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The demand for health inputs and the production of birthweight in South Carolina: A latent variable approach

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The Demand for Health Inputs and the Production of Birthweight in South Carolina: A Latent Variable Approach

by

Richard Anderson

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Abstract

The Demand for Health Inputs and the Production of Birthweight: A Latent Variable Approach

by

Richard Anderson

Advisor Professor Michael Grossman

This dissertation applies a theoretical model that estimates both infant health production functions and demand functions for prenatal care in the context of a static economic model of the family and household production. The hypothesis of the model is tested empirically using data on births and abortions in South Carolina during 1986 which was provided by the Office of Vital Records and Public Health Statistics of the South Carolina Department of Health and Environmental Control. The specific aim of the research is to investigate the causes of race-specific birth outcomes and the sources of differences in these outcomes. To accomplish this, race-specific birthweight production functions and prenatal care demand functions that control for self-selection in the resolution of a pregnancy as a live birth or abortion are estimated.

A brief examination of race-specific trends in the problems of neonatal mortality and low birthweight is followed by a review of recent research into these questions and a discussion of some of the methodological problems encountered. The analytical framework is then discussed with particular emphasis on the source of the dominant unobserved determinant of reproductive outcomes and how to measure it. The next section details the sources of the data used and describes each variable that appears in the model. This includes an explanation of the specification, the test for endogeneity, and the identification of the model. The empirical results are presented separately for adults and for teenagers following previous literature. Regardless of race, the results provide significant evidence of the existence of selectivity bias in both the estimation of birthweight production functions and prenatal care demand functions for adults and teenagers. Additionally, the sign pattern of the residual covariances suggest a model that emphasizes the cost of abortion as the dominant unmeasured component of birth outcomes. The results support the importance of recent findings in the field which have emphasized the importance of self-selection in the resolution of a pregnancy.

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Chapter One: Introduction

The problems of neonatal mortality and low birthweight in the United States have generated a large volume of research and resulted in new government programs aimed at reducing the incidence of both. Although infant mortality rates have been falling, there is still a large gap in race specific rates. Overall, the infant mortality rate fell from 12.6 deaths per 1000 live births in 1980 to 10.4 in 1986. However, the race specific infant mortality rate in 1986 was 8.9 deaths per 1000 live births for whites and 18 deaths per 1000 live births for blacks. In South Carolina, the subject of this study, the rate was far above the national average at 10.1 infant deaths per 1000 live births for whites and 18.1 deaths per 1000 for blacks in 1986.

With respect to the problem of low birthweight there was no improvement in the national average between 1980 and 1986 with it remaining constant at 6.8%. However, the gap between race specific rates has been increasing. In 1980 there were 5.7% of births with low birthweight (less than 2500 grams) to whites and 12.5% to blacks. By 1986 the gap had widened to 5.7% for whites and 12.7% to blacks. South Carolina is again above the national average with an overall rate of 8.6% in 1986 [Statistical Abstract of the United States 1990]. These trends coincide with an increase in the number of pregnant women who delay the initiation of prenatal care until the third trimester or who receive no care at all. This rose from 5.1% in 1980 to 6% in 1986. When separated by race the increase has again been more dramatic for blacks. In fact, for blacks the number of women delaying care until the third trimester or receiving no care increased by 26% while the increase for whites was only 16% [National Center for Health Statistics 1990].

During this same period there has been a decrease in the percentage of births to teenage mothers. This fell from 15.6% in 1980 to 12.6% in 1986. South Carolina is again far above the national average. In South Carolina there were 19.8% births to teenage mothers in 1980 and 16.6% in 1986. Finally, during this same period, a large percentage of all pregnancies were terminated by induced abortions. This rate actually declined somewhat from 29.3 legal abortions per 1000 women age 15 to 44 in 1980 to 28% in 1985. In this case South Carolina is far below the national average. In South Carolina in 1980 there were 18.2 legal abortions per 1000 women age 15 to 44 while in 1985 this fell to 13.7.

These trends all underscore the importance of gaining a better understanding of the production of birthweight and the demand for prenatal care inputs. The specific aim of my research is to investigate the causes of race specific birth outcomes and the source of differences in these outcomes. With this in mind, I will estimate race specific birthweight production functions and prenatal care demand functions that control for self-selection in the resolution of a pregnancy as a live birth or abortion. A woman's decision to terminate a pregnancy, which may have an important impact on the birthweight distribution, can hardly be considered a random decision. In fact, it should depend on such factors as the cost of contraception, the cost of abortion, and the health endowment of the fetus.

Following an approach pioneered by Grossman and Joyce(1990), I will attempt to incorporate the choice based nature (Heckman 1979) of micro vital statistical data into estimates of birthweight production functions. By using the household production function approach to consumer behavior and a model of fertility control which is able to incorporate information from a woman's decision to resolve her pregnancy as a birth or abortion, I hope to obtain more accurate estimates of infant health production functions and of the demand for prenatal medical care.

Previous research in this area has included ecological studies which helped document the relationship between the use of family planning clinics and reductions in the rate of neonatal mortality (Grossman and Jacobowitz 1981 and Joyce 1987). Others have shown that the availability of abortion services can be associated with reductions in neonatal mortality (Corman and Grossman 1985 and Joyce 1987). Further, it has been demonstrated that a pregnancy described as "wanted" can be associated with the early initiation of prenatal care and other healthy behaviors (Marsiglio and Mott 1988; Weller, Eberstein, and Baily 1987; and (Joyce 1990). In addition, there have been comprehensive government reports on infant health in the United States which recommend directing efforts at reducing the number of unwanted pregnancies in order to improve birth outcomes (Institute of Medicine 1985) and (U.S. Department of Health and Human Services 1986). In fact, a White House Task Force on Infant Mortality, formed by President Bush in 1988, recommended additional spending of $500 million a year to reduce the infant mortality rate by focusing on measures that will increase the prompt initiation of prenatal care (New York Times, August 6, 1990).

Previous studies of the effect of the availability of abortion services, contraception, and family planning on infant health have all encountered the methodological problem of using self-assessments to measure the wantedness of a pregnancy. Researchers have been forced to emphasize reduced form as opposed to structural estimates because of the difficulty of measuring such unobserved biological factors as the mother's health endowment, nutrition, exercise, and the avoidance of stress. If a woman's behavior is affected by knowledge of her health endowment or if inputs like nutrition and exercise are correlated with the demand for health care then estimates of the impact of prenatal care on birthweight will be biased.

The problem of adverse selection in the demand for health inputs has been recognized by Rosenzweig and Schultz (1982,1983,1988), Corman, Joyce, and Grossman (1987), and Joyce (1987). These authors argue that a woman who anticipates a problematic birth, based on conditions unknown to the researcher, will demand more remedial care while those who anticipate a problem free birth will demand less care. Each study cited above attempts to control for adverse selection by using a two stage least squares technique that employs such instrumental variables as local area prices, parents income, and education. However, all these studies have ignored the problem of self selection in pregnancy resolution.

There are actually three potential sources of bias inherent in any attempt to measure the effect of prenatal care on birthweight. The first, as mentioned above, would be the existence of adverse selection in a woman's decision as to the appropriate level of input use during her pregnancy. In other words, a woman who anticipates having a difficult or problematic birth may demand more prenatal care while a woman anticipating a problem free birth will demand less prenatal care. As a result any measures of the effects of prenatal care on birthweight will be underestimated.

A second and potentially more serious source of bias would be the existence of favorable selection in input use (Gortmaker 1979) (Institute of Medicine 1985). That is, a woman's demand for prenatal care may be only another manifestation of healthy behavior. Thus a woman who seeks out prenatal care early in her pregnancy may be inclined to choose a more nutritious diet, follow an appropriate exercise regime and try to avoid stress. If such inputs are left out because of the difficulty in measuring them, then the impact of prenatal care on birthweight will be overestimated.

Finally, a third potential source of bias would be the existence of self-selection in a woman's decision to resolve her pregnancy as a birth or abortion. There are two possible forms that this self-selection could take. First, if a woman with a poor health endowment is more likely to abort and if a woman with a favorable health endowment (or one who wants to make a large investment in infant health) is more likely to give birth then the resolution of pregnancy will be characterized by favorable selection. Alternatively, if a woman who wants to invest little in infant health is more likely to give birth than one who desires a large investment in infant health, then the resolution of pregnancy is characterized by adverse selection.

The following study will adopt a recent approach pioneered by Grossman and Joyce (1990) that simultaneously controls for self-selection in pregnancy resolution and in the demand for prenatal medical care services in estimating infant health production functions. Their approach is to treat the estimation of infant health production functions and prenatal care demand functions as a general problem in self-selection. That is, they assume that women who give birth are actually a self-selected sample from the population of pregnant women. Because of the widespread availability of contraception and abortion services, a woman can now control the timing of pregnancy and number of births. A woman who chooses to give birth will differ from those who choose abortion in several unobserved ways including "wanting" their pregnancy. Therefore, women who give birth can be considered a censored sample from the population of all women who become pregnant. It is therefore possible to apply recently developed econometric techniques that correct for selectivity bias Heckman (1979) Maddala(1983).

