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REVISIT THE EFFECT OF THE PRENATAL MEDICAL CARE USE ON THE BIRTH OUTCOME OF NEWBORN BABY*

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Abstract

The ambiguity of the effect of prenatal medical care on the health status of newborns may originate from the fact that individual decision-making of purchasing care is not fully considered, and this in turn may cause an endogeneity issue in the estimation process. This paper aims to empirically examine the effect of prenatal medical care by controlling the endogeneity issue in estimation process. We employed the Two Step Least Square method using appropriate instrumental variables. The estimation results suggest prenatal medical care use has a positive effect on birth outcomes. Additionally, the results were strengthened by performing a robustness test

Keywords: birth outcome, prenatal medical care, endogeneity, instrumental variables
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I. *Introduction*

Prenatal medical care has been regarded as a principal means of reducing risk of pre-term births and low birth weight, alongside other adverse birth outcomes and pregnancy conditions. The major components of prenatal care are dietary counseling, smoking cessation, drug avoidance and the timely treatment of complications during the birth process (Alexander and Korenbrot 1995). The provision of prenatal medical care may decrease the probability of low birth weight (Rosenzweig and Shultz 1983; Frank et al 1991). Nevertheless, the effect of prenatal care on birth outcomes is a controversial issue in the obstetrics and gynecology literature. The influence of prenatal care differs by the woman involved and her individual characteristics, which means that results differ depending on the sample used (e.g., Handler et al 1996; Williamson et al 1996; Mikhail 1999; Novick 2009).

In terms of the issue of evaluating the effect of prenatal medical care on newborn health status, there is also a lack of consensus. Specifically, the maternal decision to consume prenatal medical care has been given as exogenous (Frank et al 1992). However, since there may be several determinants that have not been observed by researchers, this decision process should, in fact, be regarded as endogenous. More specifically, the mother's health and socio-demographic characteristics may affect her decisions on prenatal medical care service use. For example, even though a pregnant woman may initially not have the intent to use prenatal services, a family member or neighbor's recommendation might induce her to do so. Alternatively, even if a woman wishes to use such services, a problem with access to medical institutions due to an inadequate number of local hospitals might work as a barrier.

Therefore, it is natural to regard the demand for prenatal care as self-selective process, which suggests that, without controlling unobserved individual's heterogeneity that might affect the decision to purchase prenatal medical care services and, in turn, influence infant health status, the estimation results for the effect of prenatal medical care on birth outcomes might be biased. This issue may provide an explanation for the insignificant effect of prenatal care on infant health status that has been found in previous works (Grossman and Joyce 1990; Kaestner and Waidmann 1999).

Based on this reasoning, the core methodological issue in evaluating the effect of prenatal medical care on the health status of newborns is how to control for the endogeneity caused by the pregnant woman's self-selection process in purchasing it. Several previous works have tried to control this endogeneity issue by using the instrumental variable approach (Warner 1995; Liu 1998). These studies, however, have not mentioned the appropriateness of the instrumental variables used such as the relevance to the endogenized variable and the exogeneity to the error term.

In light of this endogeneity problem, this study seeks to find appropriate instrumental variables that can resolve it, and suggests variables representing features of community in which the individual pregnant woman lives as appropriate candidates. Specifically, in this study, the percentage of insurance holders in the total population of the local community and accessibility to medical institutions measured as the number of medical institutions per unit of population, are considered as the instrumental variables. The rationale of using these variables will be discussed and their appropriateness will also be tested.

Additionally, as mentioned earlier, previous works on the effectiveness of prenatal services have performed an empirical analysis based only on certain target population of certain limited area, so it will be problematic to generalize the result to whole population. For example, Warner (1995) introduces estimation results for black mothers, Grossman and Joyce (1990) use data from the vital statistics for only one area, New York City, and for only one year, 1984, and Liu (1998) uses data from Virginia in 1984, drawn from a sample with an age of only 20 and above. Similarly, Rous and Jewell et al (2004) examine the issue using data from Texas. This paper is, however, considerably less vulnerable to this sampling issue because we use a nationally represented dataset sourced from *The Vital Statistics Birth Cohort Linked Birth/Infant Death Data*, published by the National Center for Health Statistics (NCHS).

In brief, this paper aims to investigate the causal relationship between prenatal medical care use and the health status of newborns, and in this process we control for the endogeneity issues caused due to pregnant women's self-selective process by using appropriate instrumental variables. We also address the sampling problem by using national birth data. Furthermore, in this paper, the robustness of our estimation results might be tested by performing several checks. The paper is organized as follows. Section II provides empirical analysis by introducing data and variables, and the estimation model. Section III presents the estimation results, in Section IV the robustness checks are discussed, and section V concludes the paper.

II. *Empirical Analysis*

1. Data and Variables

As stated, our primary data source is The Vital Statistics Birth Cohort Linked Birth/Infant Death data from 1995 to 2002 published by the National Center for Health Statistics (NCHS). This is a nationally representative survey that details the approximately four million live births a year that occur in the United States. For instance, live births in 1995 numbered 3,554,152. Data consist of information on the number of prenatal care visits and birth outcomes such as birth weight and Apgar score[1]. It also provides demographic information about the mother's age, race, education, marital status, pregnancy condition, and newborn conditions.

In this study, the whole data from the NCHS is so extensive that only 1% of the sample has been used. The method of extracting this 1% of whole data is denoted as Simple Random Sampling (SRS), in which units are selected with equal probability and without replacement. Within this process, we tried to make the descriptive statistics of the sample become equal to those of the whole population. So, the number of samples used in this study was 206,719 while the total number was 20, 673, 859. The resemblance of the 1% sample data is verified by comparing Table 1 which introduces the descriptive statistics for the whole data, with Table 1-1 which shows that of the 1% sampled data.

Regarding the descriptive statistics of the variables used in this study, for birth outcomes, we use two variables: birth weight and Apgar score. Birth weight is represented by gram unit and is a continuous variable whose mean is 3,339g. For Apgar score, the average is 8.95 and a higher score indicates a better health status. We adopt the number of prenatal care visits as the

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[1] The Apgar score is a useful measure of infant condition which is based on heart rate, respiratory effort, color, reflex irritability and muscle tone. It evaluates infant condition after 1 and 5 minutes.

