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The Effect of Prenatal Care in Preventing Potentially Avoidable Maternal Complications (PAMCs); An Empirical Investigation with Emphasis on Racial Disparities in Access and Outcome

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THE EFFECT OF PRENATAL CARE IN PREVENTING POTENTIALLY AVOIDABLE MATERNAL COMPLICATIONS (PAMCS); AN EMPIRICAL INVESTIGATION WITH EMPHASIS ON RACIAL DISPARITIES IN ACCESS AND OUTCOME

by

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Dedication

This is dedicated to my loving and generous husband, Dr. Ramy Naguib, and my Kids Ryan, Robert and Rana. Thank you for adding joy to my life.

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I would like to thank the members of my dissertation committee, Dr. Albert Okunade, Dr.Andrew Hussey, Dr. Oleksandr Nikolsko-Rzhevskyy, and, in particular, Dr. Cyril Chang, for their wise guidance and assistance throughout my studies and the development of this dissertation. Dr. Okunade made time for discussions and offered advice and guidance, not only for my research but also throughout my Ph.D. years. His wise guidance helped me overcome any obstacles. Dr. Hussey made time for discussions and offered critical observations on the breadth and depth of econometrics and economics in general. Dr. Nikolsko-Rzhevskyy provided continuing critical suggestions that lead to improvements of this study. Dr. Chang provided leadership, deep insights on, and thoughtful consideration into the notions and details of health economics research. Without his help and wise guidance I might still be navigating blindly for opportunities available for relevant and interesting research.

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ABSTRACT

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The Effect of Prenatal Care in preventing Potentially Avoidable Maternity Complications (PAMCs); An Empirical Investigation with Emphasis on Racial Disparities in Access and Outcome. Major Professor: Dr. Cyril Chang, Ph.D.

This dissertation is composed of one essay that utilizes the Shelby County Birth Certificate Data for the years 2004-2006 to propose three models that evaluate the effectiveness of prenatal care in preventing Potentially Avoidable Maternal Complications (PAMCs) among different ethnicity groups while making a case for its relevance to economic theory and public policy. The complications can be reduced through effective prenatal care. Given the ethnical diversity of the U.S., and the observed disparities in maternal complications and access to prenatal care, it is critical that I analyze the relationship between prenatal care and maternal complications.

To correct for the endogeneity of prenatal care -following an accepted econometric remedy to the problem of endogeniety- this study applies a simultaneous equation model that includes predicted rather than estimated values of prenatal care to correct for the inconsistency and biasedness.

To further examine this relationship and to improve the model, I apply the Hurdle estimation approach combined with the Simultaneous Equation model. This approach confirmed the inverse relationship between prenatal care and PAMC with greater magnitude for estimates than the previous model. Blacks, women ages 30-35, and women with lower years of education were less likely to receive prenatal care and hence, more likely to experience PAMC. However, for some variables such as white women, underweight, overweight and obese women, were significantly more likely to receive

prenatal care and also significantly more likely to experience PAMC, opposing our original hypothesis.

Therefore, I further apply the Blinder Oaxaca decomposition model to count for observed and unobserved factors causing the disparities between ethnicities in prenatal care access and experiencing PAMC. Results demonstrate that education, Body Mass Index, and type of insurance, are significant contributors to widening the explained differences between Hispanic mothers and mothers of other ethnicity groups.

In summary, this study helps to pave the way toward a role for health economics in emerging research on prenatal care and pregnancy complications. As health care expenditures consume an ever larger portion of U.S. national output, insights on the relationship between prenatal care and PAMCs through an economic lens underscore the significance of this study.

