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Income Effects and Neonatal Health: New Evidence from the Coal Boom*

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Abstract

This study estimates the effects of income shock on health. We analyze infant birth weight and mortality in Kentucky, Ohio, and West Virginia during the 1970s using the sharp coal price increase as an exogeneous income shock. This variation has been used in several previous papers. Individual level natality data are used for the birth weight analysis and county level per capita income is instrumented with the value of coal reserves in the county. An exogenous $1,000 increase in income in 2015 dollars increased birth weight by 5.5 grams but it is not statistically significant. The numbers of low birth weight babies decreased by 0.1%p with an exogenous $1,000 increase in income but again statistically insignificant and 1.3% of the sample mean (7.6%). Since we examine miners mostly, our results might have limited generalizability to general population.

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Keywords : Income effects, Neonatal Health, Coal Boom

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Ⅰ. Introduction

Studies have shown that low birth weight is associated with high social costs. Thus, public policy has focused on improving the health of newborns (Almond et al., 2005; McCormick et al., 1992; and Richards et al., 2001). The most significant threats to newborn health are inadequate nutrition and lack of access to health services. According to UNICEF, every year approximately 60 million women around the world give birth in unfavorable circumstances, in the absence of skilled health personnel. In the US, an important policy initiative that was formulated to address these issues is the Women, Infants, and Children (WIC) program, which served 8.9 million people in 2012 at a cost of $7.1 billion dollars (USDA WIC, n.d.). The purpose of the program was to improve the nutritional well-being of children under five and of low-income pregnant women.

In addition to this kind of in-kind support program, U.S. has also provided cash support programs to enhance child health. Aid to Families with Dependent Children (AFDC), Temporary Assistance for Needy Families (TANF) and Earned Income Tax Credits (EITC) are cases in point. A series of studies examined the health effects of these cash support programs. For instance, Currie and Cole (1993) reported an increase in birth weight associated with the AFDC program. Strully et al. (2010) also found increased birth weights and reduced maternal smoking after an increase in EITC.

Measuring pure income effects is important, as this form of research contributes to fundamental knowledge. According to traditional economic theory, cash transfers are considered efficient policy measures, because they can increase individual incomes without distorting wages or the relative prices of goods and services. Most current cash transfer programs are not ideal for estimating the pure income effects of cash transfers, however, because the vast majority of these programs are conditional. Aforementioned child support programs are mostly associated with certain conditions, such as single parents, jobs, education, and immunization. Accordingly, individuals who receive benefits from cash transfer programs may have unique characteristics, since these individuals must qualify for programs as mentioned previously. It would follow, then, that treatment groups would be created as a result of an individual self-sorting process. This implies that most existing studies on the effects of conditional cash transfers may suffer from selection bias. The ultimate policy effect of these programs, then, will be a combination of the sorting and the pure income effects. In addition, a majority of studies on more traditional cash transfer programs in the U.S., such as AFDC, TANF and EITC, may only show behavioral effects of limited groups satisfying their eligibility requirements.

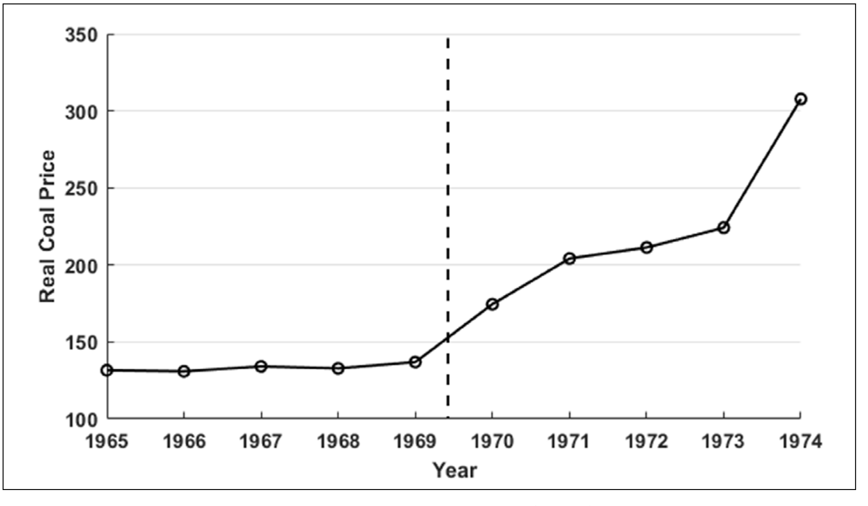
Drawing upon the empirical strategy suggested by Black et al. (2002, 2005), we estimate pure income effects on health, more specifically on neonatal health. Income changes can impact neonatal health through their influence on women's fertility decisions and on women's health-related behavior during pregnancy. To accurately estimate the pure income effects, we study the relationship between neonatal health and aggregate income shock, utilizing the coal price hike of the 1970s as the shock. We focus on the Appalachian area of the US, where coal mining was prevalent at that time. To minimize impacts from fertility decisions, we use a time span for the study such that people would not have had the opportunity to alter their fertility decisions.