TABLE 1. DESCRIPTIVE STATISTICS

	N	Mean	Standard Deviation	Min	Max
Outcomes					
Birth Weight (gram)	20,673,859	3,339	529	1,276	4,593
Five minutes APGAR	18,682,193	8.96	0.61	0	10
Prenatal Medical Care					
Number of Prenatal Care Visits	20,673,859	11.57	3.48	0	22
Demographic variables					
Male	20,673,859	0.51	0.50	0	1
Age of the Mother	20,673,859	27.52	5.78	18	54
Race of Mother					
White	20,673,859	0.80	0.40	0	1
Black	20,673,859	0.15	0.36	0	1
American Indian	20,673,859	0.01	0.10	0	1
Other	20,673,859	0.04	0.19	0	1
Hispanic of Mother	20,673,859	0.14	0.34	0	1
Education of Mother					
≤Middle School	20,673,859	0.04	0.19	0	1
High School Drop Out	20,673,859	0.12	0.33	0	1
High School Graduates	20,673,859	0.34	0.47	0	1
Some College	20,673,859	0.24	0.43	0	1
College graduates and Over	20,673,859	0.26	0.44	0	1
Married	20,673,859	0.71	0.45	0	1
Pregnancy conditions					
Gestation	20,673,859	38.95	2.22	17	47
Weight Gain (kg)	20,673,859	13.73	5.63	0	31
Live-birth order	20,673,859	2.06	1.20	1	24
Tobacco use during pregnancy	20,673,859	0.12	0.32	0	1
Alcohol use during pregnancy	20,673,859	0.01	0.09	0	1
Newborn conditions					
Plural	20,673,859	0.03	0.16	0	1
Method of Delivery Recode					
Vaginal (excludes Vaginal after previous C-section)	20,673,859	0.75	0.43	0	1
Vaginal birth after previous C-section	20,673,859	0.03	0.16	0	1
Primary C-section	20,673,859	0.13	0.34	0	1
Repeat C-Section	20,673,859	0.09	0.28	0	1
Medical Risk Factors Reported Flag	20,673,859	0.29	0.45	0	1
Newborn Flag	20,673,859	0.07	0.26	0	1
Congenital Flag	20,673,859	0.01	0.12	0	1
Regionalism variables					
Percent Insured	20,673,859	0.86	0.04	0.67	0.94
Number of Hospitals	20,673,859	52.52	51.37	1	213
Critical Access Hospitals	20,673,859	12.42	17.00	0	72
Acute Care Hospitals	20,673,859	40.10	40.98	1	178

Note: Medical Risk Factors Reported Flag: Anemia (Hct.<30/Hgb.<10), Cardiac disease, Acute or chronic lung disease, Diabetes, Genital herpes, Hydramnios/Oligohydramnios, Hemoglobinopathy, Hypertension-chronic, Hypertension-pregnancy-associated, Eclampsia, Incompetent cervix, Previous infant 4000+ grams, Previous preterm or small-for-gestational-age infant, Renal disease, Rh sensitization, Uterine bleeding, Other Medical Risk Factors

Newborn Flag: Anemia Hct.>39/Hgb.<13), Birth injury, Fetal alcohol syndrome, Hyaline membrane disease, Meconium aspiration syndrome, Assisted ventilation-less than 30 minutes, Assisted ventilation-30 minutes or more, Seizures, Other Abnormal Conditions of the Newborn

Congenital Flag: Anencephalus, Spina bifida/Meningocele, Hydrocephalus, Microcephalus, Other central nervous system anomalies, Heart malformations, Other circulatory/respiratory anomalies, Rectal atresia/stenosis, Tracheo-esophageal fistula/Esophageal atresia, Omphalocele/Gastroschisis, Other gastrointestinal anomalies, Malformed genitalia, Renal agenesis, Other urogenital anomalies, Cleft lip/palate, Polydactyly/Syndactyly/Adactyly, Club foot, Diaphragmatic hernia, Other musculoskeletal/integumental anomalies, Down's syndrome, Other chromosomal anomalies, Other congenital anomalies

Table 1-1. Descriptive Statistics (1% Sample by Year)

	N	Mean	Standard Deviation	Min	Max
Outcomes					
Birth Weight (gram)	206,719	3,339	529	1,276	4,593
Five minutes APGAR	186,928	8.95	0.61	0	10
Prenatal Medical Care					
Number of Prenatal Care Visits	206,719	11.58	3.46	0	22
Demographic variables					
Male	206,719	0.51	0.50	0	1
Age of the Mother	206,719	27.53	5.78	18	52
Race of Mother					
White	206,719	0.80	0.40	0	1
Black	206,719	0.15	0.36	0	1
American Indian	206,719	0.01	0.10	0	1
Other	206,719	0.04	0.19	0	1
Hispanic of Mother	206,719	0.13	0.34	0	1
Education of Mother					
≤Middle School	206,719	0.04	0.19	0	1
High School Drop Out	206,719	0.12	0.33	0	1
High School Graduates	206,719	0.34	0.47	0	1
Some College	206,719	0.24	0.42	0	1
College graduates and Over	206,719	0.26	0.44	0	1
Married	206,719	0.71	0.45	0	1
Pregnancy conditions					
Gestation	206,719	38.95	2.23	19	47
Weight Gain (kg)	206,719	13.74	5.62	0	31
Live-birth order	206,719	2.06	1.20	1	18
Tobacco use during pregnancy	206,719	0.12	0.32	0	1
Alcohol use during pregnancy	206,719	0.01	0.09	0	1
Newborn conditions					
Plural	206,719	0.03	0.16	0	1
Method of Delivery Recode					
Vaginal (excludes Vaginal after previous C-section)	206,719	0.75	0.43	0	1
Vaginal birth after previous C-section	206,719	0.03	0.16	0	1
Primary C-section	206,719	0.13	0.34	0	1
Repeat C-Section	206,719	0.09	0.28	0	1
Medical Risk Factors Reported Flag	206,719	0.29	0.45	0	1
Newborn Flag	206,719	0.07	0.26	0	1
Congenital Flag	206,719	0.01	0.12	0	1
Regionalism variables					
Percent Insured	206,719	0.86	0.04	0.67	0.94
Number of Hospitals	206,719	52.41	51.19	1	213
Critical Access Hospitals	206,719	12.36	16.96	0	72
Acute Care Hospitals	206,719	40.05	40.84	1	178

Note: See Table 1

measure of prenatal medical care use. The range for this was from 0 to 22, with a mean of 11.58.

Concerning the mother's socio-demographic characteristics, the average age of mothers was 27.53 and white women accounted for approximately 80% of the sample, Black 15%, American

Indian 1% and others race 4%. Education level was classified as under middle school, high school drop-out, high school graduate, some college and college graduate and over. These accounted for 4%, 12%, 34%, 24% and 26% of the sample, respectively. The portion of unmarried mothers was about 29%.

Concerning the pregnancy condition during gestation, weight gain (kg) during pregnancy, live-birth order and tobacco and alcohol use are used. The average week period of gestation is 38.95. The average weight gain during pregnancy was 13.74kg. The live-birth order refers to the total number of previous children the mother has had, with an average of 2.06. Lastly, the percent of tobacco use during pregnancy was 12% and alcohol use during pregnancy was 1%.

Additionally, to capture newborn condition, we use plural births and method of delivery. Plural births indicate babies born in twins or triplets, and etc. Among this group, twins represent around 3% of the sample. For delivery method, the vaginal birth[2], vaginal birth after previous C-section, primary C-section and repeat C-section accounted account for 75%, 3%, 13% and 9% respectively.