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CHAPTER ONE

INTRODUCTION

Pregnancy and childbirth are generally times of joy for parents and families. An environment that cares for women's health raises the odds of safe motherhood and healthy childbirth. Unfortunately, each year, around the world more than half a million women die from preventable conditions related to pregnancy and child birth, and nearly 4 million newborns die within 28 days of birth (Unicef 2009). Even mothers in the U.S. don't fare as well as might be expected. In 1980, only 12 women died from causes related to pregnancy or delivery for every 100,000 live births. However, in 2008 maternal mortality rate rose dramatically with 17 women death for every 100,000 live births. This rise in maternal mortality rate is very surprising, especially since the U. S. has one of the highest growth rates in health care spending. The share of GDP devoted to health care spending grew from 9% of GDP in 1980 to 16% of GDP in 2008. This 7% increase in health spending as a share of GDP is one of the largest across the OECD countries (Kaiser Family Foundation, 2011).

Prenatal care has been recognized as the cornerstone of the U.S. health care system for pregnant women and public health intervention focused on reducing low birth weight and preterm birth by increasing prenatal care (Alexander and Kotelchuck 2001). The prevailing characterization of prenatal care as a public health intervention focused on reducing low birthweight and preterm birth. During the last several decades, a decrease in infant mortality rates has occurred in spite of rises in the rates of low birth weight and preterm birth which reflects the public health approaches (National Center for Health Statistics, 1995). More attention has been devoted to increasing prenatal care services, supported by several studies that linked inadequate prenatal care to low birthweight and

preterm birth (Alexander and Kotelchuck 1996, 2001; Kogan, Alexander, et al. 1994). In 2010, 7.4% of Shelby County mothers had no prenatal care, which is a higher percentage than across the state, compared to 2.1% (*Data book 2012: Health* 2012). Consequently, the infant mortality rate in Shelby County in 2010 remains more than 50% higher than the national rate (10.3 vs. 6.1 infant deaths per 1,000 live births), while the percentage of preterm births (12,8%) higher than the national percentage of 12% (*Data book 2012: Health* 2012). However, much less attention has been directed to the association between prenatal care and maternal deaths and maternity complications.

Potentially Avoidable Maternity Complications (PAMC) and their Significance

PAMCs are conditions that may often be preventable through access to prenatal and primary care of reasonable quality, or through maternal healthy behaviors often promoted by prenatal care such as premature delivery, deliveries complicated with anemia, intrauterine death, complications associated with drug, alcohol or tobacco abuse and premature rapture of membranes (Laditka, Laditka, and Probst 2006a). The PAMC indicator development team was led by Sarah B. Laditka, and included James N. Laditka, Melanie Mastanduno, Michele Lauria, and Tina Foster"(Laditka et al. 2005). In their study, Laditka et al.'s concept is that PAMCs are "a set of pregnancy-related complications defined by an inter-disciplinary team of experts on access to health services and health disparities. PAMCs are defined for antepartum, delivery, and postpartum hospitalizations". Research suggests that minorities have a higher prevalence of gloomy conditions (Lu and Halfon 2003). Thus, PAMC might provide an improved indicator for comparing pregnancy outcomes among different race/ethnicity groups.

The lifetime risk of maternal deaths is greater in the U. S. than in 40 other countries (Deadly Delivery: The Maternal Health Care Crisis in the USA 2010). The report also noted severe pregnancy-related complications that nearly caused death have increased by 25 percent since 1998. Up to 40 percent of near misses are considered preventable with better quality of care (Geller et al. 2007). Furthermore, the report shows in a state-by-state examination that Tennessee ranks 38th in maternal mortality, with 11.7 deaths per 100,000 live births. While in 2004, Tennessee ranked 48th in overall health and 42nd in women's overall health, with poor maternal health as a leading contributor to poor birth outcomes. Complications associated with pregnancy affect many women, and disproportionately those in minority groups (Deadly Delivery: The Maternal Health Care Crisis in the USA 2010).

This dissertation uses the Shelby County Birth Certificate Data for the years 2004, 2005 and 2006 to evaluate the effectiveness of prenatal care in preventing Potentially Avoidable Maternity Complications (PAMC) among different ethnicity groups (non-Hispanic black, non-Hispanic white, non-Hispanic other race, and Hispanics) to analyze differences in access and outcome.