The specific population I will consider is the cohort of pregnant women residing in South Carolina during the year of 1986. South Carolina is one of 14 vital registration areas in the United States that submits information on induced abortions to the National Center for Health Statistics. By combining induced abortion records for 1986 with birth certificates during the same year it is possible to generate a sample of pregnant women, all of whom conceived within a 20 month period. Since the effect of pregnancy resolution on the demand for prenatal care is likely to differ by race and age group (as illustrated by the wide variation in abortion rates as shown in table 1), I divide the population into subgroups of white adults, black adults, white teenagers, and black teenagers.

For each of these sub-groups I estimate a three equation model.

TABLE #1

Mean birthweight, percentage of light births and birth ratio

GROUP	BIRTHWEIGHT (grams)	% LIGHT BIRTHS	BIRTH RATIO
White teenagers	3292.58	.080	.558
White Adults	3410.559	.059	.835
Black teenagers	3022.912	.140	.755
Black Adults	3138.89	.115	.805

note: light birth - birthweight less than 2500 grams

The first equation is the probability that a woman will give birth given that she has become pregnant. This becomes the criterion equation allowing for a test of self-selection in the remaining two equations. The second equation is an infant health production function in which birthweight is used as a proxy for infant health. The third equation is a prenatal care demand function which uses the number of months a pregnant woman delays before seeking prenatal care as the dependent variable.

The methodology outlined above when combined with the possibility of using micro vital records on both induced abortions and live births allows me not only to avoid the necessity of asserting in advance whether adverse or favorable selection is the appropriate case, but the sign pattern of the residual covariances will indicate which type of selection exists in the decision to give birth or the decision to initiate early prenatal care.

The model specified actually includes three unobservables in the birth probability equation and the prenatal care demand function. These include the health endowment of the fetus, the cost of contraception and the cost of abortion. The birthweight production function also includes two unobservables including the health endowment and an endogenous input which reflects such healthy behavior as proper diet, exercise, and avoidance of stress.

Previous economic models of fertility emphasized the use of contraception to reduce the uncertainty associated with timing a pregnancy. Michael and Willis(1975), Heckman and Willis(1975), Holtz and Miller(1988). However, the legalization of abortion has now provided an alternative to contraception in controlling the number and timing of births. Like contraception, induced abortion reduces this uncertainty only at a positive price. By assuming that this price includes unmeasured components that vary among women it becomes possible to improve our understanding of infant health and the resources allocated to its production.

Chapter Two: Analytical Framework

Following Grossman and Joyce (1990), I will employ an analytical framework that estimates both infant health production functions and demand functions for infant health inputs in the context of a static economic model of the family and household production. The utility function of the parents or parent depends on their own consumption, the number of births, and the survival probability of each birth. (Birthweight is the primary indicator of survival probability.) The number of births and the outcome of each birth are treated as endogenous variables. Birthweight is assumed to depend on such endogenous inputs as the quantity and quality of medical care, the own time of the mother, nutrition, exercise, avoidance of stress, the reproductive efficiency of the mother and other aspects of efficiency in household production.

Maximizing the utility function subject to production and resource constraints generates a demand function for birthweight in which birthweight is related to input prices, efficiency, income and taste. The interaction of birthweight demand and production functions determines the demand for prenatal care and other endogenous inputs.

Following Grossman and Joyce (1990), I specify a three equation model including an equation for the probability of giving birth once pregnant (π), an equation for the production of birthweight (b) and an equation for the demand for prenatal care (M). The three equations are given below:

$$(1) \quad \pi_i = \alpha_1 Z_i + \alpha_2 c_i + \alpha_3 a_i + \alpha_4 ei$$

$$(2) \quad b_i = \beta_1 X_i + \beta_2 M_i + \beta_3 q_i + \beta_4 e_i$$

$$(3) \quad M_i = \gamma_1 Y_i + \gamma_2 c_i + \gamma_3 a_i + \gamma_4 e_i$$

In this system of equations, Z_i, X_i, Y_i, c_i, a_i, and e_i represent exogenous variables or vectors of variables. For example, the birth probability equation (1) includes a vector of variables given by Z_i which control for the determinants of the optimal number of children and the spacing or timing of births. These determinants include mother's education, mother's age, marital status and family income. In the same equation the cost of contraception is captured by c_i and it is assumed to be directly related to the money price and indirectly related to its availability and the efficiency of the mother in its use. The cost of abortion is captured by a_i and reflects not only the direct and indirect cost of obtaining an abortion but the physic cost as well. Finally, the health endowment of the fetus is captured by e_i.

The birthweight production function given by equation (2) includes a vector of exogenous variables given by X_i, which controls for the reproductive efficiency of the mother. These include such determinants as the mother's education and marital status to measure efficiency as well as such biological inputs as mother's age, the sex of the newborn and parity. The birthweight equation also includes two endogenous variables given by M_i and q_i. The demand for prenatal care M_i controls for the use of medical inputs and uses the number of months a women delays the initiation of medical care, once pregnant, as a proxy variable. The endogenous input q_i measures such healthy behavior as proper diet, appropriate exercise and avoidance of stress.

In the prenatal care demand function (3), the vector of variables Y_i includes determinants of the demand for health inputs such as family poverty, mother's education, mother's age, marital status and the number of previous live births (or parity).

In addition, there is an unspecified demand function for healthy behavior that has the same argument as the demand function for prenatal care and each equation contains an unspecified random disturbance term. The observed variables in each of the three equations will be discussed in detail in the next section.

Assuming that contraception and abortion are alternative methods of birth control then an increase in the price of contraception or a decrease in the price of abortion should increase the probability of becoming pregnant. The implication of this is that an increase in the price of contraception should decrease the probability of giving birth ($\alpha_2 < 0$) while a reduction in the price of abortion should decrease the probability of giving birth ($\alpha_3 >0$). We may therefore assume that a woman who becomes pregnant when she has a low cost of averting a pregnancy must "want" that pregnancy. Logically, then a fall in the cost of contraception or abortion should increase the quantity of prenatal care demanded ($\gamma_2 < 0$, $\gamma_3 < 0$) and raise the level of the healthy behavior input. The force at work here is that the cost of averting a pregnancy or birth lowers the optimal number of children and raises the optimal amount of resources devoted to each birth. Or in other words, a reduction in the price of averting a birth raises the level of "wantedness".

It is also likely that a women whose potential or actual fetus has a favorable health endowment will choose to have more children and are more likely to give birth ($\alpha_4 > 0$). They also demand less prenatal care as the favorable health endowment of the fetus causes them to allocate resources away from the production of infant health. This follows because an increase in the health endowment of the fetus is equivalent to an increase in real income. Given the assumption that all commodities in the utility function are superior, then the optimal value of each should rise. With money income fixed, this is achieved by reallocating some resources away from infant health.

Since variables such as the price of contraception, the price of abortion, the health endowment of the fetus, and the healthy behavior input are not observed or are measured imperfectly it is not possible to quantify their effects precisely. We can however measure their impact on reproductive outcomes by including the impact of these variables in the disturbance term of each equation (U_{ji}) and then obtaining estimates of the covariances between disturbance terms across equations.

It is therefore necessary to rewrite the model as follows:

$$\pi_i = \alpha_1 Z_i + U_{1i}$$

$$b_i = \beta_1 X_i + \beta_2 M_i + U_{2i}$$

$$M_i = \gamma_1 Y_i + U_{3i}$$

where

$$U_{1i} = \alpha_2 c_i + \alpha_3 a_i + \alpha_4 e_i$$

$$U_{2i} = \beta_3 q_i + \beta_4 e_i$$

$$U_{3i} = \gamma_2 c_i + \gamma_3 a_i + \gamma_4 e_i$$

If we denote the covariances between the disturbance terms as σ_{12}, σ_{13}, σ_{23}, then:

$$\sigma_{12} = \alpha_4 \beta_4 \sigma_c^2 + \alpha_2 \beta_3 \sigma_{qc} + \alpha_3 \beta_3 q_a$$

$$\sigma_{13} = \alpha_4 \gamma_4 \sigma_c^2 + \alpha_2 \gamma_2 \sigma_c^2 + \alpha_3 \gamma_3 \sigma_a^2$$

$$\sigma_{23} = \beta_4 \gamma_4 \sigma_c^2 + \beta_3 \gamma_2 \sigma_{qc} + \beta_3 \gamma_3 \sigma_{qa}$$ [1]

where:

σ_j^2 = is the variance of variable j

σ_{qj} = is the covariance between q and j

$\alpha_3, \alpha_4 > 0$

$\gamma_2, \gamma_3, \gamma_4, \sigma_{qc}, \sigma_{qa} < 0$

$\beta_3, \beta_4 > 0$

It is also assumed that e, c, and a are mutually uncorrelated and that q does not depend on e.