To measure mothers' health risk factors, a set of medical risk factors[3] are used in this study. These have major influence on pregnancy complications and infant survival, and contain 17 factors that are risky to maternal state, whose value is 1 if mother has at least one of these factors and 0 otherwise. 29% of the sample had at least one of these risk factors. Controlling for the intrinsic medical risk factors related to the newborn, we use what we term Newborn flag[4] and Congenital flag[5]. The former represents certain medical risk factors that an infant may have. There are nine risk factors, whose value is coded 1 if a baby has at least one of these risk factors and 0 otherwise. Babies with these risk factors were at 7%. Congenital Flag represents certain innate risks in newborns, including the major causes of neonatal deaths, physical defects and metabolic diseases. This group contains 22 factors and is also coded so that it is 1 if a baby is born at least one of these innate risks and 0 if not. This group accounted for approximately 1%.

Concerning the instrumental variables (IVs) used in this paper, the percentage of insured out of the total population at county level is obtained from the US Census Bureau's Small Area Health Insurance Estimates (SAHIE). Moreover, another instrumental variable, the number of medical institutions per unit population at county level, was obtained from the American Hospital Association (AHA). Both of them represent community features where individual lives. The percentage of insured out of the total population at county level was 86%, with a

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[2] In the case of vaginal birth, the one after experiencing previous C-section is excluded.

[3] These comprise Anemia, Cardiac disease, Acute or chronic lung disease, diabetes, Genital herpes, Hydramnios/Oligohy dramnios, Hemoglobinopathy, Hypertension-chronic, Hypertension-pregnancy-associated, Eclampsia, Incompetent cervix, Previous infant of 4000+grams, Previous preterm or small-for-gestational-age infant, Renal disease, Rh sensitization, Uterine bleeding, Other Medical Risk Factors

[4] Newborn Flag: Anemia, Birth injury, Fetal alcohol syndrome, Hyaline membrane disease, Meconium, aspiration syndrome, Assisted ventilation-less than 30 minutes, Assisted ventilation-30 minutes or more, Seizures and Other Abnormal Newborn Condition.

[5] Congenital Flag: Anencephalus, Spina bifida/Meningocele, Hydrocephalus, Microcephalus, Other central nervous system anomalies, Heart malformations, Other circulatory/respiratory anomalies, Rectal atresia/stenosis, Tracheo-esophageal fistula/Esophageal atresia, Omphalocele/Gastroschis, Other gastrointestinal anomalies, Malformed genitalia, Renal agenesis, Other urogenital anomalies, Cleft lip/palate, Polydactyly/Syndactyly/Adactyly, Club foot, Diaphragmatic hermia, Other musculoskeletal/integumental anomalies, Down's syndrome, Other chromosomal anomalies and Other congenital anomalies

range between 67% and 94%, and the average number of hospitals by county was 52.41, with a range from 1 to 213. When calculating average number of hospitals by county, we additionally use those of critical access hospitals and acute care hospitals. A Critical Access Hospital (CAH) is a hospital certified under a set of Medicare Conditions of Participation, which are structured differently than the acute care hospital. Some of the requirements for CAH certification include having no more than 25 inpatient beds; maintaining an annual average length of stay of no more than 96 hours for acute inpatient care; offering 24-hour, 7-day-a-week emergency care; and being located in a rural area, at least 35 miles drive away from any other hospital or CAH. The reason of using information on CAH is for considering the regional characteristics of the rural area.

2. Estimation Model

The following Equation (1) is utilized for estimating the effect of prenatal medical care use on birth outcome:

$$Birth\ Outcome_{ijt} = \alpha_1\, PNC_{2ijt} + \alpha_2\, PNC^2_{2\mathrm{ijt}} + \alpha_3\, X_{ijt} + \alpha_4\, M_{ijt} + \alpha_5\, N_{ijt} + u_{ijt} \tag{1}$$

where $Birth\ Outcome_{ijt}$ is the birth outcome of new born baby i who is born in j region at t year, PNC_2 represents the total number of doctor-visits for prenatal medical care services during pregnancy, X is a vector of the individual socio-demographic characteristics, M is a vector of pregnancy condition, N is a vector of newborn condition, and u is an error term assumed to follow a white-noise process.

For birth outcome, this study uses the two variables of birth weight and Apgar score, and the use of prenatal care is represented by total number of doctor-visits during pregnancy. We also use the square term of the total number of doctor-visits. As shown in Fig. 1, the relationship between prenatal care use represented at the horizontal axis and the birth weight represented at the vertical axis, is not shown to have linear relationship but is shown to be reverse U-shaped, hence a square term of it is additionally inserted for capturing non-linear pattern. Furthermore, the reverse U-shape curve suggests that use beyond some point might cause the health status of newborn to be aggravated, which might be contradicted with main theme of this paper. This awkward phenomenon might be, however, interpreted by the reverse causality between them. More specifically, the poor health status of fetus might increase the demand for prenatal medical care and this demand should be categorized to be curative one which is far from preventive intent of purchasing it. Hence, the reason for using a square term of it is thus to discern the object of utilizing prenatal care, and in this paper, we performed the auxiliary estimation only using poor health status of newborn for confirming the reverse U-shaped curve between them.

In the estimation process, while the control of the endogeneity issue of individual self-selective process of consuming prenatal medical care might play a significant role in obtaining a robust estimation result, there will also be another estimation issue related to sample-selection bias. The sample-selection problem might be caused by including only those respondents who answered they have utilized prenatal care at least once. In the data, out of the total 20,673,859 observations, there were 150,922 who had never used any prenatal services. If estimation was performed using only a sample that is prone to use prenatal care and the criterion for selecting the sample is arbitrarily made by researcher him/herself, the estimation results might suffer from sample-selection bias.

We thus use Heckman's sample-selection model not only for confirming the existence of the sample selection problem but also for obtaining more efficient results. Before applying this model, as a basic step we check whether there are significant differences between prenatal care service users and non-users. With this process, two sample t-tests are progressed by each variable of two groups. If the test of homoscedasticity of variables is satisfied, a pooled method is carried out and if not, the Satterthwaite method is performed for executing the t-test. Excluding the plural variable, the results for the other mother's socio-demographic variables and medical risk factors showed significant difference. Specifically, the group of non-users of prenatal care was on average two years younger than their counterparts and the portion of under high school graduates was much higher at 80%, compared to 50% in the user group. As such, it is natural to infer that the estimation results might be biased if including only information pertaining to the user group of prenatal medical care services.