The rest of this paper is organized as follows. Section 2 reviews natural experimental setting, and Section 3 discusses methods. Section 4 presents the results, and finally Section 5 concludes the paper.

Ⅱ. Natural Experiment Setting

Following a stable price period that lasted through 1969, the US coal price increased significantly from 1970 onwards (see Figure 1 for 1965-1974 prices). We use the exogenous income shock generated by the coal price increase as a natural experiment. We define our study area as the US states of Kentucky, Ohio, and West Virginia, which have significant coal reserves; data from Black et al. (2002) provide us with information about the coal reserves in these areas. Based on this data, we classify each county as a No Coal area or a Large Coal area. A county is defined as No Coal if it has coal reserves less than 100 million tonsand Large Coal if it has coal reserves greater than or equal to one billion tons.

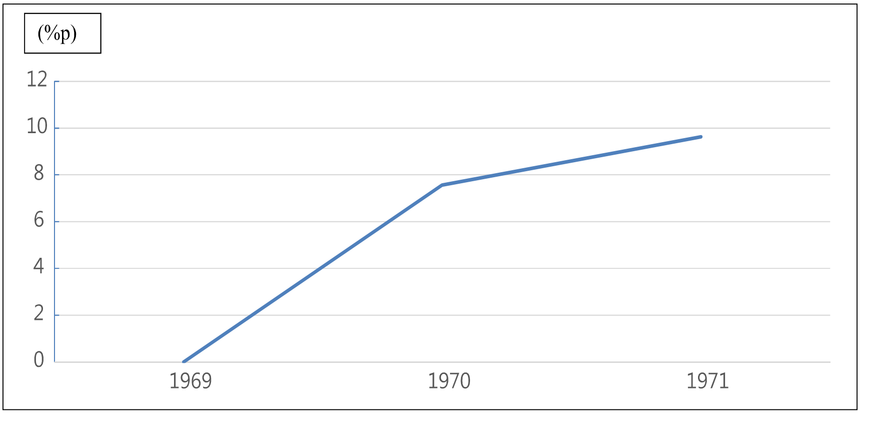
〈Figure 1〉 The real price of coal, (1965-1974)



Notes: Based on Figure 1 in Black et al. (2005) Real price has been recalculated using 2015 as a baseline. This figure plots the ratio of the producer price index for bituminous coal to the CPI.

The most important question in this natural experiment is whether the coal price increase truly resulted in higher personal income. In this case, Large Coal areas should have had higher personal income growth compared to No Coal areas during the coal boom. According to Figure 2, Large Coal areas did experience positive income growth. In contrast, although we did not show this in Figure 2, No Coal areas did not show any change in the real per capita personal income level.[1)] Therefore, we are confident that the coal price increase did indeed generate meaningful exogenous personal income variation according to area of residence. In addition, the proposed case has the following unique characteristics as a natural experiment setting.

⟨Figure 2⟩



Notes: The relative real per capita personal income increase in Large Coal areas compared to No Coal areas Based on the Regional Economic Information System(REIS) of the Bureau of Economic Analysis. REIS provides data since 1969.

First, mining was a male-dominated industry in the early 1970s.[2)] Wives prepared the food that the miners brought to work, they cleaned the miners' clothes, and somehow, they managed to support

1) Average real per capita personal income change in 1970 compare to 1969 is 0.17% for no coal, 4.18% for moderate and 8.23% in large coal areas. We have 169 counties as no coal, 56 as moderate and 38 as large coal counties.

2) The first woman miner was officially hired in 1973 in a mine in West Virginia (captured on Jan. 24, 2017; Article on the Christian Science Monitor http://www.csmonitor.com/1988/0711/acoal.html?cmpid=gigya-mail).

their children on what little pay the miners brought home (Women in the mine wars, http://www.pbs.org/wgbh/americanexperience/features/general-article/minewars-women/). Since there were no female miners in our study period, the natural setting of our experiment provides a unique opportunity to measure pure income effects. This is because the social reality of gender roles at the time eliminated the substitution effect that would have resulted from the increase in the miners' wages.

Second, in our study, there was a sudden and sharp economic impact, and we examine outcomes only during short time frames between 1969 and 1970 to minimize possible bias from composition changes. The coal price was flat through 1969, and then in 1970, the coal price increased 28%. Babies conceived in 1970 and born in 1971 experienced the coal price increase in utero, and therefore, they were not impacted by pregnancy decisions. In other words, their mothers were already pregnant. We eliminate selection and composition issues by choosing time periods before people could alter their pregnancy decisions.