To determine whether the health endowment of the fetus, the cost of contraception, or the cost of abortion is the dominant unmeasured determinant of reproductive outcomes, we can use the sign pattern of the covariances. Consider the following alternatives:

1) The health endowment model (there is no variation in the price of abortion or the price of contraception) ie:

$$\sigma_c^2 = \sigma_a^2 = \sigma_{qc} = \sigma_{qa} = 0$$

thus $\sigma_{12} > 0$ and $\sigma_{13}, \sigma_{23} < 0$

In this model only the health endowment of the fetus varies and women who are more likely to give birth will be associated with above average birthweight and will be less likely to initiate early prenatal care. This reflects adverse selection in input use since a women whose fetus has a poor health endowment is likely to demand a large amount of prenatal care. It also reflects favorable selection in pregnancy resolution since a woman whose fetus has a relatively large health endowment will be more likely to give birth. This particular model has been emphasized in previous work by Rosenzweig and Shultz (1982,1983) Corman, Joyce and Grossman (198") and Joyce (1987).

2) The cost of contraception model (there is no variation in the price of abortion or the health endowment of the fetus) ie:

$$\sigma_a^2 = \sigma_e^2 = \sigma_{qc} = \sigma_{qe} = 0$$

$$\sigma_{12}, \quad \sigma_{13}, \quad \sigma_{23} > 0$$

Therefore, a reduction in the price of contraception will increase the likelihood that a pregnant woman will give birth and will increase her demand for prenatal care. This implies that a reduction in the cost of contraception can have a positive effect on birthweight. It reflects favorable selection in input use since a woman who is more likely to give birth will demand more prenatal care. It also reflects favorable selection in pregnancy resolution since a woman with a high value of the healthy behavior input is more likely to give birth. Note that the covariance between the disturbance terms in the birth probability and birthweight equation is positive ($\sigma_{12} > 0$) and that the covariance between the disturbance terms of the birth probability and prenatal care demand function is also positive ($\sigma_{13} > 0$).

3) The cost of abortion model (there is no variation in the cost of contraception or the health endowment of the fetus)

$$\sigma_c^2 = \sigma_e^2 = \sigma_{cq} = \sigma_{qe} = 0$$

thus $\sigma_{12}, \sigma_{13} < 0$ and $\sigma_{23} > 0$

In this model only the price of abortion varies and women who are more likely to give birth will be associated with lower than expected birthweight and less demand for prenatal care. This reflects favorable selection in input use since a woman who is more likely to give birth will demand less prenatal care. It also reflects adverse selection in pregnancy resolution since a woman with a relatively low value of the healthy behavior input is more likely to give birth .

Of course, adverse or favorable selection in pregnancy resolution is determined by the sign of the correlation between the disturbance term in the birth probability equation and the disturbance term in the birthweight equation:

$\sigma_{12} > 0$ favorable selection

$\sigma_{12} < 0$ adverse selection

Adverse or favorable selection in input use is determined by the sign of the correlation between the disturbance term in the birth probability equation and the disturbance term in the prenatal care demand function:

$\sigma_{13} > 0$ adverse selection

$\sigma_{13} < 0$ favorable selection

To summarize, the disturbance terms in the birth probability and prenatal care demand functions are formed by the effects on the mother's behavior of the price of abortion, the price of contraception and the health endowment of the fetus. The disturbance term of the production function is formed by the health endowment of the fetus and the healthy behavior input. The importance of these difficult to measure determinants of birth outcomes can be understood more fully by examining the sign pattern of the pairwise covariances among the disturbance terms. The specific pattern, as outlined previously, will indicate whether the cost of abortion, cost of contraception or the health endowment of the fetus has the dominant effect on the determination of reproductive outcomes.

In order to obtain estimates of the covariances referred to above I will employ a methodology developed by Heckman (1979). This approach not only yields the needed covariances σ_{12} and σ_{13} but also eliminates the bias which would be inherent in any estimates of the production function which ignored the censored nature of the birth sample. Additionally, the estimate of the impact of the early initiation of prenatal care on birthweight has controlled for both adverse and favorable selection in input use. This coefficient would have been biased downward by adverse selection and biased upward by favorable selection had these factors been ignored.

In particular, all three equations used in the model apply to pregnant women while only the last two apply to women who actually give birth. For women who give birth,

$$\pi_i > 0 \quad \text{or} \quad U_{1i} > -\alpha_1 Z_i$$

and $E(b_i \mid X_i \, M_i \, \pi_i > 0) = \beta_1 X_i + \beta_2 M_i + E(U_{2i} \mid U_{1i} > -\alpha_1 Z_i)$

$E(M_i \mid Y_i \, \pi_i > 0) = \gamma_1 Y_i + E(U_{3i} \mid U_{1i} > -\alpha_1 Z_i)$

Heckman(1979) has shown that ordinary least squares estimates will be biased if U_{1i} and U_{2i} are correlated. If so, then the conditional mean of U_{2i} in the first equation above is not zero and the regressors are correlated with the disturbance term. Heckman has shown that if this is the case then unbiased estimates can be obtained as follows:

By assuming that the joint distribution of U_{1i} and U_{2i} and the joint distribution of U_{1i} and U_{3i} are bivariate normal densities it is possible to fit the birth probability equation as a probit function and compute the inverse of Mill's ratio for each woman who gives birth:

$$\lambda_i = f(Q_i)/F(Q_i)$$

$$Q_i = \alpha_1 Z_i/\sigma_1$$

f = the density function for a standard normal variable.

F = the distribution function for a standard normal variable.

When the inverse of Mill's ratio is inserted as a regressor the equation can be written as follows:

$$b_i = \beta_1 X_i + \beta_2 M_i + (\sigma_{12}/\sigma_1)\lambda_i + V_{2i}$$

$$M_i = \gamma_1 Y_i + (\sigma_{13}/\sigma_1) + V_{3i}$$

The inclusion of the inverse of Mill's ratio as a regressor also helps reduce the potential problem of the endogeneity of prenatal care in the birthweight equation. That is , prenatal care and the disturbance term in the birthweight equation (U_{2i}) will be correlated unless we control for sample selection by including the inverse of Mill's ratio as a regressor. Differences in the inverse of Mill's ratio among women who give birth reflect differences in the health endowment of the fetus, the price of abortion or the price of contraception. Since these factors generate some of the correlation between the prenatal care and the disturbance term (U_{2i}), the biases they introduce will be reduced by including the inverse Mill's ratio in the birthweight equation.

Chapter Three: Data and Estimation

The data base used in estimating the model specified above was constructed from a variety of sources. The data on births and abortions in South Carolina during 1986 was provided by the Office of Vital Records and Public Health Statistics of the South Carolina Department of Health and Environmental Control. Both the birth records and induced abortion records included information on the mother's county of residence, the mother's age, the mother's education level, the race of the mother, the number of previous children born alive, and the mother's marital status. The birth records alone included information on the sex of the newborn infant, the birthweight in grams, and the number of months the woman delayed before seeking prenatal care. Since both records of births and abortions provide information on the mother's county of residence, I was also able to merge local area income, health program and abortion provider variables with the individual micro data. The data on variables measuring the availability of reproductive health services was provided by the Alan Guttmacher Institute. The data provided was at the county level and included the number of providers of 30 to 390 abortions, the number of providers of 400 or more abortions, and the number family planning clinics. These measures were adjusted to reflect the availability per 1000 women age 15 to 44.

The income variable measured by the percentage of families below the poverty level in each county was taken from the Bureau of Health Professions Area Resource File for August of 1989. The Area Resource File is a county based data file which summarizes secondary data from a wide variety of sources. I chose not to use a race specific income variable because these measures all had a high percentage of missing observations. The information on the number of WIC centers operating in each county was obtained from the Food and Nutrition service of the U.S. Department of Agriculture. This was used to construct a dichotomous variable that equals one if the mother lives in a county that operates a WIC Center and zero otherwise. These are health centers operated by the Federal Supplemental Food Program for Women, Infants and Children. These centers provide prenatal and obstetrical care to poor women under the 1972 amendment to the Child Nutrition Act of 1966.

During the year of 1986 there were approximately 52,237 live births and 14,287 induced abortions to residents of South Carolina. From the population of all women who became pregnant I drew randomly chosen subsamples. The population was divided into four groups including white adults (over 20 years of age), black adults, white teens and black teens. For white adults, the sample included 10,345 live births and 2,041 induced abortions. For black adults the sample included 7,410 lives births and 1,789 induced abortions. With respect to teenagers, the samples included 3,085 live births and 2,506 induced abortions to white teenagers and 4,553 live births and 1,477 induced abortions to black teenagers. The sample sizes were chosen to maintain the same percentage of live births to total pregnancies that existed for the entire population of each subgroup.