Therefore, as an estimation specification for solving this sample-selection problem, Heckman's sample-selection model was used, in which the sample-selection bias is controlled by inserting an estimated inverse Mills ratio into the conditional demand equation (Heckman 1976; Grossman and Joyce 1990; Liu 1998). According to Heckman's sample-selection model, if the hypothesis that the coefficient of estimated inverse Mills ratio is zero, could be rejected, we might conclude the sample-selection bias should be extant. Hence, if we reject the hypothesis, the estimation result from applying Heckman's model will be regarded as robust. This model is specified as Equations (2) and (3) below:

$$PNC_{1ijt} = \beta_1 X_{ijt} + \varepsilon_{1ijt} \tag{2}$$

$$PNC_{2ijt} = \beta_2 X_{ijt} + \delta_2 Z_{jt} + \rho\lambda + \varepsilon_{2ijt} \tag{3}$$

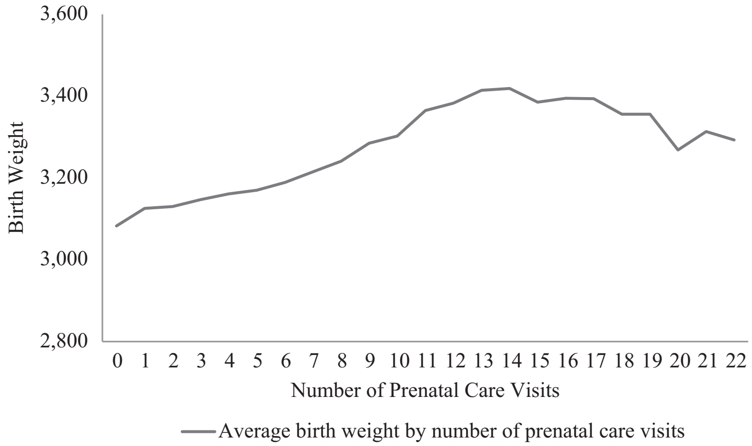
where PNC_1 is the indicator representing whether prenatal care is used, at 1 if the mother has at least one visit and 0 otherwise, PNC_2 represents the conditional demand for prenatal care use based on the assumption that at least one time of visit for prenatal care use has been done, Z is a vector of the instrumental variables, λ is an estimated inverse Mills ratio, and ε_1, ε_2 are error terms assumed to follow a white-noise process.

3. Endogeneity Issue of Individual Decision on Prenatal Medical Care Use

Regarding the endogeneity problem originated from the self-selective properties of prenatal medical care use, as mentioned before, we apply Two Step Least Square method (TSLS) based on using the instrumental variable (IV) specification. As the IVs, we use the percentage of insured out of the total population at county level and the number of medical institutions classified as critical access hospitals and acute care hospitals, per unit population at county level. Warner (1995) applies similar method for controlling endogeneity by utilizing individual's whether to have health insurance as IV. It is, however, not regarded as appropriate IV because the decision on purchasing health insurance might also be affected by unobserved individual idiosyncratic characteristics. Hence it is natural to infer that using this variable might cause another endogeneity issue.

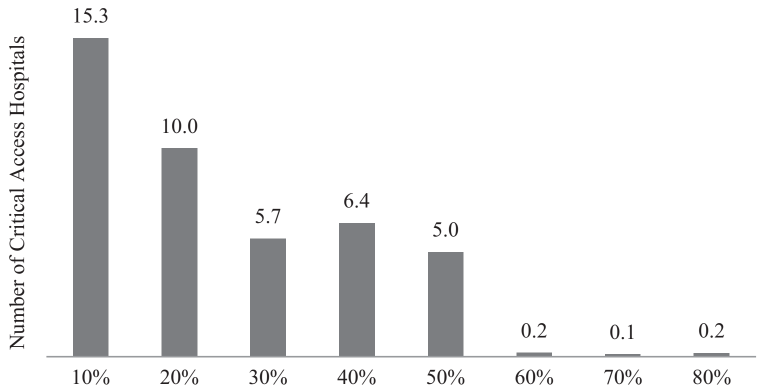
Therefore, we utilize the variables representing the properties of region where individual lives as alternative IVs, such as (i) the percentage of insured out of the total population at

FIGURE 1. AVERAGE OF NUMBER OF PRENATAL CARE VISITS



Source: National Center for Health Statistics

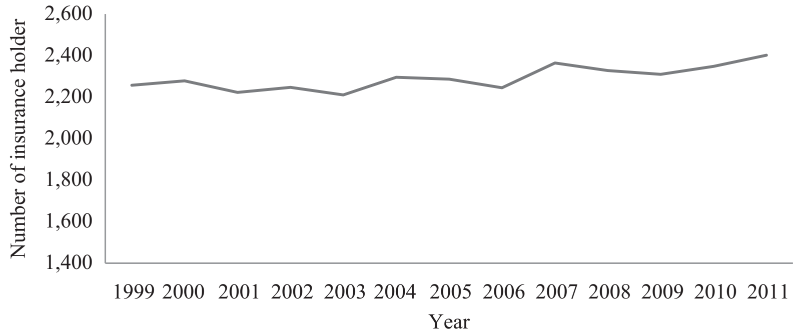
FIGURE 2. NUMBER OF CRITICAL ACCESS HOSPITALS BY BLACK RATE



Source: American Hospital Association

county level and (ii) the number of medical institutions per unit population at county level. Intuitively, the percentage of insured out of the total population indicates the economic status of the specific region involved, which may influence individual decisions on purchasing prenatal medical care services. Furthermore, the number of hospitals per unit population in a specific area indicates how easily an individual can have access to medical services; hence this regional feature might also affect the individual use of prenatal care. For instance, as shown in Figure 2 below, the average number of critical access hospitals was about 0.1 to 0.2 in regions where the portion of African Americans is above 60%, whereas this value was about 10.0 to 15.3 in those regions where the portion was below 20%. Therefore, this figure shows that mothers who live

FIGURE 3. THE NUMBER OF HEALTH INSURANCE HOLDER IN THE STATE OF ARKANSAS



Note: numbers represent values in thousands

Source: The US Census of Bureau

in Afro-American condensed regions may experience the access problem of using prenatal care irrespective of their intentions.

However, it is unlikely that the individual unobserved characteristics which might affect baby's birth outcome would be correlated with these regional variables. As shown in Figure 3 in which the number of health insurance holders for the state of Arkansas per each year is depicted. The number of health insurance holders was 2,257 thousand in 1999 and was 2,401 thousand in 2011, which suggests that there were not dramatic changes through this period, and also suggests that the values of the regional variables might be little influenced by individual characteristics (Norton 1994). So based on this example and reasoning, regional variables may be used as instrumental variables for identifying the effect of prenatal care use on baby's birth outcomes.

More specifically, the predicted value of conditional prenatal medical care services obtained by estimating equation (3) is used as regressor instead of its own real value, in equation (1). In this process, the exogeneity of it might be quarantined by utilizing IVs in estimation process of equation (3). The existence of endogeneity of it has been tested by utilizing Hausman's specification test which the predicted residual of equation (3) is used as new regressor of equation (1) and the statistical significance of it will play a role in recognizing its endogeneity.

