 2015. "Impact of Early Life Shocks on Human Capital Formation: Evidence from El Niño Floods in Ecuador." Working Paper.

Rossin-Slater, Maya. 2011. "The Effects of Maternity Leave on Children's Birth and Infant Health Outcomes in the United States." *Journal of Health Economics* 30 (2): 221–39.

Rossin-Slater, Maya. 2013. "WIC in Your Neighborhood: New Evidence on the Impacts of Geographic Access to Clinics." *Journal of Public Economics* 102: 51–69.

Rossin-Slater, Maya. 2017. "Signing Up New Fathers: Do Paternity Establishment Initiatives Increase Marriage, Parental Investment, and Child Well-Being." *American Economic Journal: Applied Economics* 9 (2): 93–130.

Rossin-Slater, Maya, and Miriam Wüst. 2015. "Are Different Early Investments Complements or Substitutes? Long-Run and Intergenerational Evidence from Denmark." Working Paper.

Royer, Heather. 2009. "Separated at Girth: US Twin Estimates of the Effects of Birth Weight." *American Economic Journal: Applied Economics* 1 (1): 49–85.

Sanders, Nicholas J. 2012. "What Doesn't Kill You Makes You Weaker: Prenatal Pollution Exposure and Educational Outcomes." *Journal of Human Resources* 47 (3): 826–50.

Scholte, Robert S., Gerard J. van den Berg, and Maarten Lindeboom. 2015. "Long-Run Effects of Gestation during the Dutch Hunger Winter Famine on Labor Market and Hospitalization Outcomes." *Journal of Health Economics* 39: 17–30.

Schwandt, Hannes. 2017. "The Lasting Legacy of Seasonal Influenza: In-Utero Exposure and Labor Market Outcomes." Institute of Labor Economics Discussion Paper 10589.

Shah, Manisha, and Bryce Millett Steinberg. 2017. "Drought of Opportunities: Contemporaneous and Long-Term Impacts of Rainfall Shocks on Human Capital." *Journal of Political Economy* 125 (2): 527–61.

Sievertsen, Hans Henrik, and Miriam Wust. 2015. "Discharge on the Day of Birth, Parental Response and Health and Schooling Outcomes." Working Paper.

Simon, David. 2016. "Does Early Life Exposure to Cigarette Smoke Permanently Harm Childhood Welfare? Evidence from Cigarette Tax Hikes." *American Economic Journal: Applied Economics* 8 (4): 128–59.

van den Berg, Gerard J., Maarten Lindeboom, and France Portrait. 2006. "Economic Conditions Early in Life and Individual Mortality." *American Economic Review* 96 (1): 290–302.

Venkataramani, Atheendar S. 2012. "Early Life Exposure to Malaria and Cognition in Adulthood: Evidence from Mexico." *Journal of Health Economics* 31 (5): 767–80.

von Hinke Kessler Scholder, Stephanie, George L. Wehby, Sarah Lewis, and Luisa Zuccolo. 2014. "Alcohol Exposure *In Utero* and Child Academic Achievement." *Economic Journal* 124 (576): 634–67.

Ward, Courtney, and Shelley Phipps. 2014. "Influenza, the In Utero Environment, and Developmental Outcomes of Pre-school Children." Working Paper.

Wernerfelt, Nils, David J. G. Slusky, and Richard Zeckhauser. 2017. "Second Trimester Sunlight and Asthma: Evidence from Two Independent Studies." *American Journal of Health Economics* 3 (2): 227–53.
Wherry, Laura R., and Bruce D. Meyer. 2016. "Saving Teens: Using a Policy Discontinuity to Estimate the Effects of Medicaid Eligibility." *Journal of Human Resources* 51 (3): 556–88.
Wherry, Laura R., Sarah Miller, Robert Kaestner, and Bruce D. Meyer. 2015. "Childhood Medicaid Coverage and Later Life Health Care Utilization." National Bureau of Economic Research Working Paper 20929.
Yi, Junjian, James J. Heckman, Junsen Zhang, and Gabriella Conti. 2015. "Early Health Shocks, Intra-household Resource Allocation and Child Outcomes." *Economic Journal* 125 (588): F347–71.