The analysis is possible because many of the parental characteristics reported on the birth certificates are also reported on induced abortion records. After merging the data on births and abortions along with county level income and availability measures I am

Table # 2

Means by Pregnancy Outcome for White and Black Adults

	WHITE		BLACK	
	Birth	Abortion	Birth	/bortion
Birthweight	3410.559	--------	3138.89	---------
Illegitimacy	.069	.735	.446	.759
Education < 9	.023	.012	.018	.003
High School Education	.404	.395	.529	.496
Education > 12	.447	.511	.280	.443
Male	.51	-----	.504	-----
Age 35-39	.056	.067	.054	.074
Age 40	.005	.016	.009	.018
Delay	2.751	-----	3.7	-----
Parity	.874	.75	1.416	1.376
Clinics	.128	.115	.168	.141
AB 30 per	.005	.006	.005	.006
AB 400 per	.008	.012	.010	.015
WIC	.671	.745	.635	.703
Family Poverty	12.374%	12.262%	14.94%	14.009%
Lambda	.176	-.8961	.29748	-1.230
Observations	10,345	2,042	7,410	1,789

able to specify an equation which will predict the probability of giving birth once a woman has become pregnant.

A more detailed description of the variables used is provided below: (see table #2 for the mean values of each variable)

1) Birthweight - the birth weight in grams of the fetus at the time of delivery.

2) Prenatal Care Delay - the number of months a woman delays from the date of the last normal menses until she receives prenatal care.

3) Parity - the number of previous live births now living or now dead.

4) Age 35-39 - a dichotomous variable that equals one if the mother's age is between 35 and 39 years.

5) Age 40 - a dichotomous variable that equals one if the mother is 40 years of age or older.

6) Age 17 - a dichotomous variable that equals one if the woman is 17 years of age or younger.

7) Education < 9 - a dichotomous variable that equals one if the woman completed less than 9 years of schooling.

8) High School Education - a dichotomous variable that equals one if the woman completed 12 years of schooling.

9) Education > 12 - a dichotomous variable that equals one if the woman completed more than 12 years of schooling.

10) Illegitimacy - a dichotomous variable that equals one if the woman is not married at any time during the period from conception to birth or induced abortion.

11) **Male** - a dichotomous variable that equals one in the infant is a male.

12) **Family Planning Clinics** - a county level variable measuring the number of family planning clinics per 1000 women age 15 to 44.

13) **Abortion Providers 30-390** - a county level variable measuring the number of providers of from 30 to 390 abortions a year per 1000 women age 15 to 44.

14) **Abortion Providers +400** - a county level variable measuring the number of providers of over 400 abortions a year per 1000 women age 15 to 44.

15) **Family Poverty** - a county level variable measuring the percentage of families below the poverty level.

16) **Lambda** - the inverse of Mill's ratio which is a monotonically decreasing function to the probability of giving birth once a woman has become pregnant.

The birthweight of the child is used in this study as a indicator of infant health. The infant health outcome variable is linked to infant survival and to the prospects of subsequent growth and development in medical literature. There have actually been two distinct health effects of low birth weight cited in the medical literature. These include a relatively transitory trauma associated with delivery and its immediate consequences as well as more permanent side effects that result in a higher probability of later childhood morbidity and mortality. (Beck and VanDerBerg 1975).

Prenatal care is measured by the number of months a woman delays after her last normal menses before seeking prenatal care. A woman who does not receive any prenatal care is assumed to have delayed 10 months. Thus it should be pointed out that the measure of prenatal care I employ in my analysis should be negatively related to birthweight.

With respect to the quality of the data used, there was no real problem. In fact, the percentage of observations with missing values or data reported incorrectly was surprisingly small. The variables reporting mother's age, mother's race, sex of the infant, birthweight and marital status had no missing values in the birth file. For mother's education and county of residence, there were fewer than 1% missing observations. The few observations containing missing variables were deleted prior to construction of the data set used.

I have also chosen to specifically focus on whites and blacks and have thus excluded all other racial groups. This is done in an attempt to make my results more comparable to previously published work. However, in South Carolina this does not pose a serious problem because over 99% of the population of pregnant women falls into the categories of white or black.

The main thrust of the model specified is to use the information encapsulated in the decision to give birth as an input in the birth outcome production function. To accomplish this the first equation estimated will predict the probability of giving birth once a woman is pregnant. This is possible because many of the characteristics of the mother that are reported on birth certificates are also reported on the induced termination records. By combining the birth and abortion files it is possible to specify a multivariate equation with a dichotomous dependent variable which has a value of one if the woman gives birth and zero if she aborts. Birth probability is a function of a vector of exogenous variables (Z_i) which includes such factors as mother's age, mother's education, marital status, income, availability of abortion services and availability of family planning services. In particular, unmarried women or older women are more likely to abort because the pregnancy is more likely to be unwanted. The price of abortion is measured imperfectly by assuming that price is a negative correlate of availability. By the same reasoning, the price of contraception is inversely correlated with the number of family planning clinics. In both cases I use the number of clinics or abortion providers per 1000 women age 15 to 44. The mother's education is another measure of the price of contraception. A woman with more education should be a more efficient producer of contraception. Thus a woman who becomes pregnant when she has a low cost of contraception should be more likely to give birth.

In the second equation specified, birthweight is a function of a vector of exogenous variables (X_i) and an endogenous variable (M_i). The birthweight production function is a structural equation based on the relationship between the demand for health inputs and the outcome of a birth as measured by birthweight. The vector of variables (X_i) includes such exogenous variables as mother's education, mother's age, marital status, the number of previous live births and the sex of the infant. The number of previous live births is used to control for a woman's reproductive capability, while the mother's education is used to control for her efficiency in household production (Grossman 1972). Prenatal care is also included in the birthweight equation and because it may be an endogenous input it requires special consideration in order to obtain unbiased estimates of its effect. In order to test whether prenatal care is actually endogenous or exogenous I will use the Wu - Hauseman Test (Wu 1973) (Hausman 1978) to measure the correlation between the prenatal care variable and the birthweight equation residuals. If the null hypothesis of no correlation is rejected then it will be more appropriate to use the predicted values of prenatal care from equation 3 in the birthweight production function. Consider the model:

$$(1)\quad b_i = \alpha_1 M_i + \alpha_2 X_i + e_i$$

$$(2)\quad M_i = \beta_1 Y_i + V = \hat{M} + V$$

where:

b_i = birthweight

M_i = prenatal care

X_i, Y_i = exogenous variables

e_i, V_i = disturbance terms

$\alpha_1, \alpha_2, \beta$ = population parameters

Consider the estimated regression:

$$(3)\quad b_i = a_1 \hat{M} + a_2 X + a_3 V + e$$

where M and V are obtained from the prenatal care demand function. If e and V are not correlated then:

$$E(a_1) = E(a_3) = \alpha_1$$

and if e and V are correlated then:

$$E(a_1) = \alpha_1 \neq E(a_3)$$

The Wu-Hausman test is a test of the hypothesis that $a_1 = a_3$. It is performed by rewriting equation (3) as follows:

$$b = a_1\hat{M} + a_2X + a_3V + a_1V - a_1V + e$$

$$b = a_1(\hat{M} + V) + a_2 X + (a_3 - a_1) V + e$$

$$(4) \quad b = a_1M + a_2X + cV + e$$

When equation (4) is fit by ordinary least squares then the Wu-Hauseman test becomes a test of whether c differs from zero. Following Nakamura and Nakamura (1981) the statistic employed for testing the linear restriction is calculated as follows:

$$F = \frac{RRSS - URSS}{URSS} \cdot \frac{N - 2G - K_1}{G}$$

where

RRSS = the restricted residual sum of squares from the regression of delay on X_i and Y_i

URSS = the unrestricted residual sum of squares from the regression of delay on X_i and e

N = the number of observations

G = the number of endogenous variables

K_1 = the number of independent regressors in the birthweight equation (including λ)

The critical F has (1, n - number of parameters) as the degrees of freedom.

To implement this strategy I fit,

$$M = d_1Y + d_2X + d_3\lambda + V$$

where

λ = Mill's ratio

and kept the residuals (V). I then fit

$$b = a_1M + a_2X + cV + a_3\lambda$$

using the actual values for M in this equation. Since both X and Y are used in estimating (M) I also included the sex of the newborn infant as a regressor in the equation. That is, the residuals from the equation predicting prenatal care corrected for selection are used as right hand side regressors in the birthweight equation.

Finally, I use birthweight (measured in grams) as the dependent variable in the birthweight production function as opposed to a dichotomous variable for low birthweight, because Heckman's two stage procedure requires the dependent variable in the structural equation to be continuous.