III. *Estimation Results*

First of all, to confirm the existence of endogeneity in the individual use of prenatal medical service, we perform the Hausman test and the null hypothesis of the error terms being independent each other was rejected, so we could conclude that the individual self-selective process of consuming prenatal medical care might cause the endogeneity problem. Therefore, the application of the Instrumental Variable based on the Two Step Least Square method is justified as the estimation specification producing robust results[6]. Hence, in the first step, the determinants of individual use of prenatal care are estimated, and in this process as mentioned earlier, the Heckman's sample selection model is applied for confirming sample-selection problem. The sample size of estimating equation (2) and (3) is different because the cases of non-user of prenatal services are excluded in estimating equation (3).

The first step estimation results are shown at Table 2. Concerning the sample-selection issue, the estimation result suggests there may be a sample-selection bias because an inverse Mills ratio is found to have a statistically significant effect on prenatal care use. Hence, the inverse Mills ratio of -0.115 is interpreted that the estimation results of equation (3) might be overestimated if we fail to consider the sample selection issue.

Regarding the socio-demographic variables, mother's age is shown to have statistically significant positive effect not only on the probability of prenatal care use but also on the conditional demand for prenatal care base. As the mother's age increases, the birth outcome of her baby would be relatively poor compared with younger mother, hence it is natural to assume that the elder a mother, the greater is her interest in using prenatal medical care. Additionally, mother's education level is shown to have significant positive effect, which indicates that the higher level of human capital represented by education level might induce her to invest to a greater extent on her health status. In this context, a mother who is less interested in promoting her health status would be expected to use prenatal medical care services to a lesser extent, which might explain the negative effect of smoking or drinking behaviors on prenatal medical care.

Concerning the endogeneity issue, as mentioned before, we applied an Instrumental Variable (IV) specification. In this paper, we perform a couple of tests to check the appropriateness of this approach, including the F-test for relevance and the Sargan test for exogeneity whose results are shown at Table 2. First, we compute F-test statistics whose value is 4.92, which allows us to reject the null hypothesis that the IVs do not have statistical relevance with prenatal medical care use. Additionally, we use the Sargan test to verify the exogeneity of the IVs. The test result was 1.34 with a p-value of 0.262, which suggests that we could not reject the null hypothesis that IVs do not have correlation with error term of equation (1). Therefore we reach the conclusion that the variables used as IV in this study such as the percentage of insured out of total population and a number of critical hospitals per unit population are appropriate enough for us to apply 2SLS.

Regarding the second step process in which the effects of prenatal medical care use on birth outcomes are estimated, the estimation results of 2SLS are introduced in Table 3. We perform a stepwise estimation process in which the independent variables are sequentially

[6] As shown at equation (1), the model specification is expressed to be nonlinear one with endogenous explanatory variables. In the standard case where endogenous explanatory variables appear linearly, the CF approach leads to the usual 2SLS estimator. But there are differences for models nonlinear in endogenous variables and certain nonlinear models with endogenous explanatory variables are most easily estimated using the Control Function (CF) method (Wooldridge & Imbens., 2007) in which the predicted residual of the first step regression expressed by equation (3) is inserted as control function of equation (1) in order to control the endogeneity problem originated from unobserved individual characteristics. The control function (CF) approach relies on the same kinds of identification conditions with either two stage least squares (2SLS) or generalized method of moments (GMM). Hence, in this paper, not only 2SLS method but CF method is applied for confirming estimation results drawn from 2SLS. The estimation results of the CF method are significantly similar with those of the 2SLS especially with the effect of prenatal medical care use on health status of newborn baby. Therefore, even with the nonlinear models with endogenous explanatory variables, the 2SLS method might be regarded as an appropriate one. The estimation results of applying the CF method are available upon request.

TABLE 2. HECKMAN'S SAMPLE SELECTION MODEL

	Probability of Prenatal Medical Care Demand	Conditional Prenatal Medical Care Visit
Demographic variables		
Age of the Mother	0.011***	0.035***
	(0.002)	(0.002)
Race of Mother		
White (Reference)		
Black	-0.216***	-0.395***
	(0.027)	(0.024)
American Indian	0.064	-0.960***
	(0.100)	(0.085)
Other	-0.149**	-0.881***
	(0.062)	(0.038)
Hispanic of Mother	-0.107***	-0.617***
	(0.031)	(0.025)
Education of Mother		
≤Middle School (Reference)		
High School Drop Out	0.114***	0.578***
	(0.041)	(0.049)
High School Graduates	0.241***	1.024***
	(0.040)	(0.046)
Some College	0.422***	1.256***
	(0.047)	(0.047)
College graduates and Over	0.472***	1.229***
	(0.055)	(0.048)
Married	0.326***	0.550***
	(0.024)	(0.020)
Pregnancy conditions		
Liveorder	-0.138***	-0.333***
	(0.008)	(0.007)
Tobacco use during pregnancy	-0.192***	-0.152***
	(0.027)	(0.026)
Alcohol use during pregnancy	-0.532***	-0.743***
	(0.065)	(0.089)
Regionalism variables		
Percent Insured		2.338***
		(0.289)
Number of Critical Access Hospitals Rate		0.005**
		(0.002)
Heckman's mills ratio		
Heckman's lambda		-0.111***
		(0.014)
Observations	206,719	205,209
Sargan Test	1.34 (p=0.262)	
F-Test	4.92 (p=0.027)	

Note: Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Year and State dummy variables are included in Model Specifications.

included, so that Models (1) through (4) are differentiated by the process. Model (1) is basic specification in which only prenatal medical care use is utilized as explanatory variable. In

Model (2), the socio-demographic variables are added to Model (1), and in Model (3) the pregnancy conditions are further added. Model (4) represents the full specification that also includes newborn conditions. Furthermore, in order to compare the estimation results of 2SLS with OLS, Model (4*), which applies OLS, is also introduced in Table 3.

Prenatal care use is shown to have a statistically significant positive effect on birth weight in all models, which suggests that greater use of prenatal care service should enhance the health status of newborn baby measured as birth weight. Likewise the square term is shown to have a statistically significant negative effect on birth weight in all models, which might produce reverse U-shaped curve shown at Figure 1 and be interpreted that the positive effect of prenatal care use is shown to decrease as a mother uses services more frequently. Based on the estimation results drawn by Model (4), we calculated the peak point in which the health outcome represented by birth weight is maximized, and it was reached with 13.31 separate doctor-visits for prenatal care. Generally speaking, the optimal schedule of prenatal care use recommended by obstetricians is monthly visits to a health care professional up to six months, twice a month during the seventh and eighth month and weekly after 36 weeks until the pregnant woman delivers at weeks 38-40 (womenshealth. gov 2012). Hence the estimated peak point makes sense in this context.