Several past studies reported Black women as more likely to have pregnancy complications than non-Hispanic White (Alexander and Cornely 1987b; Bennett et al. 1998). Black women are more likely to die from pregnancy-related complications or to have fetus or infant who dies than women of other race (Kallan 2001; Centers for Disease Control 2001).

Sadly, disparities in maternal complications and birth outcomes for Hispanic women have received less attention (Vargas Bustamante et al. 2010; Albrecht and Miller

1996), especially since the Hispanic population is the fastest growing minority group in U.S. According to the U.S. Census Bureau, the Hispanic population increased by 15.2 million between 2000 and 2010, accounting for over half of the 27.3 million increase in the total population (Ennis, Ríos-Vargas, and Albert 2011). The recorded resident Hispanic population in Tennessee grew 35% from 2000 to 2004, while Shelby County ranks the 2nd county with the highest growth in resident Hispanic population (Bruch and Ziehl 2006). Hispanics will be the largest minority group in the U.S., representing 26.4% of the total U.S. population, while Blacks will be the second largest minority group comprising 13.5% of the population (Ennis, Ríos-Vargas, and Albert 2011).

Among the few studies of pregnancy complications for Hispanics, findings were mixed, since Hispanics in various subgroups (e.g. Cuban Americans, and Mexican Americans) differ in social and economic characteristics (Balcazar, Cole, and Hartner 1992). Albrecht and Miller (1996) found that Cuban Americans are at lower risk of pregnancy related morbidity, compared with other Hispanic subgroups. Other studies discussed the Hispanic paradox, also known as the "epidemiologic paradox", which refers to the finding that Hispanics tend to have health outcomes comparable to, or in some cases better than those of their U.S. Non-Hispanics, even though Hispanics have lower average income and education (Franzini, Ribble, and Spears 2001). Hence, the present study presents an examination of association between adequate prenatal care access and improved delivery and birth outcomes of different race/ethnicity groups of women compared to Hispanic women.

Reducing disparities in health status and access to health care among ethnic groups have recently become a major focus of interest in the U. S. In the past few

years, the US Department of Health and Human Services has launched major initiatives in this area (US Department of Health and Human Services 2010), including the Healthy People 2020 goal of eliminating "health disparities among different segments of the population" and activities at the National Institutes of Health supporting research to better understand ethnic disparities role in improving birth outcomes such as infant mortality, neonatal mortality, low birth weight, and preterm birth rates (Fiscella 1995). Counseling regarding the appropriate diet, drug and alcohol avoidance and timely treatment of complications are the major components of prenatal care (Alexander and Korenbrot 1995b). Particular attention has been devoted to research on the effects of prenatal care on low birth weight, and most research found a direct association between adequate prenatal care and increased birth weight or inadequate prenatal care and low birth weight (Joyce 1995). Moreover, researchers concluded that differentials in prenatal care access among different ethnicity groups are main reason for the increased low birth weight rates for blacks, since black women obtain less prenatal care than whites (Frank et al. 1993).

There is a dearth of research evaluating the role of prenatal care in reducing or preventing potentially avoidable maternity complications (PAMC) and no research has taken the econometric approach. Past researchers mostly used one-stage estimation by performing a simple logit regression of PAMC on maternal characteristics and access to prenatal care (Laditka, Laditka, and Probst 2006b; Laditka et al. 2005). These studies ignored the tendency for a pregnant woman to have information on her health endowment (for example, genetic makeup) that may influence her decision on access to prenatal care. Past studies, therefore, tend to underestimate the effect of prenatal care utilization and

can miss important differences in health care access among ethnic groups due to this endogeneity of prenatal care. Econometric theory suggests that the endogeneity problem in prenatal care and birth outcome can be remedied using a simultaneous equations model and three-stage least squares estimation technique. In the first stage, prenatal care equation is estimated on mother's socio-economic and demographic characteristics and the price of prenatal care which is measured by insurance coverage. In the second stage, the predicted value of prenatal care is used to estimate the birth outcome equation. To my knowledge this technique has not yet been applied to evaluate the role of prenatal care on PAMC.