Third, our study population is similar to the target group for federal programs such as WIC. A large or medium-sized coal-producing region's median income—\$6,842 and \$7,287 in 1984 dollars, respectively—is below the 25th percentile of income in the United States, which was \$7,368 in 1984 dollars. The income qualification for participation in WIC was below 185% of the federal poverty line, with 33% of the total population belonging to the group below 200% of the federal poverty line, based on data from the Kaiser family foundation (Kaiser Family Foundation, n.d.). The majority of our study population in coal areas, then, would have been eligible for WIC. Therefore, the findings of our study could be quite similar to those of a federal level welfare program, such as WIC.

Lastly, our study compares babies born in geographically adjacent areas. By comparing a baby born in a coal mining area to other babies born nearby, in non-mining areas, we minimize the bias from unobservable characteristics.

Ⅲ. Methods

1. Date

We use data from three main sources. First, we use the Natality Detail File for data on newborn health.[3] This dataset records comprehensive information on all live births in the United States, including birth weight, which has been used in previous studies as a reliable indicator of newborn health (Rosenzweig and Schultz, 1983; Corman et al., 1987; Rosenzweig and Wolpin, 1991; Almond et al., 2005). The Natality Detail File also contains detailed demographic information, such as maternal age, education, race, and place of residence. For each baby, it includes the birth month and year, gender, and the baby's birth order.[4] Furthermore, it provides information about pregnancy characteristics, such as parity, plurality, and prenatal care (e.g., the timing of the first prenatal visit). Having this information allows us to control many of the observable characteristics that impact birth weight.

Second, we use information on newborn mortality. These data include information on state and county of residence, race, sex, and age and year of death for all deaths that occurred in the U.S.[5] Lastly,

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3) Depending on the recording area, the dataset contains either 50% or 100% of the possible data points. We weighted the data accordingly for every regression and descriptive analysis in this study.

4) Black et al. (2002) used Kentucky, Ohio, Pennsylvania, and West Virginia. We decided to exclude babies born in Pennsylvania, since the data did not contain maternal education level.

we measure economic conditions using per capita personal income (PCPI) rather than the unemployment rate, a common approach in other studies. County level PCPI annual data is available in the Regional Economic Information System of the Bureau of Economic Analysis. All prices are converted to 2015 baselines using Consumer Price Index (CPI).

2. Outcomes

We use birth weight as a composite measure of children's health, because it is widely known to have a considerable influence on health and socioeconomic outcomes later in life (Rosenzweig and Schultz, 1983; Corman et al., 1987; Rosenzweig and Wolpin, 1991; Almond et al., 2005). We use low birth weight (LBW) as the second measure of children's health. In so doing, we comply with the general convention and define LBW as a birth weight less than 2,500 grams. We define LBW as an indicator variable that takes a value 1 if a baby is born with low birth weight. Almond (2005) pointed out that medical costs and mortality rates are significantly higher for LBW babies than for their counterparts.

Mortality is the ultimate health outcome that we can measure. Common measures of newborn mortality are early neonatal mortality (less than seven days), neonatal mortality (less than 28 days), and infant mortality (less than one year). We merge the county level data by year, since mortality data do not contain individual identifiers that can be matched with birth data. For example, the infant mortality rate is calculated by dividing the number of deaths of infants younger than one year by the number of live births, and then multiplying this quotient by 1000. We use mortality data to count the

5) Linked birth and death data do not exist at the individual level for the period of interest. However, the shock is at the aggregated level, and meaningful variation is therefore not lost.

number of deaths within a certain period for each county: the number of infants who died at an age of less than seven days in one year in a given county is used as the numerator. The denominator is the number of live births in that county from the same time period, January through December in 1970. In this example, we calculated an average neonatal mortality of 15.00.

3. Key Independent Variable: Income

For the independent variable, we use PCPI, which is the average income of people living in a county. While reverse causality will be less of an issue for newborns, a third factor (such as a discount factor) could impact income as well as the birth weight of newborns. For example, parents who place high value on their future would attain higher education as well as invest more in their children during pregnancy. When people overwork their income and health are negatively correlated. Subsequently baby's health measured by birth weight will be impacted due to individual health change. Even at the aggregated level, this confounding third factor might bias the estimate. Thus, we employ an instrumental variable approach to solve the endogeneity issue for income, with the real value of coal reserves as our instrumental variable. By using this approach, only income changes generated by the coal price increase in the mining area are considered. In addition, we do not lose any variation by using county level income instead of individual level income, because the instrument varies at the county level.