The peak point calculated on the basis of the estimation results in Model (4*) by OLS is, however, 20.33, which might seem to be exceptionally higher than the normal range. So we can infer that the estimation results without considering individual decisions on prenatal care use might be biased. Specifically, under the OLS specification, the objects of using prenatal care, such as both the preventive goal for checking mother or baby's health status and the curative goal for having treatment of either mother or baby's health problems, are not clearly separated because individual self selective decision making process for purchasing prenatal medical care are not fully controlled. In other words, the larger number of peak point from OLS might be caused by the notion that a mother or baby's comparatively poor health status will induce her to more frequently use prenatal medical care services, which suggests that the revere causality might exist. Therefore, it will be reasonable to perform an auxiliary estimation in which the cases of mother or baby's health status being abnormally poor are excluded for allowing us to obtain more robust estimates as to the effect of prenatal care use on birth outcomes. This additional estimation will be introduced later.

Furthermore, as a specification check, we use the Apgar score as another variable representing birth outcomes, and the results are introduced in Table 4. While prenatal care use is also shown to exert a statistically significant positive effect on the Apgar score in all models, its square term also shows a positive effect, suggesting that the estimation results might be solid with different specification. Furthermore, the estimation results from Model (4) are somewhat different from those of Model (4*), which also indicates that controlling for the endogeneity should be carefully carried out in the estimation process.

TABLE 3. THE EFFECT OF PRENATAL MEDICAL CARE ON BIRTH OUTCOME (Birth Weight)

Birth Weight	Model (1)	Model (2)	Model (3)	Model (4)	Model (4*)
Prenatal Medical Care					
Number of Prenatal Care Visits	-156.610***	300.026***	507.748***	492.918***	15.979***
	(31.433)	(36.096)	(67.130)	(64.952)	(1.170)
Number of Prenatal Care Visits ^ 2	10.145***	-14.976***	-19.307***	-18.514***	-0.393***
	(1.384)	(1.587)	(1.382)	(1.329)	(0.050)
Demographic variables					
Male		109.599***	118.766***	117.030***	117.087***
		(2.269)	(2.003)	(1.936)	(1.934)
Age of the Mother		1.662***	0.070	-0.180	1.575***
		(0.241)	(2.078)	(2.014)	(0.223)
Race of Mother					
White (Reference)					
Black		-180.376***	-119.413***	-119.913***	-141.458***
		(4.041)	(23.422)	(22.704)	(3.200)
American Indian		16.899	124.378**	126.314**	50.911***
		(12.963)	(57.607)	(55.826)	(10.856)
Other		-210.304***	-104.119**	-109.331**	-158.162***
		(6.614)	(52.168)	(50.572)	(5.210)
Hispanic of Mother		-38.973***	11.704	6.224	-31.908***
		(4.307)	(36.588)	(35.468)	(3.406)
Education of Mother					
≤Middle School (Reference)					
High School Drop Out		-49.286***	-92.184***	-94.315***	-32.960***
		(7.346)	(34.661)	(33.591)	(5.910)
High School Graduates		19.921**	-97.253	-99.512*	-0.993
		(8.029)	(60.599)	(58.722)	(5.550)
Some College		67.434***	-84.592	-86.221	22.498***
		(8.644)	(74.203)	(71.906)	(5.757)
College graduates and Over		93.541***	-73.393	-68.528	33.816***
		(8.876)	(72.559)	(70.306)	(5.911)
Married		100.834***	10.361	7.366	43.014***
		(3.512)	(32.510)	(31.501)	(2.626)
Pregnancy conditions					
Gestation			100.499***	87.690***	86.187***
			(0.613)	(0.592)	(0.593)
Weight Gain (kg)			12.125***	14.231***	13.927***
			(0.189)	(0.181)	(0.181)
Liveorder			60.581***	67.376***	44.562***
			(19.608)	(19.008)	(0.992)
Tobacco use during pregnancy			-178.375***	-180.272***	-186.203***
			(9.497)	(9.203)	(3.331)
Alcohol use during pregnancy			24.113	24.801	-28.916**
			(45.081)	(43.697)	(11.272)
Newborn conditions					
Plural				-710.181***	-716.938***
				(6.095)	(6.109)
Method of Delivery Recode					
Vagina [Reference]					
Vaginal birth after previous C-section				-0.718	2.184
				(5.862)	(5.858)
Primary C-section				15.473***	11.146***
				(3.335)	(3.322)
Repeat C-Section				61.803***	62.896***
				(3.712)	(3.703)
Medical Risk Factors Reported Flag				-33.575***	-34.647***
				(2.273)	(2.275)
Newborn Flag				-74.312***	-72.145***
				(4.473)	(4.460)
Congenital Flag				-74.132***	-73.090***
				(9.316)	(9.287)
Observations	205,209	205,209	205,209	205,209	205,209
R-squared	0.019	0.050	0.262	0.310	0.312
Hausman's specification Test			-2.06 (p = 0.040)		

Note: See Table 2

TABLE 4. THE EFFECT OF PRENATAL MEDICAL CARE ON BIRTH OUTCOME (APGAR Score)

APGAR Score	Model (1)	Model (2)	Model (3)	Model (4)	Model (4*)
Prenatal Medical Care					
Number of Prenatal Care Visits	0.208***	0.322***	0.712***	0.600***	0.010***
	(0.039)	(0.046)	(0.095)	(0.093)	(0.002)
Number of Prenatal Care Visits ^ 2	-0.009***	-0.017***	-0.016***	-0.013***	-0.0004***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.00008)
Demographic variables					
Male		-0.018***	-0.015***	-0.010***	-0.010***
		(0.003)	(0.003)	(0.003)	(0.003)
Age of the Mother		0.0002	-0.013***	-0.012***	-0.001***
		(0.0003)	(0.003)	(0.003)	(0.000)
Race of Mother					
White (Reference)					
Black		-0.096***	0.074**	0.063*	-0.056***
		(0.005)	(0.033)	(0.032)	(0.005)
American Indian		-0.048***	0.339***	0.316***	0.012
		(0.017)	(0.081)	(0.079)	(0.016)
Other		-0.066***	0.293***	0.261***	-0.004
		(0.008)	(0.073)	(0.072)	(0.007)
Hispanic of Mother		-0.051***	0.200***	0.177***	-0.012**
		(0.006)	(0.052)	(0.051)	(0.005)
Education of Mother					
≤Middle School (Reference)					
High School Drop Out		-0.014	-0.242***	-0.219***	-0.024***
		(0.010)	(0.049)	(0.048)	(0.009)
High School Graduates		0.026**	-0.380***	-0.344***	-0.006
		(0.011)	(0.085)	(0.084)	(0.008)
Some College		0.040***	-0.459***	-0.417***	-0.010
		(0.012)	(0.105)	(0.103)	(0.009)
College graduates and Over		0.045***	-0.444***	-0.406***	-0.011
		(0.012)	(0.102)	(0.100)	(0.009)
Married		0.061***	-0.163***	-0.150***	0.020***
		(0.004)	(0.046)	(0.045)	(0.004)
Pregnancy conditions					
Gestation			0.027***	0.019***	0.019***
			(0.001)	(0.001)	(0.001)
Weight Gain (kg)			-0.0001	0.0004	0.0003
			(0.0003)	(0.0003)	(0.0003)
Liveorder			0.137***	0.121***	0.018***
			(0.028)	(0.027)	(0.001)
Tobacco use during pregnancy			0.067***	0.066***	0.022***
			(0.013)	(0.013)	(0.005)
Alcohol use during pregnancy			0.211***	0.198***	-0.035**
			(0.063)	(0.062)	(0.016)
Newborn conditions					
Plural				-0.085***	-0.082***
				(0.011)	(0.011)
Method of Delivery Recode					
Vagina [Reference]					
Vaginal birth after previous C-section				-0.032***	-0.030***
				(0.009)	(0.009)
Primary C-section				-0.080***	-0.082***
				(0.005)	(0.005)
Repeat C-Section				-0.004	-0.002
				(0.005)	(0.005)
Medical Risk Factors Reported Flag				-0.025***	-0.024***
				(0.003)	(0.003)
Newborn Flag				-0.399***	-0.399***
				(0.010)	(0.010)
Congenital Flag				-0.220***	-0.219***
				(0.023)	(0.023)
Observations	185,563	185,563	185,563	185,563	185,563
R-squared	0.010	0.014	0.023	0.060	0.059