The Research Question

This study focuses on illuminating the role of prenatal care in reducing or preventing potentially avoidable maternity complications (PAMC). Access to prenatal care will be evaluated and examined among different ethnicity groups to determine how differences in prenatal care visits impact pregnancy complications among these groups and how the level of prenatal care utilization is dependent on the ethnicity of the mother. Furthermore, this study aim is to determine what differences in prenatal care access and experiencing complications can be attributed to observed factors such as income, education and health insurance coverage; and unobserved factors such as their health endowments, religious beliefs and their perception about health necessities. This should help policymakers to develop strategies to reduce disparities in prenatal care access and experiencing PAMC.

New Contribution

As previously mentioned, past studies that evaluated the relationship between prenatal care and pregnancy complications, tend to underestimate this relationship and differences among the ethnicity groups due to the endogeneity of prenatal care. The present study extends the literature in several ways. This study is among the few examining the association between prenatal care and PAMCs among the ethnicities and different types of insurance coverage. Economists have mostly studied the relationship between prenatal care and birth outcomes, however, less attention, if any, has been paid to examine the impact of prenatal care on PAMCs through an econometric model. Moreover, to my knowledge, this is the first study to use the three-stage least squares approach to estimate the impact of prenatal care on PAMC. The two-stage least squares approach has been adopted by many economists in estimating the association between prenatal care and improved birth outcomes to avoid the endogeneity problem of prenatal care. This approach led to consistent and unbiased estimates, and significant regression estimates. However, three-stage least squares has not yet been applied to evaluate the relationship between prenatal care and PAMCs. The few related studies reported inconsistent estimates because they did not take into consideration the endogeneity of prenatal care by not using two stage least squares estimation. Furthermore, since complicated pregnancies tend to entail more prenatal care visits, while healthy women have relatively fewer prenatal care visits, I also include predicted PAMC value with maternal characteristics in the prenatal care visits equation.

The analysis is further refined by evaluating access to prenatal care in a two-step econometric approach, often referred to as the Double-Hurdle or Cragg Model (Cragg

1971). In the first step, the pregnant mother decides whether or not to seek prenatal care and then, in the second step, the frequency of prenatal care use, i.e. number of visits, will be determined by the gynecologist. Therefore, the mother's frequency of prenatal care utilization cannot be evaluated unless the decision is initiated to access prenatal care.

Furthermore, this study extends past examining racial and ethnic disparities in prenatal care utilization and mother's experience of PAMCs. Several studies found differences among ethnic groups in access to prenatal care and in experiencing pregnancy complications (Stinson and Thurston 2002; Paqueo and Gonzalez 2003; Aizer, Lleras-Muney, and Stabile 2004). Even after controlling for other included exogenous variables such as maternal age, education, income and insurance coverage, the disparities are still to be found.

Disparities among ethnicities may be divided into two parts, observed characteristics and unobserved factors. Differences in observed characteristics such as income, health insurance coverage or health status will likely affect health care access and utilization. Yet there are unobserved factors that contribute to these disparities. Ethnic groups may have different cultural attitudes in regards to modern medicine techniques, or their different perception about health necessities and look for health services mostly when the problem is serious and often irreversible. Even language itself may represent an important barrier to health care access.

To develop policies targeted at reducing disparities in prenatal care access, it is important to identify the factors most strongly associated with differences in access and in PAMC. This study uses the Blinder-Oaxaca decomposition technique (Blinder 1973b; Oaxaca 1973b) to identify the factors explaining the disparities among ethnicity groups,

and to investigate the extent to which differences in access to prenatal care and the incident of complications may be explained by observed characteristics and unobserved characteristics.