4. Econometric Model

Two-stage Least Squares. We are interested in the following equation.

$$Y_{ict} = f + Real\ PCPI_{c(t-1)} {}^{*} g + X_{ict} {}^{*} h + v_{ict}, \qquad (1)$$

where Y is the birth weight or LBW; i denotes the individual; c denotes the county; and t denotes the year. X includes information about the mother, such as age, race, and education level; the birth order-first child, second or later child; the mother's age-less than 19 years, 20-24 years, 25-29 years, 30-34 years, 35-39 years, and greater than or equal to 40 years; race-white, black, or other; and education level-no high school degree, high school graduate, college graduate, and higher than college graduate.[6)]

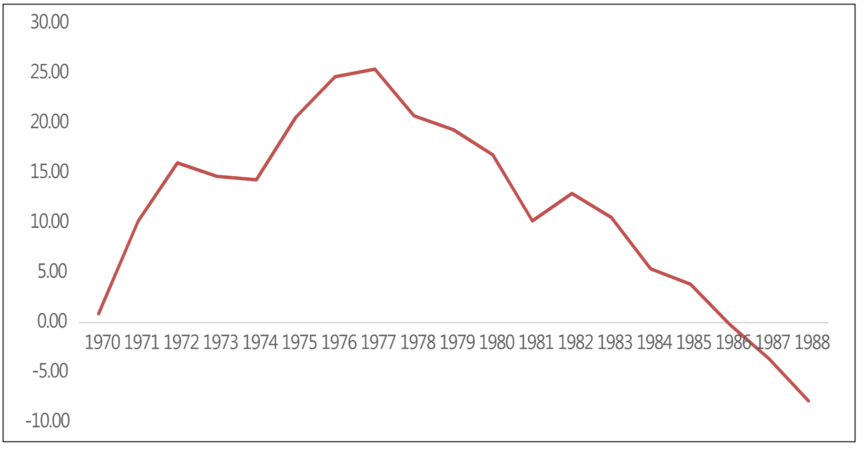
Wool (1981) described how U.S. employment stabilized from 1965 to 1969 and then expanded steadily for the next 10 years. During the expansion, the mining industry work force became younger and more educated. These composition changes may have induced the growth rate of newborns in coal areas compared to adjacent, non-coal areas, as shown in Figure 3. The birth rate grew by 13.21% from 1969 to 1977 in Large Coal areas, while No Coal areas showed a negative 13% growth during the same time frame. This represents a 26%p difference in growth rates between Large and No Coal areas. To minimize these newborn composition changes, we use data over a period of two years: one year before and one year after the coal price increase.

Babies normally spend 40 weeks (i.e., 10 months) in the mother's womb. When a population of women experiences a positive income shock in any given month, it is logical to conclude that any babies born 10 months later are fully exposed to the shock. When people in the mining area experienced positive income shocks in 1970, babies born in 1971 would have experienced the positive income shock in

6) There are missing values in race, education, and number of children: 0.1% for race, 1.3% for education and 0.3 % for number of children. Including these observations does not change results qualitatively.

utero. Therefore, the birth outcomes of the 1971 cohorts would have been improved compared to the 1970 cohorts, who were in the mother's womb in 1969 and, thus, not exposed to the shock.

〈Figure 3〉 Large Coal Area's birth growth rate compared to No Coal



Note: Authors calculation based on Natality detail file. For each area, birth growth rate is calculated based on 1969 birth cohorts and the change compared to No Coal is presented on the Y axis.

Real PCPI, aggregated at the county level, is not exogenous. To address this issue, we use two-stage least squares (TSLS) based on Black et al. (2002). The first stage equation takes the following form:

$$Real\ PCPI_{c(t-1)} = a + Real\ CRV_{c(t-1)} {}^{*} b + X_{ict} {}^{*} d + u_{ict}, \qquad (2)$$

Our instrument is real coal reserve value. Real coal reserve value is defined as coal reserve in million tons multiplied by producer price index for coal divided by consumer price index. We use Black et al (2002)'s coal reserve.

For this instrumental variable to be valid, the real coal reserve value (real CRV) should impact the health of a newborn only through real per capita personal income (real PCPI). It is difficult to conceptualize another path toward health impact other than through income due to an increase in the coal reserve value.[7] The first stage of the regression shows that the areas that are associated with the mining industry experience a positive income shock compared to areas with no mining industry during the coal price increase.

We estimate mortality by means of the following model:

$$MR_{ct} = f + Real\ PCPI_{c(t-1)}{}^{*}g + X_{ct}{}^{*}h + v_{ct}\,, \qquad (3)$$

where $MR_{ct} \equiv \frac{The\ \nu mber\ of\ deaths\ of\ infants\ under\ 7\ days\ (28\ days,\ 1\ year)\ old}{The\ number\ of\ liveb\ irths} \times 1000$

is the mortality rate; c denotes the county; and t denotes the year. The unit of observation is the county. X includes the following information: the proportion of babies that are firstborn, second born, later children or birth order missing; maternal age less than 19 years, 20-24 years, 25-29 years, 30-34 years, 35-39 years, and greater than or equal to 40 years; the proportion of mothers that are white, black, and other races; and the maternal education level. The first stage is the same as equation (2).

Ⅳ. Results

1. Health of Newborns

Table 1 summarizes all births in Kentucky, Ohio, and West Virginia from 1970 to 1971. During this period, 543,798 babies were born.[8] Average birth weight is 3,293 grams and 7.6% of births are

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7) When mining activities increased the air or water pollution of the areas, this may have caused adverse health outcomes. However, this effect is not clear for the fetus during pregnancy. If there is a negative health impact, then we are calculating a lower bound here.