Note: See Table 2

IV. *Robustness Check*

Accordingly, based on the estimation results shown in Tables 3 and 4, we can see that there may be statistically significant effects of prenatal care use on birth outcome. In this paper, in order to confirm the estimation results, a robustness check is performed by controlling of the mother and baby's idiosyncratic characteristics which might affect the decisions on purchasing prenatal care. As mentioned before, the failure of considering the individual characteristics which might influence the consumption of prenatal medical services might obscure the effect of prenatal care use on the baby's health outcome, which is shown at the estimation results from applying OLS method.

Considering this issue, we focus on the pregnancy and newborn conditions in which a mother or baby's heterogeneity might emerge. Given this, as mentioned earlier, we extract abnormal cases from the sample in terms of both mother and baby's health status. In previous literature, abnormal conditions of pregnancy have been classified as preterm and low birth weight: the baby's birth weight being lower than 2500 grams and the gestation period being shorter than 37 weeks have been applied in the extraction process (Conway and Deb, 2005).

We perform an identical estimation process using extracted abnormal samples which is composed of not only lower birth weight than 2500 grams but also shorter gestation period than 37 weeks. The estimation results for Heckman's sample selection model are introduced in Table 5 and those of 2SLS in Table 6. Firstly, while the square term of prenatal care use has a significant positive effect, prenatal care use itself is not shown to have statistically significant effect on birth weight, so it is sure to infer that the estimation results are clearly different from the results drawn using whole sample. Therefore, it might be inferred that the inclusion of abnormal cases in estimation process might cause the results for the effect of prenatal care use on birth outcome to be biased. Additionally, when using the Apgar score as representative of the birth outcome in Table 7, the results seem similar to those for using birth weight.

Based on this finding, we can surmise that excluding the abnormal sample in the estimation process will make the results become more robust. Hence, the estimation result showing a significant positive effect of prenatal care use on birth outcomes with using whole samples in which the abnormal cases are included, would be considered as evidence of the effect of prenatal care use on birth outcome being robust and reliable.

V. *Conclusion*

This paper investigates the effect of prenatal medical care use on birth outcomes. Specifically, this paper deals with the endogeneity issue of an individuals' use of prenatal care, which might originate from the self-selective aspect of the process. As the solution of endogeneity issue, the 2SLS method has been applied with the percent of insured from the total population and the number of medical institution per unit of population used as Instrumental Variables. Concerning the appropriateness of these variables as IV, several tests were performed and the results of which supported the validity of using them as IV.

The estimation results from the 2SLS method suggest that there might be significant positive effect of prenatal medical care use on birth outcomes. Additionally, we find that the

Table 5. The Robustness Check: Heckman's Selection Model
(Samples of abnormal conditions of pregnancy)

	Probability of Prenatal Medical Care Demand	Conditional Prenatal Medical Care Visit
Demographic variables		
Age of the Mother	0.018**	0.033***
	(0.007)	(0.008)
Race of Mother		
White (Reference)		
Black	-0.279***	-0.558***
	(0.080)	(0.110)
American Indian	-0.298	-1.850***
	(0.295)	(0.533)
Other	-0.200	-1.191***
	(0.209)	(0.201)
Hispanic of Mother	-0.089	-0.953***
	(0.109)	(0.144)
Education of Mother		
≤Middle School (Reference)		
High School Drop Out	0.295**	0.455*
	(0.149)	(0.266)
High School Graduates	0.261*	1.039***
	(0.144)	(0.254)
Some College	0.657***	1.172***
	(0.172)	(0.261)
College graduates and Over	0.463**	1.471***
	(0.190)	(0.267)
Married	0.389***	0.832***
	(0.082)	(0.102)
Pregnancy conditions		
Liveorder	-0.125***	-0.099***
	(0.023)	(0.035)
Tobacco use during pregnancy	-0.225***	-0.618***
	(0.082)	(0.119)
Alcohol use during pregnancy	-0.940***	-1.327***
	(0.151)	(0.377)
Regionalism variables		
Percent Insured	1.070	
	(0.988)	
Number of Critical Access Hospitals	-0.002	
	(0.006)	
Heckman's mills ratio		
Heckman's lambda		-0.469***
		(0.119)
Observations	9,419	9,365

Note: See Table 2

results remain trustworthy with the robustness checks in which either only abnormal case have been used as sample in the estimation process.

However, several limitations of this paper should be mentioned. First of all, there is a lack

Table 6. The Robustness Check: 2SLS Model of Using Birth Weight (Samples of abnormal conditions of pregnancy)