The prenatal care demand function, like the birth probability function, is treated as a reduced form equation. As such it includes such exogenous determinants as mother's education, mother's age, marital status, family poverty, the number previous live births and the number of WIC Centers. In order to achieve identification of the prenatal care demand equation I assume that the availability of family planning clinics and the availability of abortion providers has no impact on the demand for prenatal care. Alternatively, identification could have been achieved by the non-linear relationship between the inverse of Mill's ratio (λ) and the regressors in the birth probability equation. In this case even if the variables in vector Z_i and the variables in vector Y_i are the same, the equations are still identified. Of course the model is on firmer ground if there are unique determinants of each equation.

There are also two variables in the prenatal care equation which are excluded from the birth probability equation. They are the number of previous live births and the number of WIC Centers. Parity is included in the prenatal care equation because it reflects experience with pregnancy and birth. Women who have experienced a previous birth are more likely to understand the benefits of prenatal care. Parity, may in fact, control for a woman's health endowment. The optimal number of children and parity are governed by command over resources, prices, efficiency, taste, marital status and mother's age. The number of WIC Centers should be a determinant of how much prenatal care is received.

The birthweight production function also meets the rank and order conditions for identification since it excludes measures of income and the availability of abortion and family planning services. At the same time it includes a unique dichotomous variable for the sex of the child.

Chapter Four: Empirical Results for Adults

Separate estimates were obtained for four groups including white adults, black adults, white teenagers and black teenagers. The purpose of following a strategy that separates teenagers from adults is twofold. First, I am attempting to minimize the potential problems of endogeneity that apply particularly to teenagers. Second, I am trying to make my results comparable to previous studies which have adopted the same approach.

Empirical results of the birth probability and prenatal care demand functions are presented in Tables 3 and 5. The birth probability equation predicts the probability of giving birth, given that a woman is pregnant. This equation is estimated using a maximum likelihood probit. The prenatal care demand function is estimated twice, once by ordinary least squares and once after having been corrected for selection by using the inverse of Mill's ratio as a regressor and adjusting the standard errors. (Heckman 1979)

Tables 4 and 6 present estimates of the birthweight production function using three alternative approaches. The first approach estimates the birthweight production function by using ordinary least squares and does not correct for selectivity or endogeneity. The second approach estimates the birthweight production function having corrected for selectivity bias again by including the inverse of Mill's ratio as a regressor. The final approach estimates the birthweight production function having not only corrected for selectivity bias but also correcting for simultaneous equations bias by treating prenatal care as an endogenous variable. This is accomplished by fitting the equation using a two stage least squares procedure (Lee, Madalla, Trost 1980).

Table #3 Birth Probability and Prenatal Care Demand Estimates for Adult White Women

	Birth Probability Probit	Prenatal Care (OLS)	Prenatal Care (Selection)
Intercept	2.108	2.88	2.868
	(25.627)	(41.263)	(38.125)
Family Planning Clinics	.542		
	(2.419)		
Family Poverty %	-.004	.010	.011
	(-.733)	(2.793)	(2.957)
Education < 9	.249	-.116	.00003
	(1.739)	(-1.093)	(0)
High School Education	-.414	-.460	-.654
	(-7.043)	(-9.524)	(10.72)
Education > 12	-.548	-.820	1.078
	(-9.322)	(-16.758)	(16.296)
Abortion Providers (30 to 390)	1.642		
	(.689)		
Abortion Providers (400 +)	-5.367		
	(-4.459)		
Mothers age 35-39	-.259	-.239	-.389
	(-3.914)	(-3.642)	(-5.547)
Mothers age 40	-.757	-.265	-.839
	(-4.821)	(-1.299)	(-4.124)
Illegitimate	-2.146	1.453	-.549
	(-59.688)	(24.456)	(-2.185)
Parity		.210	.212
		(12.896)	(12.371)
Women, Infants and Children Centers		.042	-.014
		(1.343)	(-.407)
Lambda			2.115
			(8.331)
F - Statistic		160.812	149.789
Chi - Squared	4308.3		
R - Squared		.122	.126
Observations	12,386	10,345	10,345

Table #4
Birthweight Production Functions for Adult White women(age>19)

	OLS	OLS (Selection)	TSLS (Selection)
Intercept	3248	3250	3096.57
	(143.319)	(143.245)	(7.751)
Education < 9	-28.303	-41.252	-37.423
	(-.681)	(-.976)	(-.825)
High School Education	123.974	145.53	172.418
	(6.565)	(6.620)	(2.667)
Education > 12	187.731	216.990	263.428
	(9.753)	(8.860)	(2.372)
Mothers age 35-39	-.708	15.915	30.679
	(-.028)	(.592)	(.741)
Mothers age 40	-110.515	-47.417	-23.455
	(-1.392)	(-.561)	(-.255)
Illegitimate	-96.834	120.694	84.325
	(-4.071)	(1.074)	(.387)
Parity	25.848	25.469	14.791
	(4.037)	(3.981)	(.522)
Male	132.836	132.754	133.359
	(11.573)	(11.573)	(11.529)
Prenatal Care Delay	-19.572	-19.096	31.548
	(-5.117)	(-4.998)	(.240)
Lambda		230.359	-269.891
		(-1.983)	(-2.328)
F - Statistic	40.376	36.721	
WU Test F		2.058	
R - Squared	.033	.034	
Observations	10,345	10,345	10,345

Table #5 Birth Probability and Prenatal Care Demand Estimates for Adult Black Women

	Birth Probability Probit	Prenatal Care (OLS)	Prenatal Care (Selection)
Intercept	2.00 (23.829)	3.23 (28.820)	3.213 (26.909)
Family Planning Clinics	.193 (1.215)		
Family Poverty %	.010 (2.44)	-.009 (-1.903)	.005 (1.041)
Education < 9	.328 (1.546)	-.075 (-.408)	.067 (.322)
High School Education	-.662 (-11.716)	-.142 (-2.109)	-.642 (-5.817)
Education > 12	-1.02 (-17.284)	-.402 (-5.207)	-1.248 (-7.649)
Abortion Providers (30 to 390)	-2.15 (-.647)		
Abortion Providers (400 +)	-5.15 (-4.72)		
Mothers age 35-39	-.430 (-6.532)	-.497 (-4.688)	-.858 (7.202)
Mothers age 40	-.857 (-5.966)	-.845 (-.331)	-.857 (3.154)
Illegitimate	-.888 (-26.071)	.932 (19.097)	.158 (1.159)
Parity		.260 (13.942)	.255 (13.311)
Women, Infants and Children Centers		.047 (.937)	-.294 (-.557)
Lambda			2.449 (6.386)
F - Statistic		80.2993	76.470
Chi - Squared	1153.3		
R - Squared		.088	.093
Observations	9,199	7,410	7,410

Table #6
Birthweight Production Functions for Adult Black Women (age>19)

	OLS	OLS (Selection)	TSLS (Selection)
Intercept	3078.25	3065.19	3221.96
	(112.473)	(108.333)	(6.722)
Education < 9	28.582	16.364	11.302
	(.507)	(.286)	(.193)
High School Education	68.003	107.985	104.140
	(3.298)	(3.677)	(2.256)
Education > 12	104.303	173.310	159.321
	(4.409)	(4.023)	(1.697)
Mothers age 35-39	38.853	67.241	44.364
	(1.196)	(1.889)	(.477)
Mothers age 40	36.091	98.294	99.427
	(.462)	(1.167)	(1.084)
Illegitimate	-65.163	-3.515	48.409
	(-4.262)	(-.099)	(.386)
Parity	18.266	18.154	31.042
	(3.161)	(3.139)	(.788)
Male	158.44	158.392	156.995
	(11.121)	(11.128)	(10.886)
Prenatal Care Delay	-22.752	-22.234	-72.302
	(-6.402)	(-6.249)	(-.478)
Lambda		-196.695	-213.418
		(-1.928)	(-1.743)
F - Statistic	27.675	25.285	
WU Test F		.346	
R - Squared	.032	.033	
Observations	7,410	7,410	7,410

Estimates of the birth probability equation for both black and white adults yielded the following results. The dichotomous variables for the completion of 12 years of schooling and for more than 12 years of schooling were both statistically significant and lower the probability of giving birth. The dichotomous variables for the mothers age being between 35 and 39 and for the mothers age exceeding 40 were both statistically significant and lower the probability of giving birth. The dichotomous variable indicating whether the mother is married is also statistically significant and lowers the probability of giving birth. The number of large scale abortion providers (400+) per 1000 women age 15 to 44 is statistically significant and an increase in the number of providers lowers the probability of giving birth. With respect to the remaining regressors used, the results are as follows. The areal variable of family poverty has no effect on the probability that a white woman will give birth while it increases the probability that a black woman will give birth. A dichotomous variable that equals one if the mother has less than nine years of schooling increases the probability of giving birth for both black and white women. However, this variable is only significant if a two tail test is applied at the 5% level of significance. If a one tail test is applied at the 5% level of significance then it becomes statistically insignificant. The number of family planning clinics per 1000 women age 15 to 44 increases the probability that a white woman will give birth while it has no effect on the probability that a black woman will give birth.