8) We use weights since Kentucky, Ohio, and West Virginia reported 50 percent sample of live births.

〈Table 1〉 Descriptive Statistics

Period: 1970-1971	Mean	Standard Deviation
Birth Weight (in gram)	3,293.3	587.1
Low Birth Weight (<2500 grams)	0.076	0.266
Real Per Capita Personal Income (in2015dollars)	23,903.3	4,258.8
Real Coal Reserve Value	0.424	1.400
Male	0.514	0.500
Age of the Mother	24.40	5.46
White	0.888	0.315
Black	0.107	0.310
Other	0.004	0.062
Race Not Available	0.001	0.024
No High School Diploma	0.324	0.468
High School Diploma	0.595	0.491
Some College	0.056	0.229
College Diploma or Higher	0.013	0.112
Education Not Available	0.013	0.113
Number of Children	2.554	1.915
Number of Children Not Available	0.003	0.058
First Child	0.360	0.480
Second Child	0.260	0.438
Third Child	0.159	0.365
≥ Fourth Child	0.221	0.415
Total Obs.	543,798	

Note: During 1970-1971, almost every observation represents a 50% sample, while some observations represent a 100% sample. Our calculation was done by assigning twice the weight to the 50% sample. Furthermore, we excluded any observations from a county with less than 100 newborns.

low birth weight. Per capita personal income measured in 2015 dollar is 23,903 with standard deviation of 4,259 dollars. Fraction of boys among newborn is 51.4% and 89% of mothers are white. Sixty percent of mothers graduated from high school in our sample. Thirty two percent of mothers have lower educational attainment than high school. Average number of children is 2.6 and 36 percent of newborns in our sample is the first child. Twenty six percent of our sample is second child and thirty seven percent is third child and above.

Table 2 reports the results using birth weight as an outcome. In the first column, the OLS result shows that a $1,000 increase in real PCPI (in 2015 dollars) did not result in a statistically significant change in birth weight. In the second column, we report the first stage regression results. An increase in the real coal reserve value increases the real per capita personal income. The first stage results are quite strong, increasing our confidence in the TSLS result. In the last column, the TSLS result shows that an exogenous $1,000 increase in real PCPI increases birth weight by 5.5 grams, and this result is statistically insignificant. Standard errors are clustered by county level. This magnitude is small since it is 0.15(=5/3293.3) percent of sample mean.

Table 3 shows "Low Birth Weight" as an outcome variable. OLS did not show any statistically significant impact in the first column. The first stage shows a statistically significant result with a t value of 7, which is quite high. In the last column, it is shown that the number of infants born with low birth weight-defined as less than 2500 grams-decreased by 0.1%p, which was 1.3% of the sample mean (7.6%). This is statistically insignificant at the conventional confidence level and very small in magnitude. An exogenous $1,000 increase in real PCPI is 4% (=1000/23,903) increase in income, which is sizable, but it did not change low birth weight statistically significant way. When we consider 10% increase in income which is 2,400 dollar increases it will only impact the low birth weight probability by 0.24%p, which is still small. Hoynes et al. (2015) found that a $1,000 income shock leads to a 2 to 3 percent decline in low birth weight using earned income tax credit variation. The population difference might partly explain the difference. Although we have clean exogenous income shock our population who works in the mining

⟨Table 2⟩ The Effect of Income on Birth Weight

Period: 1970-1971	Dependent Variable: Birth Weight		
	OLS	2SLS 1ststage	2SLS 2ndstage
Instrument:			
Real Coal Reserve Value		1.034**	
		(0.147)	
Independent Variables:			
Real Per Capita Personal Income (in 2015 dollars; in thousand dollars)	-0.761		5.494
	(2.921)		(8.805)
First Child	-40.637**	-0.003**	-40.622**
	(4.852)	(0.001)	(4.838)
Number of Children Not Available	-27.201	0.076**	-27.623
	(21.906)	(0.022)	(21.804)
Mother's age 20-24 years	28.825**	-0.001	28.833**
	(4.320)	(0.001)	(4.306)
Mother's age 25-29 years	45.857**	-0.004**	45.888**
	(4.062)	(0.002)	(4.047)
Mother's age 30-34 years	68.106**	-0.001	68.124**
	(4.564)	(0.002)	(4.550)
Mother's age 35-39 years	65.534**	-0.002	65.554**
	(9.393)	(0.002)	(9.359)
Mother's age 40+ years	82.948**	0.001	82.965**
	(11.486)	(0.004)	(11.453)
Black	-230.806**	-0.004**	-230.769**
	(4.914)	(0.001)	(4.897)
Other	-139.377**	-0.007	-139.306**
	(14.823)	(0.006)	(14.776)
Race Not Available	-119.746**	-0.059**	-119.304**
	(50.961)	(0.020)	(50.850)
High School Graduate	81.074**	0.001	81.065**
	(3.339)	(0.001)	(3.328)
College Graduate	96.179**	0.002	96.163**
	(4.891)	(0.002)	(4.873)
Higher than College	75.885**	-0.002	75.916**
	(9.790)	(0.005)	(9.756)
Education Not Available	33.845**	-0.016**	33.968**
	(14.569)	(0.005)	(14.531)
Constants	3,325.388**	16.529**	3,222.323**
	(48.046)	(0.087)	(145.057)
County Fixed Effect?	Y	Y	Y
Year Fixed Effect?	Y	Y	Y
Clustering s.e.	Y	Y	Y
R^2	0.032	0.995	0.032
Obs.	543,798	543,798	543,798