Birth Weight	Model (1)	Model (2)	Model (3)	Model (4)	Model (4*)
Prenatal Medical Care					
Number of Prenatal Care Visits	20.096	-40.158	78.805	124.098	5.789**
	(58.367)	(67.404)	(106.806)	(103.374)	(2.418)
Number of Prenatal Care Visits ^ 2	-1.118	0.294	4.029	4.639*	-0.132
	(2.812)	(3.304)	(2.844)	(2.757)	(0.108)
Demographic variables					
Male		-9.280	23.064***	22.968***	23.007***
		(6.718)	(5.597)	(5.429)	(5.426)
Age of the Mother		-0.647	-6.590**	-7.905***	-0.638
		(0.672)	(3.009)	(2.917)	(0.559)
Race of Mother					
White (Reference)					
Black		-43.788***	71.644	88.481*	-33.367***
		(10.807)	(50.060)	(48.580)	(7.734)
American Indian		-143.869***	241.603	345.294**	-43.078
		(42.785)	(168.124)	(163.567)	(36.195)
Other		-43.014*	182.036*	237.649**	-25.556
		(23.278)	(106.297)	(103.137)	(15.634)
Hispanic of Mother		-44.609***	149.468*	197.539**	-10.491
		(14.808)	(84.788)	(82.370)	(10.078)
Education of Mother					
≤Middle School (Reference)					
High School Drop Out		29.897	-76.562*	-101.731*	-6.312
		(21.183)	(43.806)	(42.522)	(16.728)
High School Graduates		58.867**	-165.571*	-220.522*	-2.477
		(23.223)	(93.278)	(90.633)	(16.003)
Some College		63.746**	-183.072*	-247.981*	-0.901
		(24.874)	(104.785)	(101.835)	(16.593)
College graduates and Over		72.611***	-241.855*	-317.333*	0.587
		(27.889)	(131.315)	(127.629)	(16.913)
Married		23.854*	-150.186*	-193.751*	-13.784**
		(13.061)	(73.653)	(71.553)	(7.005)
Pregnancy conditions					
Gestation			77.564***	71.964***	70.779***
			(1.505)	(1.517)	(1.548)
Weight Gain (kg)			1.289***	3.518***	3.339***
			(0.473)	(0.491)	(0.492)
Liveorder			24.692***	34.100***	13.377***
			(9.060)	(8.839)	(2.460)
Tobacco use during pregnancy			90.867	117.055**	-17.094**
			(55.690)	(54.074)	(8.060)
Alcohol use during pregnancy			282.298**	354.255**	86.058***
			(120.836)	(117.232)	(22.054)
Newborn conditions					
Plural				-63.204**	-67.919***
				(7.057)	(7.177)
Method of Delivery Recode					
Vagina [Reference]					
Vaginal birth after previous C-section				6.784	6.561
				(16.730)	(16.799)
Primary C-section				-80.354**	-81.624***
				(6.667)	(6.664)
Repeat C-Section				-50.817**	-53.423***
				(10.574)	(10.604)
Medical Risk Factors Reported Flag				-37.583**	-37.593***
				(5.486)	(5.490)
Newborn Flag				-76.630**	-75.759***
				(7.156)	(7.150)
Congenital Flag				-42.988**	-43.020**
				(18.095)	(18.072)
Observations	9,365	9,365	9,365	9,365	9,365
R-squared	0.011	0.014	0.328	0.368	0.369

Note: See Table 2

Table 7. The Robustness Check: 2SLS Model of Using APGAR Score (Samples of abnormal conditions of pregnancy)

APGAR Score	Model (1)	Model (2)	Model (3)	Model (4)	Model (4*)
Prenatal Medical Care					
Number of Prenatal Care Visits	0.045	-0.112	0.511	0.668	0.011
	(0.170)	(0.203)	(0.435)	(0.425)	(0.010)
Number of Prenatal Care Visits ^ 2	-0.002	0.0004	0.008	0.005	-0.0003
	(0.008)	(0.010)	(0.010)	(0.010)	(0.0004)
Demographic variables					
Male		-0.054**	-0.014	-0.006	-0.006
		(0.023)	(0.022)	(0.022)	(0.022)
Age of the Mother		0.005**	-0.019	-0.022*	0.004*
		(0.002)	(0.013)	(0.012)	(0.002)
Race of Mother					
White (Reference)					
Black		-0.081**	0.385*	0.405**	-0.021
		(0.036)	(0.211)	(0.206)	(0.030)
American Indian		-0.241	1.244*	1.469**	0.071
		(0.211)	(0.731)	(0.718)	(0.198)
Other		-0.042	0.888**	0.972**	0.057
		(0.076)	(0.446)	(0.436)	(0.059)
Hispanic of Mother		-0.160***	0.607*	0.696**	-0.032
		(0.059)	(0.358)	(0.349)	(0.048)
Education of Mother					
≤Middle School (Reference)					
High School Drop Out		0.108	-0.274	-0.326*	0.018
		(0.089)	(0.188)	(0.183)	(0.079)
High School Graduates		0.198**	-0.643	-0.757*	0.028
		(0.097)	(0.395)	(0.386)	(0.077)
Some College		0.232**	-0.706	-0.834*	0.052
		(0.101)	(0.443)	(0.433)	(0.079)
College graduates and Over		0.226**	-0.964*	-1.111*	0.010
		(0.111)	(0.553)	(0.541)	(0.081)
Married		0.112**	-0.548*	-0.619*	0.015
		(0.045)	(0.311)	(0.304)	(0.027)
Pregnancy conditions					
Gestation			0.098**	0.086**	0.084**
			(0.006)	(0.006)	(0.006)
Weight Gain (kg)			0.002	-0.001	-0.001
			(0.002)	(0.002)	(0.002)
Liveorder			0.068*	0.064*	-0.011
			(0.038)	(0.038)	(0.012)
Tobacco use during pregnancy			0.507**	0.560**	0.088**
			(0.232)	(0.227)	(0.031)
Alcohol use during pregnancy			0.931*	1.069**	0.080
			(0.505)	(0.494)	(0.072)
Newborn conditions					
Plural				0.127**	0.120**
				(0.027)	(0.028)
Method of Delivery Recode					
Vagina [Reference]					
Vaginal birth after previous C-section				-0.018	-0.018
				(0.076)	(0.076)
Primary C-section				-0.163*	-0.165*
				(0.028)	(0.028)
Repeat C-Section				-0.043	-0.047
				(0.042)	(0.042)
Medical Risk Factors Reported Flag				0.028	0.028
				(0.023)	(0.023)
Newborn Flag				-0.303*	-0.302*
				(0.032)	(0.032)
Congenital Flag				-0.746*	-0.746*
				(0.134)	(0.134)
Observations	8,558	8,558	8,558	8,558	8,558
R-squared	0.018	0.021	0.069	0.109	0.109

Note: See Table 2

of information about the income level of the households in the data set. Income level may affect an individual's use of medical care (Grossman 1972), so we use parents' education level, the percentage of insured out of the total population and the number of hospital per unit of population as proxy variables representing individual income level. The last two variables, however, may not represent individual level features, but will rather reflect community level features. Hence, if we can obtain more concrete information about individual income level, the estimation results would become more robust and precise.

Moreover, we have not considered the supply side effect on prenatal medical care use. As many previous researches (Pauly and McGuire 1991; Dranove 1988; Lim 2009) suggest that the induced-demand from physician might affect the patient's use of medical care, there might be likelihood that the individual use of prenatal care could be affected by doctor's recommendation. The data set used in this paper, however, does not include any information on supply side, so this should be mentioned as another limitation. Lastly, the data set used in this study is regarded as repeated cross-sectional one, in which the unobserved individual heterogeneity might not be effectively controlled. As mentioned earlier, since it might be main reason of the endogeneity occurring on individual use of prenatal care, the data set used in this study might be regarded as suboptimal. When addressing individual decisions on pregnancy, however, it might be unhelpful to utilize a panel data set because there are few time varying variables, with these being at most the mother's age or weight gain. Therefore, it is not necessarily valid to say that using panel data would yield more significant gains in obtaining estimation results compared with using a repeated cross-sectional dataset in estimation process.

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