For white and black women the relationship between the number of years of completed schooling and the likelihood of aborting a pregnancy is approximately monotonic. Since there is more than one dichotomous variable measuring education the coefficient of each is compared to the omitted category which is the completion of 9 to 11 years of schooling. For both blacks and whites there is an inverse relationship between the number of years of schooling and the probability of giving birth.

Following a national trend, older women of both races are less likely to give birth than women between 20 and 34 years of age (Henshaw et al. 1985). Older women are more likely to abort because the pregnancy is more likely to be mistimed or unwanted.

When interpreting the results for the birthweight production function and the prenatal care demand function it is necessary to focus on the role of sample selection bias and on the effect of prenatal care on birthweight. There is strong evidence of sample selection in the birthweight production functions for both black and white adults. In the birthweight production functions estimated by ordinary least squares and corrected for selection, the coefficient of the inverse of Mill's ratio(lambda) is both negative and significant at the 5% level of significance. When the production functions are obtained by two stage least squares the signs are the same and the estimates are also significant at the 5% level, For both black and white adults the sign patterns among the residual covariances suggest a model that emphasizes the cost of abortion. In particular, women who abort have a lower cost of abortion and should demand more infant health. Conversely, women who give birth have a high cost of abortion and therefore allocate fewer resources to each birth.

In my view, the negative coefficient of lambda in the birthweight production function is due to the high psychic cost of obtaining an abortion in South Carolina. In fact, the birth ratios for both blacks and whites are far above the national averages. This may be one possible explanation for the fact that South Carolina has the largest rate of infant mortality in the country at 14.7 deaths per 1000 live births.

There is also strong evidence of sample selection bias in the prenatal care demand function for both blacks and whites. That is, the unobserved factors which raise the probability of giving birth are negatively correlated with the unobserved factors which decrease delay in the initiation of prenatal care. The sign of lambda in the prenatal care demand function is both negative and significant.

In estimating the prenatal care demand functions there appears to be little difference of the results by race. However, it seems clear that failure to correct for self-selection has resulted in biased estimates for every statistically significant variable, With respect to education, the dichotomous variable for less than 9 years of schooling is statistically insignificant for both blacks and whites. However, for the remaining education variables there is a direct linear relationship between the number of years of schooling and demand for prenatal care. The importance of education increases by approximately 30% when lambda is included in the prenatal care demand equation.

The results are similar with respect to the mother's age. There appears to be a direct relationship between the mother's age and the demand for prenatal care. The effect of the age on the demand for prenatal care increases significantly when controlled for selection bias for whites but remains fairly constant for blacks.

Parity is used in estimating the prenatal care demand function in an attempt to control for the mother's health endowment under the assumption that is serves as a proxy for experience with pregnancy and birth. Parity is statistically significant for both groups and reduces the demand for prenatal care. It would appear that women with a favorable health endowment seek less prenatal care. The results are fairly constant when controlled for selection.

Family poverty is statistically significant for whites only causing a reduction in the demand for prenatal care. An increase in poverty will increase delay and thus reduce birthweight indirectly.

One surprising result is that the existence of WIC Centers in the mother's county of residence has no effect on the demand for prenatal care by blacks or whites.

My estimates of the birthweight production function provide strong evidence of the existence of sample selection bias for both black and white adult women. For both groups lambda is both negative and significant at the 5% level, The results suggest that the unobserved factors which raise the probability of giving birth are negatively correlated with the unobserved factors which increase birthweight. The residual pattern of the covariances indicates that the shadow price of abortion is higher for both black and white women who give birth.

With respect to education there appears to be a monotonically increasing relationship between the number of years of completed schooling and birthweight for white adults and a more U-shaped relationship for black adults. For both blacks and whites, the dichotomous variable of less than nine years of education is statistically insignificant. When corrected for selection the effect of education on birthweight becomes even stronger. For black adults the effect of education on birthweight rises by approximately 60% when lambda is included in the birthweight equation. For white adults the effect of education on birthweight increase by approximately 16% when corrected for selection. Since more educated women are more likely to abort, those who do not may have a much higher cost of abortion. Of course, education has a direct effect on birthweight as well as an indirect effect that results from it causing a reduction in delay.

The effects of parity and male are similar in that they both cause an increase in birthweight, are statistically significant, and are unaffected by the inclusion of lambda as a regressor. Parity has a slightly larger effect on birthweight for whites while male has a larger effect on birthweight for whites.

One surprising result is that the mother's age appears to have no effect on birthweight. For both whites and blacks age is statistically insignificant.

When uncorrected for selection the OLS estimates of the effect of illegitimacy are statistically significant and indicate that it reduces birthweight. However, once corrected for selection, illegitimacy becomes statistically insignificant. This holds true for both white and black adults.

As expected the OLS estimates of prenatal care delay are negative and statistically significant. Thus, the longer the period of time between a woman becoming pregnant and when she first seeks medical care, the lower the weight of the infant at birth. For whites, each month of delay in seeking prenatal care reduces birthweight by 19 grams and for blacks by 22 grams. The results are virtually identical after correcting for selection.

For both black and white adults, the results indicate that the sample of women who choose to abort would have had a substantially higher potential mean birthweight had they carried to term than the actual mean birthweight of the sample of women who chose to give birth. This difference between the potential mean birthweight of the abortion sample and the mean birthweight of the birth sample can be attributed to both observed and unobserved characteristics. For adult black women, if both factors are taken into account, the potential mean birthweight of the abortion sample is 3417 grams compared to a mean birthweight in the birth sample of 3139 grams. This represents a difference of 278 grams or almost a 9% increase. If only the unobserved factors are considered, then this difference increases to 300 grams or 9.5%. For adult white women the results are even more dramatic. In fact, when observed and unobserved factors are taken into account, the potential mean birthweight of the abortion sample is 3728 grams compared to a mean birthweight for the birth sample of 3411 grams. This represents a difference of 317 grams or 9.3% relative to the mean birthweight of the birth sample. To gauge the magnitude of this selection effect consider that a one month delay in initiating prenatal care reduces birthweight by 19 grams or .5% for whites and by 22 grams or .6% for blacks. (see appendix #1)

In order to test whether delay should be treated as an endogenous variable in the birthweight equation, I estimated the equation using two stage least squares. In this case the fitted values of delay were substituted for the actual values of delay as right hand side regressors in the birthweight equation. The effects of prenatal care delay on birthweight were increased twofold for white women and threefold for blacks, however the estimates were not significant at the 5% level. It was therefore impossible to reject the null hypothesis of no correlation. To further test for the endogeneity of prenatal care, I applied a Wu-Hausman test in which the residuals from the delay equation were used as right hand side regressors in the birthweight equation. For adult white women the relevant F statistic is 2.058 and for adult black women the relevant F statistic is .346. Since the critical F statistic at the 5% level of significance is 3.84, I could not reject the null hypothesis of no correlation between the error term in the delay equation and birthweight.

After considering the unique conditions that exist in South Carolina, the empirical results outlined above seem to fit the situation fairly well. The fact that abortion services are not only scarce but primarily limited to urban areas coupled with the existence of a relatively poor and largely rural population would imply that these services are expensive and difficult to obtain for a large portion of the population. It remains a viable option mainly for the older, more educated, and more affluent women. The data support this conclusion. Clearly, women who give birth have a higher "shadow price" of abortion than women who abort. An increase in the "shadow price" of abortion raises the optimal number of children, lowers the optimal amount of resources allocated to each birth, and lowers the quantity of the healthy behavior input demanded. The cost of abortion is the unobservable which is the driving force.

Chapter Five: South Carolina vs New York City

In comparing my results for South Carolina to those obtained by Grossman and Joyce (1990) for New York City, a pattern emerges which reflects the demographic differences between the two areas. In particular, New York City is a densely populated urban area whose residents have easy access to health care or abortion providers while South Carolina is sparsely populated, relatively rural in nature, and whose residents have little access to health care or abortion providers. For example, the population of New York City in 1988 was 8,567,000 while in the same year the entire population of South Carolina was only 3,470,000. Further, only 60.5% of the population in South Carolina lives in a metropolitan area while the remaining 39.5% live in non-metropolitan areas. (Statistical Abstract of the United States 1990) With respect to abortion providers, only 4 out of the 46 counties in South Carolina offer any abortion services at all and only 2 counties have more than one large scale abortion provider (over 400 per year). This would appear to indicate that abortion should be the dominant unmeasured component of health outcomes.