Note: *, ** denote 10% and 5% statistical significance, respectively. We use all births from Kentucky, Ohio, and West Virginia between 1970 and 1971 and linked one year lagged real PCPI. During 1970-1971, almost every observation represents a 50% sample, while some observations represent a 100% sample. Our calculation was done by assigning twice the weight to the 50% sample.

〈Table 3〉 The Effect of Income on Low Birth Weight

Period: 1970-1971	Dependent Variable: Low Birth Weight (<2500 grams)		
	OLS	2SLS 1ststage	2SLS 2ndstage
Instrument:			
Real Coal Reserve Value		1.034**	
		(0.147)	
Independent Variables:			
Real Per Capita Personal Income (in2015dollars;inthousanddollars)	0.0005		-0.001
	(0.0011)		(0.002)
First Child	-0.006**	-0.003**	-0.006**
	(0.001)	(0.001)	(0.001)
Number of Children Not Available	-0.006	0.076**	-0.006
	(0.012)	(0.022)	(0.012)
Mother's age 20-24 years	-0.012**	-0.001	-0.012**
	(0.001)	(0.001)	(0.001)
Mother's age 25-29 years	-0.013**	-0.004**	-0.013**
	(0.002)	(0.002)	(0.002)
Mother's age 30-34 years	-0.011**	-0.001	-0.011**
	(0.002)	(0.002)	(0.002)
Mother's age 35-39 years	-0.00004	-0.002	-0.00005
	(0.00289)	(0.002)	(0.00288)
Mother's age 40+ years	-0.001	0.001	-0.001
	(0.005)	(0.004)	(0.005)
Black	0.061**	-0.004**	0.061**
	(0.002)	(0.001)	(0.002)
Other	0.023**	-0.007	0.023**
	(0.007)	(0.006)	(0.007)
Race Not Available	0.052	-0.059**	0.052
	(0.034)	(0.020)	(0.034)
High School Graduate	-0.026**	0.001	-0.026**
	(0.001)	(0.001)	(0.001)
College Graduate	-0.038**	0.002	-0.038**
	(0.002)	(0.002)	(0.002)
Higher than College	-0.035**	-0.002	-0.035**
	(0.004)	(0.005)	(0.004)
Education Not Available	-0.010	-0.016**	-0.010
	(0.006)	(0.005)	(0.006)
Constants	0.083**	16.529**	0.106**
	(0.018)	(0.087)	(0.029)
County Fixed Effect?	Y	Y	Y
Year Fixed Effect?	Y	Y	Y
Clustering s.e.	Y	Y	Y
R^2	0.011	0.995	0.011
Obs.	543,798	543,798	543,798

Note: *, ** denote 10% and 5% statistical significance, respectively. We use all births from Kentucky, Ohio, and West Virginia between 1970 and 1971 and linked one year lagged real PCPI. During 1970-1971, almost every observation represents a 50% sample, while some observations represent a 100% sample. Our calculation was done by assigning twice the weight to the 50% sample.

〈Table 4〉 The Effect of Income on Mortalities

Period: 1970-1971	Dependent Variable: Early Neonatal Mortality (<7days)			Dependent Variable: Neonatal Mortality (<28days)			Dependent Variable: Infant Mortality (<1year)		
	OLS	2SLS 1st stage	2SLS 2nd stage	OLS	2SLS 1st stage	2SLS 2nd stage	OLS	2SLS 1st stage	2SLS 2nd stage
Real Coal Reserve Value		0.946**			0.946**			0.946**	
		(0.133)			(0.133)			(0.133)	
Real Per Capita Personal Income (in 2015 dollars; in thousand dollars)	0.212		0.755	0.315		0.591	0.195		-1.057
	(0.466)		(1.188)	(0.548)		(1.567)	(0.652)		(1.900)
County Fixed Effect?	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year Fixed Effect?	Y	Y	Y	Y	Y	Y	Y	Y	Y
Clustering s.e.	Y	Y	Y	Y	Y	Y	Y	Y	Y
R^2	0.669	0.996	0.666	0.678	0.996	0.677	0.701	0.996	0.693
Obs.	366	366	366	366	366	366	366	366	366
Mean of Dependent Variable Per 1,000 live births		14			15			21	

Note: *, ** denote 10% and 5% statistical significance, respectively. Each observation was weighted by the number of births

industry can be healthier than average. As a result, income will impact the health of newborn less than average population.