Study Organization

This study proceeds as follows. In chapter 2, I present a literature review where I discuss previous research on the subject of disparities in prenatal care access and in experiencing Potentially Avoidable Maternity Complication (PAMC). Chapter 3 describes the theoretical model and the data. Chapter 4 presents and discusses the descriptive statistics of the data and the regression models. Chapter 5 draws conclusions and makes recommendations. The study limitations and possible future extensions of this work are also presented.

CHAPTER 2

LITERATURE REVIEW

The goal of this chapter is to present the major factors that affect access to prenatal care and in return adverse pregnancy outcomes. In this chapter I will present the major conceptual areas that were discussed in previous studies on adverse pregnancy outcomes. These areas are prenatal care, race/ethnicity, insurance and education. However, first a detailed demonstration is given of the adverse outcome in my study, which is Potentially Avoidable Maternity Complications (PAMC).

Potentially Avoidable Maternity Complications (PAMC)

Complications of pregnancy affect many women and infants. Antepartum hospitalization for pregnancy related complications is very common with greater risks for minority women (Bennett et al. 1998; Laditka et al. 2005). Previous studies developed a broader classification system for complications, defining complications with Diagnosis Related Complications (DRGs), which are complications focused exclusively on antepartum hospitalizations (Bennett et al. 1998; Saftlas 1994). Nevertheless, a focus on antepartum period may overlook an important proportion of potentially preventable complications. A more recent study, found that 31% of women experienced morbidity during labor and delivery, after excluding those with caesarean delivery (Danel et al. 2003).

A similar indicator to potentially preventable complications has emerged to indicate access to primary care, which is hospitalization for ambulatory care sensitive (ACS) conditions (Billings et al. 1993; Laditka, Laditka, and Mastanduno 2003; Pappas et al. 1997). ACS has emerged as an indicator of access to primary care (Laditka, Laditka, and Mastanduno 2003; Billings et al. 1993) and has been adopted by the Agency

for Health Care Research and Quality (AHRQ Quality Indicators: Guide to Prevention Quality Indicators: Hospital admission for ambulatory care sensitive conditions 2001) as a Prevention Quality Indicator. This indicator measures the outcomes of preventive care for both acute illness and chronic conditions, reflecting two components of the quality of preventive care, effectiveness and timeliness (AHRQ 2001).

In 2005, Laditka et al. developed a similar indicator and extended the Prevention Quality Indicator concept to maternity care. They were the first to define a comprehensive set of pregnancy-related complications, using hospital discharge data, which specifically focus on conditions that might be preventable through access to adequate prenatal care, or through healthy behavior that may be often promoted by adequate prenatal care. Both, Potentially Avoidable Maternity Complications (PAMCs) and preventable hospitalization indicator, are based on the concept that timely access to health care can reduce the incidence of certain medical complications. PAMCs focus on diagnoses that are less likely to occur during delivery hospitalizations if the mother has had adequate prenatal care (Laditka et al. 2005). They also include specific complications that may be associated with antepartum or postpartum hospitalizations, which could be prevented through timely treatment and behavior counseling during pregnancy (Medicine 1986, 1988).

PAMCs are conditions that may often be preventable through access to prenatal and primary care of reasonable quality, or through maternal healthy behaviors often promoted by prenatal care, such as premature delivery, deliveries complicated with anemia, intrauterine death, complications associated with drug, alcohol or tobacco abuse and premature rapture of membranes (Laditka, Laditka, and Probst 2006a). Research suggests

that minorities have a higher prevalence of gloomy conditions (Lu and Halfon 2003). Thus, PAMCs might provide an improved indicator for comparing pregnancy outcomes among different race/ethnicity groups.