With respect to estimates of the birth probability equation the following differences emerge. First, education has a much stronger effect on the probability of giving birth, for both blacks and whites, in South Carolina. There is a strong linear relationship with more educated women having a lower probability of giving birth. Clearly, more educated women have a lower cost of abortion and are therefore less likely to give birth. In New York City, education has less of an impact on the decision to give birth since education is not as important in lowering the cost of abortion in an area where abortion services are readily available.

As expected, the availability of abortion providers has a more important influence on the decision to give birth in South Carolina than it does in New York City. In both cases the existence of abortion providers reduces the probability of giving birth.

In South Carolina the mother's age is also more important in the decision to give birth than it is in New York City. Older women, for whom a pregnancy is likely to be mistimed, are less likely to give birth in South Carolina than in New York City.

Finally, poverty is an important factor in increasing the probability of giving birth for blacks only in South Carolina. It is statistically insignificant for whites in South Carolina and for both groups in New York City. Given the large percentage of blacks under the poverty level in South Carolina, this further emphasizes the important role of the cost of abortion in a woman's decision to give birth. It is obviously more difficult for poor black women to access abortion providers. Since South Carolina remains a poor state, unwanted pregnancies place increasing demands on the public health system and welfare programs.

As far as the prenatal care demand equation and the birthweight production function are concerned there are several important differences which emerge when comparing the results for New York City with those for South Carolina. First, Grossman and Joyce (1990) find evidence of selectivity bias in the prenatal care demand equation and the birthweight production function for blacks only. In South Carolina, I found that this is a potential problem for both black and white adults. More importantly, Grossman and Joyce (1990) find that the coefficients of lambda in both equations are positive ($\sigma_{12}, \sigma_{13} > 0$). In other words, the unobserved factors which raise the probability of giving birth are positively correlated with the unobserved factors which cause the mother to initiate prenatal care earlier in her pregnancy. The fact that both coefficients are positive is consistent with a model emphasizing the cost of contraception.

In South Carolina, estimates of the coefficients of lambda in the prenatal care demand equation and the birthweight production function are both negative and significant, regardless of race. The unobserved factors which raise the probability of giving birth are negatively correlated with the unobserved factors which decrease delay in the initiation of prenatal care and increase birthweight. In this case, the fact that both coefficients are negative is consistent with a model emphasizing the cost of abortion.

In New York City, black women are more likely to experience an unwanted pregnancy and carry it to term if they have a relatively high 'shadow price' of contraception than if they have a low 'shadow price'. They are also likely to consume less prenatal care and invest less in other healthy behaviors that improve birthweight. In South Carolina, women with a high 'shadow price' of abortion are more likely to experience an unwanted pregnancy and carry it to term than those with a low 'shadow price', regardless of race. They are also more likely to consume less prenatal care and invest less in other healthy behaviors that improve birthweight.

A second critical difference in the results is that Grossman and Joyce find that women who abort would have had a lower mean potential birthweight had they decided to give birth than the mean birthweight of the sample of women who actually gave birth. In South Carolina, the women who chose to abort would have had a higher potential mean birthweight had they given birth than the mean birthweight of the sample of women who actually gave birth. Clearly, in New York City the availability of abortion services has had an important impact on improving birth outcomes. However, in South Carolina this has not been the case. In fact, the existence of abortion services, as they exist today, has resulted in a worsening of birth outcomes.

Chapter Six: Empirical Results for Teenagers

As mentioned previously, the population of pregnant women was partitioned in order to separate adults (age≥20) from teenagers (age≤19). The purpose of following this strategy was first to make my results more comparable to previous studies and secondly in an attempt to minimize the potential problems of endogeneity which apply particularly to teenagers.

With respect to endogeneity, there are two variables of particular concern when considering teenagers. First, the number of years of school completed will obviously be related to time spent pregnant. Second, a large percentage of pregnancies to unmarried teens can be expected to be resolved as births after marriage has occurred. To address the problem of the endogeneity of education among teenagers, I include a dichotomous variable that equals one if the mother completed at least 8 years of schooling and equals zero other wise. By choosing a low cutoff it is possible to reduce the problem of reverse causality by capturing these adolescents whose educational problems existed before they became pregnant. As far as the endogeneity of marital status, the data reveals that 90% of black teenagers who gave birth were unmarried while 35% of white teenagers who gave birth were unmarried. Thus, the endogeneity of marital status is unimportant for blacks but may be a potential problem for whites.

Despite a national trend indicating a reduction in the number of births to teenage mothers, it continues to be a particularly difficult problem in South Carolina. First of all, the percentage of births to

Table # 7

Means by Pregnancy Outcome for White and Black Teenagers

	White Teenagers		Black Teenagers	
	Birth	Abortion	Birth	Abortion
Birthweight	3292.587	------	3022.91	------
Illegitimacy	.349	.948	.895	.968
Education < 9	.115	.031	.10	.066
Male	.524	-------	.506	-----
Age 17	.350	.478	.438	.532
Delay	4.003	-------	4.647	-----
Parity	.190	.082	.352	.219
Clinics	.139	.118	.171	.146
AB 30 per	.004	.005	.004	.006
AB 400 per	.006	.009	.008	.014
WIC	.629	.697	.617	.695
Family Poverty	12.496%	11.98%	14.706%	13.895%
Lambda	.419	-.636	.400	-1.233
Observations	3,805	2,506	4,553	1,477

teenage mothers in South Carolina in 1986 is far above the national average at 16.6%. Among teenagers who chose to resolve their pregnancies as an induced abortion, 95% of the whites were unmarried while 97% of the blacks were unmarried. Additionally, 14% of the births to black teenagers were light births (under 2500 grams) and 8% of the births to white teenagers were light births. The fact that many of the births to unmarried mothers are likely to be unwanted coupled with the high cost associated with light weight births underscores the importance of this problem. In fact, many publicly funded programs have recently emerged which deliver family planning services to the young and poor. In 1970, Title X was added to the Public Service Act and provided funding for family planning services. In recent years additional services have been provided through Medicaid or MCH programs. The impact of these programs on teenage mothers may be especially significant since "adolescents are largely uninformed about reproductive physiology and about many methods of contraception."[1] Despite this, recent debates focusing on the values served by planned pregnancies and women's ability to make choices affecting fertility have resulted in increasing limits on services provided through publicly funded programs. Opponents argue that family planning and abortion services have a negative impact on teenagers by increasing sexual license.

1. Morrison D.M. Adolescent Contraceptive Behavior: A Review,Psychological Review 98(3), 1985: 538.

Empirical estimates of the birth probability equation, prenatal care demand equation and the birthweight production function for black and white teenagers are presented in tables 8 through 11. With respect to the birth probability equation, mothers age less than 17, large scale abortion providers (400+), and the mothers marital status are statistically significant and their existence reduces the probability of giving birth, regardless of race. A dichotomous variable that equals one if the mother has less than 9 years of schooling is also statistically significant for both groups, however, its existence increases the probability of giving birth. The number of family planning per 1000 women and the number of small scale abortion providers (30 to 390) are important only for white teenagers and their existence increases the probability of giving birth. Finally, the percentage of families below the poverty level is insignificant for both blacks and whites.

As far as the prenatal care demand equations are concerned there appears to be significant evidence for the existence of self-selection among black teenagers while there is no such evidence for whites. For black teenagers, the unobserved factors which raise the probability of giving birth are negatively correlated with the unobserved factors which would cause the mother to initiate prenatal care earlier in her pregnancy. Furthermore, the sign pattern of the residual covariances ($\sigma_{12}, \sigma_{13} < 0$) indicate that the model emphasizing the cost of abortion is most appropriate. In other words, black teens with a high cost of abortion are more likely to give birth and will allocate fewer resources to each birth. Clearly, failure to correct for self-selection will

Table #8
Birth Probability and Prenatal Care Demand Estimates for White Teenagers

(Selection)	Birth Probability Probit	Prenatal Care (OLS)	Prenatal Care
Intercept	1.512 (19.432)	3.337 (28.760)	3.254 (25.731)
Family Planning Clinics	.606 (2.396)		
Family Poverty %	.004 (.641)	.006 (.760)	.007 (1.012)
Education < 9	.982 (11.86)	.217 (2.074)	.401 (2.602)
Mothers age < 17	-.095 (-2.377)	.256 (3.592)	.235 (3.250)
Abortion Providers (30 to 390)	5.796 (2.170)		
Abortion Providers (400 +)	--7.97 (-5.071)		
Illegitimate	-1.990 (-41.532)	.943 (13.705)	.424 (1.323)
Parity		.616 (8.244)	.611 (8.143)
Women, Infants and Children Centers		.055 (.828)	.029 (.431)
Lambda			.580 (1.657)
F - Statistic		46.867	40.580
R - Squared		.070	.070
Observations	6,311	3,805	3,805

Table #9

Birthweight Production Functions for White Teenagers (age<20)