2. Mortality of Newborns

Although mortality of newborn is rare, 21 out of 1,000 live births died within one year of birth in our sample, it is an extreme outcome with minimum measurement error. In this section, we estimate equation (3). We report three outcomes: 7-day mortality and 28-day mortality, and 1-year mortality of newborns. The number of observations decreased substantially, since we use county level information and as a result, standard errors escalate.

We present 7-day mortality in the first three columns. Early neonatal mortality (7-day mortality) will capture health condition at birth. In the first column, the OLS result is shown. A $1,000 increase in real PCPI did not result in a statistically significant change in mortality. In the second column, the first stage result is shown, and it is statistically significant. In the last column, the TSLS result is shown. The sign of the coefficient in the TSLS is counter intuitive but it is not statistically significant.

In the following three columns we report neonatal mortality. Mean of dependent variable is 15 per 1,000 live births and this is slight increases compared to 7-day mortality. Unfortunately, the sign of the coefficient in the OLS and TSLS are all counter-intuitive but it is not statistically significant. TSLS estimate decreased some in magnitude compared to 7-day mortality.

In the last three columns we present infant mortality and the sign of the coefficient is negative as we expected. A $1,000 increases of income would lower the infant mortality by 1 out of 21 sample mean. However, infant mortality results are imprecisely estimated.

Ⅴ. Conclusion

In this paper we have examined whether an aggregate income shock induces improvement in newborn health, as indicated by birth weight, low birth weight, and mortality. We study the exogenous income shock of the coal price increase in the 1970s, which created a natural experimental setting that allowed us to isolate pure income effects. The substitution effect is minimized, since females did not work in the mining industry at that time. We also use short time frames, so that composition change is not a crucial issue. This exercise has an important implication from a policy evaluation perspective. Estimated effects of cash transfer programs in most existing studies may suffer from a bias caused by the sorting process. Accordingly, studies may fail to accurately capture the pure income effects. The proposed analysis, which is predicated on a natural experimental setting to isolate pure income effects, allows us to avoid the sorting process and draw less biased-hence, more accurate-conclusions.

We found that birth weight increased by 5.5 grams when the real per capita personal income increased by $1,000 (in 2015 dollars) but it is not statistically significant. In addition, low birth weight decreased by 0.1%p with exogenous $1,000 income shock, but this is not precisely estimated and small in magnitude. Our finding deviates from previous literature finding positive effects of income. Chung et al. (2016) found a 17.7 gram increase in birth weight per additional $1,000 in their study in Alaska. Currie and Cole (1993) found 32 grams increase in birth weight when people received benefits from the Aid to Families with Dependent Children (AFDC) program. Almond et al. (2011) estimated the impact of food stamps on birth weight. They found 2.2 grams improvement, but when they calculated treatment on the treated, it was 15-42 grams. They also found that the number of low birth weight babies decreased by 5-12%, using data from 1968 and 1977.

These differences might be due to the relevant population. Mining has historically been a physically demanding occupation (Stewart et al., 2008). Therefore, our population, mostly miners, are physically healthier people even though they might be exposed to serious injury or unhealthy environment during their work. Our results use unique exogenous income shock to identify pure income effect. However, the results might not be generalizable to general population if physically healthy people sort into mining industry.

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◈ *References* ◈

Almond, D., K. Y. Chay, and D. S. Lee (2005), "The Costs of Low Birth Weight," *The Quarterly Journal of Economics*, 120(3), 1031-1083.

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

Amarante, V., M. Manacorda, E. Miguel, and A. Virorito (2011), "Do Cash Transfers Improve Birth Outcomes?" *NBER Working Paper Series*, 17690.

Backlund E., P. D. Sorlie, and N. J. Johnson (1999), "A Comparison of the Relationships of Education and Income With Mortality: The National Longitudinal Mortality Study," *Social Science & Medicine*, 49(10), 1373-1384.

Barber, S. L., and P. J. Gertler (2009), "Empowering Women to Obtain High Quality Care: Evidence from an Evaluation of Mexico's Conditional Cash Transfer Programme," *Health Policy Planning*, 24(1), 18-25.

Black, D., K. Daniel, and S. Sanders (2002), "The Impact of Economic Conditions on Participation in Disability Programs: Evidence from the Coal Boom and Bust," *The American Economic Review*, 92(1), 27-50.

Black, D., T. McKinnish, and S. Sanders (2005), "The Economic Impact of the Coal Boom and Bust," *The Economic Journal*, 115(503), 449-476.