Two recent studies reported the benefit of using the PAMC indicator to examine disparities in delivery outcomes. One focused on a large sample of U.S. hospitals, found that Black women had higher PAMC risks at delivery than Whites (Laditka et al. 2005). Another focused on a smaller sample, Medicaid recipients, and found that, in rural areas, Blacks had significantly higher risks of PAMCs than Whites (Laditka, Laditka, and Bennett 2005).

A limitation to these studies is that they tend to neglect detailed individual socio-demographic information, aside from race/ethnicity, age, and in some instances income measures. This shortcoming leaves a gap in the maternal health literature. My study uses the PAMC indicator to investigate differences in outcomes associated with the accessibility and qualities of prenatal care among non-Hispanic Black, non-Hispanic White, non-Hispanic other race, and Hispanic women. As previously mentioned, the PAMC indicator was developed by Sarah B. Laditka, Ph.D., and included James N. Laditka, D.A., Ph.D., M.P.A., Melanie Mastanduno, R.N., M.P.H., Michele Lauria, M.D., M.S., and Tina Foster, M.D., M.P.H., M.S., of which two are board certified obstetricians and gynecologists (Laditka et al. 2005). The authors also include three health services researchers experienced in studying access to health care and health disparities, two of whom have clinical experience as registered nurses. Moreover, the authors conducted a literature review to identify and confirm each PAMC as a pregnancy related complication

that might have been prevented through routine primary or obstetrical care and reasonably healthy behaviors.

Previous studies suggest that, African American have higher PAMC compared with non-Hispanic whites (Bennett et al. 1998; Lu and Halfon 2003). Among various groups of Hispanic women, demographic and social characteristics vary remarkably which cause disparities in access to prenatal care (Albrecht and Miller 1996). For example, in their study, Albrecht and Miller (1996) concluded that Cuban Americans have higher levels of prenatal care and in return less pregnancy-related morbidity, than other Hispanic women. Nevertheless, prior research did not examine the relationship between PAMC and prenatal care access for Hispanics compared to other ethnicity groups. Hence, in this study I investigate the relationship between adequate prenatal care and the incidence of PAMC among different ethnicity groups compared to Hispanics. I hypothesize that some ethnicity groups who are more likely to experience prenatal care access barriers, will have higher PAMC risks (Laditka, Laditka, and Mastanduno 2003; Lu and Halfon 2003; Weissman, Gatsonis, and Epstein 1992).

Prenatal Care

History of Prenatal Care

Prenatal care has been recognized as the cornerstone of the U.S. health care system for pregnant women since the beginning of the twentieth century. The approach to prenatal care was originally based on the detection and treatment of preeclampsia, and later, preterm birth (Tausssig 1937; Lobenstine 1926; Thompson 1990). The emphasis in the delivery of prenatal care services has continued to change from focusing on conditions of the mother to conditions of the fetus, as low birth weight and infant

mortality continued to increase (Alexander and Kotelchuck 2001). A number of studies have indicated a relationship between the use of prenatal care services and birth outcomes. Several studies concluded that prenatal care could reduce the risk of low birthweight and preterm births, and resulting mortality (Peoples and Siegel 1983; Lieberman et al. 1987; Koonin et al. 1991; Eastman 1947).

In 1947, Eastman concluded a reduction in risk for low birthweight among mothers who received "adequate prenatal care", defined as having three or more visits (Eastman 1947). Subsequent studies further examined this relationship, however, their results were conflicting and nonsignificant (Yankauer, Goss, and Romeo 1953; Kane 1964). In 1962, Schwartz suggested a new aspect to the relationship between low birthweight and prenatal care (Schwartz 1962). He concluded that women who start prenatal care late have lower rates of very low birthweight compared to mothers who initiated early prenatal care, as they are approaching full term before their care begins (Schwartz 1962).