	OLS	OLS (Selection)	TSLS (Selection)
Intercept	3323.32 (131.378)	3327.95 (117.275)	4606.16 (2.965)
Education < 9	-85.915 (-2.658)	-97.781 (-2.116)	-16.853 (-.137)
Mothers age < 17	-22.05 (-1.00)	-20.708 (-.926)	73.688 (.620)
Illegitimate	-65.08 (-2.988)	-31.584 (-.330)	316.499 (.719)
Parity	-14.822 (-.636)	-14.574 (-.625)	213.860 (.769)
Male	108.049 (5.479)	108.040 (5.483)	109.322 (3.549)
Prenatal Care Delay	-11.043 (-2.200)	-10.995 (-2.192)	-382.500 (-.853)
Lambda		-37.426 (-.359)	-35.095 (-.215)
F - Statistic	10.715	9.201	
WU Test F		.298	
R - Squared	.016	.016	
Observations	3,805	3,805	3,805

Table #10
Birth Probability and Prenatal Care Demand Estimates for Black Teenagers

	Birth Probability Probit	Prenatai Care (OLS)	Prenatal Care
(Selection)			
Intercept	1.339 (13.176)	3.756 (23.223)	3.301 (16.589)
Family Planning Clinics	.255 (1.471)		
Family Poverty %	.006 (1.181)	.002 (.267)	.015 (2.005)
Education < 9	.399 (5.832)	.218 (1.935)	.579 (4.017)
Mothers age < 17	-.233 (-6.192)	.293 (4.130)	.071 (.809)
Abortion Providers (30 to 390)	-1.876 (-.651)		
Abortion Providers (400 +)	-7.990 (-6.381)		
Illegitimate	-.642 (-7.957)	.537 (4.980)	.067 (.415)
Parity		.541 (10.201)	.541 (10.131)
Women, Infants and Children Centers		.070 (1.015)	-.053 (.710)
Lambda			2.044 (4.176)
F - Statistic		22.924	22.035
Chi - Squared	253.72		
R - Squared		.030	.032
Observations	6,030	4,553	4,553

Table #11

Birthweight Production Functions for Black Teenagers (age<20)

	OLS	OLS (Selection)	TSLS (Selection)
Intercept	3091.54	3116.59	4662.46
	(90.456)	(81.154)	(2.371)
Education < 9	-25.714	-53.554	43.175
	(-.829)	(-1.467)	(.304)
Mothers age < 17	-42.866	-25.545	88.526
	(-2.196)	(-1.117)	(.594)
Illegitimate	-35.607	.703	206.212
	(-1.199)	(.018)	(.773)
Parity	-33.891	-34.044	185.386
	(-2.296)	(2.307)	(.661)
Male	95.500	95.726	97.242
	(5.385)	(5.403)	(3.079)
Prenatal Care Delay	-11.162	-10.852	-416.592
	(-2.737)	(-2.659)	(-.807)
Lambda		-159.566	-114.62
		(-1.448)	(-.545)
F - Statistic	8.727	7.780	
R - Squared	.011	.012	
Wu Test F		.000	
Observations	4,553	4,553	4,553

yield biased estimates in the case of black teens. For example, the effects of poverty and less than nine years of education not only increase in magnitude but become statistically significant when lambda is included as a regressor in the delay equation. Conversely, the effects of mothers age less than 17 and marital status are reduced in magnitude and become statistically insignificant. The results for parity are virtually unchanged after the inclusion of lambda.

With respect to the birthweight equation, it appears that the problem of self-selection is not important for black or white teenagers. The coefficients on lambda are insignificant for both groups. Focusing on the ordinary least squares estimates which are uncorrected for selection, the variable measuring prenatal care delay is almost identical for black and white teenagers. Each month of delay in obtaining prenatal care is expected to reduce birthweight by 11 grams. The variable male is also significant and increases birthweight for both groups. For white teens the variables of less than nine years of schooling and marital status are statistically significant and negatively related to birthweight while mothers age less than 17 and parity are statistically insignificant. For black teens, mothers age less than 17 and parity are statistically significant and negatively related to birthweight while less than nine years of schooling and marital status are statistically insignificant

Finally, when the birthweight equation is estimated by two stage least squares the effects of prenatal care are increased 35 fold for whites and 38 fold for blacks. However, the estimates are insignificant at the 5% level for teenagers of both races. The null hypothesis of no effect cannot be rejected for either group.

To substantiate the conclusion that prenatal care should not be treated as an endogenous variable, I applied a Wu test in which the residuals from the delay equation corrected for selection were used as a right hand side regressor in the birthweight equation. For white teenagers the relevant F statistic is .298 and for black teenagers the relevant F statistic is 0.00. Since the critical $F_{(1,\infty)}$ at the 5% level is 3.84, I cannot reject the null hypothesis of no correlation in either the black or white specifications.

Similar to the results obtained for adults, it appears that both black and white teens who chose to abort their pregnancies would have given birth to heavier infants had they chosen to give birth. The difference between the potential mean birthweight of the abortion sample and the mean birthweight of the birth sample is 24 grams for whites and 247 grams for blacks. For whites this represents a 1% increase while it represents an 8% increase for blacks. Of course, this difference is due to both observed and unobserved factors. For whites if we consider observed factors only then the mean birthweight of the birth sample will be almost identical to the potential mean birthweight of the abortion sample. For blacks, the mean birthweight of the birth sample will be 51 grams or 1.6% less than the potential mean birthweight of the abortion sample when only observed factors are considered.

Appendix

1. To calculate the potential mean birthweight of the abortion sample I will adopt the following strategy. It is assumed that the equations for the mean birthweight in the birth sample (b_b), mean birthweight in the abortion sample (b_a), the mean value of prenatal care in the birth sample (M_b), and the potential mean value of prenatal care in the abortion sample (M_a) can be expressed as follows:

$$b_b = \beta_1 X_b + \beta_2 M_b + (\sigma_{12}/\sigma_1)\lambda_b$$

$$b_a = \beta_1 X_a + \beta_2 M_a + (\sigma_{12}/\sigma_1)\lambda_a$$

$$M_b = \gamma_1 Y_b + (\sigma_{13}/\sigma_1)\lambda_b$$

$$M_a = \gamma_1 Y_a + (\sigma_{13}/\sigma_1)\lambda_a$$

where

λ_b = the mean of the inverse of Mill's ratio for the birth sample

λ_a = the mean of the inverse of Mill's ratio for the abortion sample X_b,X_a = the mean values of the determinants of birthweight in the birth and abortion samples

Y_b,Y_a = the mean value of the determinants of prenatal care demand in the birth and abortion samples

Since the values of λ_a and M_a are not observed for women who have abortions it is necessary to obtain their values through the following procedure. To estimate λ_a I take advantage of the following relationship:

$$0 = \lambda_a(1-p) + \lambda_b(p)$$

where

p = the proportion of women who give birth

Because λ_b and p are observed it is a simple matter to obtain λ_a.

To estimate M_a I use the following equation:

$$M_a = \gamma_1 Y_a + (\sigma_{13}/\sigma_1)\lambda_a$$

Finally, in order to find b_a I use the following equation:

$$b_a = \beta_1 X_a + \beta_2 M_a + (\sigma_{12}/\sigma_1)\lambda_a$$

where

β_1 = the coefficients of the determinants of birthweight after correcting for selection in the birth sample

β_2 = the coefficient of prenatal care delay in the birthweight equation after correcting for selection in the birth sample

The difference in the mean birthweight between the birth and abortion samples can then be calculated as follows:

$$b_b - b_a = \beta_1(X_b - X_a) + \beta_2(M_b - M_a) + (\sigma_{12}/\sigma_1)(\lambda_b - \lambda_a)$$

The first two terms capture the differences due to observed characteristics while the third term represents the difference in mean birthweight due to unobserved characteristics. It should be noted that the variable "male" in the X_a vector was not observed for women who aborted. It was therefore assumed that the proportion of male infants was the same for both groups. The values obtained are given below:

<u>Adults</u>

<u>Variable</u>	<u>White Adults</u>	<u>Black Adults</u>
b_a	3410.559	3138.890
b_a	3727.589	3417.295
λ_b	.177	.297
λ_a	-.896	-1.230
M_b	2.751	3.670
M_a	3.801	5.808

Variable	White Adults	Black Adults
σ_{12}/σ_1	-230.359	-196.695
σ_{13}/σ_1	-2.116	-2.450
$b_b - b_a$	-317.031	-278.405

Teenagers

Variable	White Teens	Black Teens
b_b	3292.59	3022.91
b_a	3364.085	3269.972
λ_b	.419	.400
λ_a	-.636	-1.233
M_b	4.00	4.647
M_a	4.312	6.252
σ_{12}/σ_1	-230.359	159.566
σ_{13}/σ_1	-.580	-2.044
$b_b - b_a$	-24.318	-247.062

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