CDC MMWR (2013), http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6231a3.htm

Chung, W., H. Ha, and B. Kim (2016), "Money Transfer and Birth Weight: Evidence from the Alaska Permanent Fund Dividend," *Economic Inquiry*, 54(1), 576-590.

Corman, H., T. J. Joyce, and M. Grossman (1987), "Birth Outcome Production Functions in the U. S.," *Journal of Human Resources*, 22, 339-360.

Currie, J., and N. Cole (1993), "Welfare and Child Health: The Link between AFDC Participation and Birth Weight," *The American Economic Review*, 83(4), 971-985.

Dehejia, R., and A. Lleras-Muney (2004), "Booms, Busts, and Babies' Health," *The Quarterly Journal of Economics*, 119(3), 1091-1130.

Gertler, P. (2004), "Do Conditional Cash Transfers Improve Child Health? Evidence from PROGRESA's Control Randomized Experiment," *American Economic Review*, 94(2), 336-341.

Hoynes, H., D. Miller, and D. Simon (2015), "Income, the Earned Income Tax Credit, and Infant Health," *American Economic Journal: Economic Policy*, 7(1), 17215, n

Kaiser Family Foundation, http://kff.org/other/state-indicator/population-up-to-200-fpl/?currentTimeframe=0&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D

Kitigawa, E., and P. Hauser, (1973), *Differential Mortality in the United States*, Cambridge, MA: Harvard University Press.

McCormick, M. C., J. Brooks-Gunn, K. Workman-Daniels, J. Turner, and G. J. Peckham (1992), "The Health and Developmental Status of Very Low-Birth Weight Children at School Age," *Journal of the American Medical Association*, 267(16), 2204?2208.

Miller, G., and B. P. Urdinola (2010), "Cyclicality, Mortality, and the Value of Time: The Case of Coffee Price Fluctuations and Child Survival in Colombia," *Journal of Political Economy*, 118(1), 113-155.

Powell-Jackson, T., and K. Hanson (2012), "Financial Incentives for Maternal Health: Impact of a National Program in Nepal," *Journal of Health Economics*, 31(1), 271-284.

Richards, M., R. Hardy, D. Kuh, and M. E. Wadsworth (2001), "Birth Weight and Cognitive Function in the British 1946 Birth Cohort: Longitudinal Population Based Study," *British Medical Journal*, 322(7280), 199-203.

Rosenzweig, M. R., and T. P. Schultz (1983), "Estimating a Household

Production Function: Heterogeneity and the Demand for Health Inputs, and Their Effects on Birth Weight," *Journal of Political Economy*, 91(5), 723-746.

Rosenzweig, M. R., and K. I. Wolpin, (1995), "Sisters, Siblings, and Mothers: The Effects of Teen-Age Childbearing on Birth Outcomes," *Econometrica*, 303-326.

Ruhm, C. J. (2000), "Are Recessions Good for Your Health?" *The Quarterly Journal of Economics*, 115(2), 617-650.

Shei, A. (2013), "Brazil's Conditional Cash Transfer Program Associated with Declines in Infant Mortality Rates," *Health Affairs*, 32(7), 1274-1281.

Smith, J. (2004), Unraveling the SES-Health Connection, Aging Health, and Public Policy: Demographic and Economic Perspectives, edited by Waites, L. New York: Population Council

Stewart, I. B., M. D. McDonald, A. P. Hunt, and T. W. Parker (2008), "Physical Capacity of Rescue Personnel in the Mining Industry," *Journal of Occupational Medicine and Toxicology*, 3(1), 22.

Strully, K. W., D. H. Rehkopf, and Z. Zuan (2010), "Effects of Prenatal Poverty on Infant Health: State Earned Income Tax Credits and Birth Weight," *American Sociological Review*, 75(4), 534-562.

USDA WIC, http://www.fns.usda.gov/wic/wic-funding-and-program-data

Wool, H. (1981), "Coal Industry Resurgence Attracts Variety of New Workers," *Monthly Labor Review*, 104(1), 3-8.

소득효과와 신생아 건강, 석탄 호황을 이용하여

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논문초록

본 연구는 소득이 건강에 미치는 영향을 추정한다. 저자들은 1970년대 석탄 가격의 가파른 증가에 따라 광산지역인 미국 Kentucky, Ohio 그리고 West Virginia주의 유아 몸무게와 사망률에 어떠한 영향이 있었는지를 분석했다. 내생적인 소득을 외생화 하기 위해 석탄매장량의 가치를 도구변수로 사용했다. 2015년 달러를 기준으로 소득이 외생적으로 $1,000 상승함에 따라 몸무게는 5.5그램 상승하였으나, 통계적으로 유의하지 않다. 소득이 외생적으로 $1,000 상승함에 따라 저체중아는 0.1%p 감소하였으나, 이 또한 통계적으로 유의하지 않다. 본 연구는 광부를 대상으로 이루어졌기 때문에, 결과의 전체인구에 대한 확장성은 제한적일 수 있다.

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