The next major development in prenatal care research came in mid 1970s with a report by Kessner et al(Kessner, Kalk, and Singer 1973). This report proposed a new index that demonstrated a systematic relationship between levels of prenatal care utilization and low birthweight using a large population database. The three factor prenatal care utilization index proposed by Kessner et al. takes into account the month of pregnancy in which prenatal care begins, the number of visits adjusted for the gestational age at delivery, and the site of care (private vs. public). Further studies that implemented this index showed that the percentage of low birthweight births decreases with increasing adequacy of prenatal care (Kotelchuck 1994; Alexander and Korenbrot 1995a).

While the site of care was intended as a measure of quality of care, some subsequent studies did not employ this index due the either not having the information or not agreeing with its use as measure of quality (Alexander and Kotelchuck 2001). The Kessner index has been criticized as an incomplete index for the utilization of prenatal care. The trimester that care began does not take into account subsequent prenatal care visits. For example, a woman who began care in the first trimester but had no more visits and a woman who began care in the first trimester and 13 regularly spaced visits would be similarly classified (Kotelchuck 1994). The Kessner index misclassifies prenatal care utilization adequacy among women who had a pregnancy for more than 36 weeks gestation (Kotelchuck 1994). For those women, it requires only 9 visits to be "adequate", while the American College of Obstetricians and Gynecologists (ACOG) recommends more than 9 visits (Gynecologists 1985).

The index was further modified by Gortmaker to the Adequacy of Care Index in 1979 and is now commonly used in the surveillance of prenatal care (Gortmaker 1979). Then in 1987, Alexander and Corneley markedly improved the Kessner index by categorizing pregnant women into six groups: those receiving no care, inadequate care, intermediate care and those for whom such information is missing or unknown (Alexander and Cornely 1987a).

This shows that prenatal care became established as the main policy goal of public health intervention for preventing low birthweight and preterm births, with the concept that by reducing the occurrence of these adverse outcomes, infant mortality, maternal complications and related care costs would be decreased because fewer high risk infants would be delivered. Consequently, even though the traditional core

component of prenatal care remains the obstetric visit, prenatal care importance is highly valued through public health policies, such as providing WIC nutrition services, due to its importance in reducing health care costs and improving mother and infant health.

Nevertheless, none of the above mentioned indices has completely overcome the problem of controlling for gestational age bias. As part of this problem is due to inaccuracy in the measurement of gestational age, part of the solution lies in improving the valid measurement of prenatal care access, like two stage regressions to control for the influence of gestational age bias.

Disparities in Prenatal Care Access

Concerns have been raised that not all racial, ethnic and socioeconomic groups have similarly benefited from advances in prenatal care. Many previous studies have suggested that women with poor pregnancy outcomes had less improvement in their access to and use of prenatal care (Misra D 1998; Alexander, Kogan, and Nabukera 2002). Most studies find that African American women receive significantly less prenatal care than white women, and are more likely to have maternity-related complications (Clarke et al. 1995; Bennett et al. 1998; LaVeist, Keith, and Gutierrez 1995; Saftlas 1994). Some researchers attribute this result, in part, to disadvantages across the life course for women in minority groups, as well as stress associated with discrimination (Dole et al. 2004; Lu and Halfon 2003).

Hispanic women, however, are more likely to have inadequate prenatal care with the lowest rates of early prenatal care and highest rates of late or no prenatal care of any ethnic group (NC Latino Health, 2003). Additional factors associated with possible adverse outcomes include language barriers, unemployment and poverty (Pope 2005).

Despite these barriers, maternal and birth complications are lower in Hispanic women in this population (Brown et al. 2007; Leslie, Diehl, and Galvin 2006). Hence, in this study, I apply the Blinder Oaxaca model to account for observed factors and observed factors contributing to this paradox.

Prenatal Care Research Challenges

A major challenge affecting prenatal care utilization is the health endowments and reproductive histories of mothers. Such factors have been among those creating the greatest concern over endogeneity (i.e., self-selection) bias in studies of the effect of prenatal care and other interventions on maternal complications birth outcomes (Alexander and Korenbrot 1995a). It is reasonable to expect that women who have health problems or have, in the past experienced difficult pregnancies, will be more likely to seek early and above average care (Clarke et al. 1999). It is also more likely that such women will experience an adverse birth outcome. Positive selection would occur, for example, if more highly educated women are more apt to acquire adequate care and, because of higher quality of life, also experience more favorable pregnancy outcomes.

Past research has shown the salience of most or all of these determinants. In this study, our interest is the degree to which these endowments affect prenatal care utilization among women as distinct as socioeconomic status (SES) and demographic characteristics among various ethnicity groups. This study corrects for endogeneity by applying a Simultaneous Equation Model, using predicted values of prenatal care rather than observed values of prenatal care. I further examine the distinction between actual use of care (utilization) and the degree to which SES characteristics and demographics facilitate or impede use (access) by applying a Double Hurdle model.

Finally, still a limitation of past studies on the use of prenatal care is the difficulty to examine the content of prenatal care. Peoples-Sheps et al., recognized that significant shortcoming in studying the relationship between maternal and birth adverse outcomes was the lack of information on the content of prenatal care (Peoples-Sheps, Kalsbeek, and Siegel 1988). An examination of the National Maternal and Infant health Survey (NMIHS) data indicated that advice on prenatal health behavior is not a uniform feature of all prenatal care (Kogan, Kotelchuck, et al. 1994) . Moreover, one third of the women surveyed reported receiving no prenatal care advice on alcohol, tobacco, or drug use, and approximately 50% received no prenatal information on breast-feeding (Kogan, Kotelchuck, et al. 1994). In a recent review of prenatal programs, Fink et al. indicated that much more progress in measuring the effectiveness of the content of prenatal care needs to be achieved (Fink, Yano, and Goya 1992). The authors noted that the criteria for determining the appropriate content of prenatal care remains an unsolved and major public health issue, one that is currently inadequately covered in literature on prenatal care.

Ethnicity

Ethnicity is difficult to define and is a poor marker for genetic variation; however, race could serve as a proxy for other measures. Such disparities in complications, which are attributed to the experience of living in the United States, prompt the question of race/ ethnicity groups' differences in access to healthcare and health outcomes.

Population differences in pregnancy complications and outcomes have become a major concern for policy makers. Many previous studies have found that African American women are more likely to experience adverse pregnancy and birth outcomes

than white or Hispanic women (Branum and Schoendorf 2002)Center for Disease Control, 1999). Clearly, disparities exist in pregnancy and delivery outcomes, which are based on race or ethnicity, but the causes of these disparity outcomes and therefore the solution to the problem of health disparities are less clear.

African American women illustrate this disparity in pregnancy across socioeconomic status with increased rates of adverse outcomes such as preterm birth, low birth weight, and poorer adverse maternal outcomes when compared to white women (State-specific maternal mortality among black and white women-United States, 1987-1996; Brown et al. 2011). Paradoxically, Hispanic women often possess similar or worse socioeconomic determinants of birth outcomes such as employment status, poverty, late entry to prenatal care and language barriers when compared to African American and white women in the United States. However, poor birth outcomes, such as preterm birth, infant mortality, and low birth weight are often lower when compared to African –American and White women in populations from similar socioeconomic circumstances (Brown et al. 2007; Guendelman et al. 2005, 2006a, 2006b).

Hispanic women are more likely to have inadequate prenatal care with the lowest rates of early prenatal and highest rates of late or no prenatal care of any ethnic group (Guendelman et al. 2006b). Additional factors associated with possible adverse outcomes include language barriers, unemployment, and poverty (NC Latino Health, 2003). Despite these barriers, standard adverse outcome measures, like preterm birth and low birth weight rates are lower in Hispanic women (NC Latino Health, 2003; Pope 2005). Hence, in this study I apply the Blinder Oaxaca model, to determine what are the observed factors and the unobserved factors that contribute to this epidemiological paradox.

Insurance

There has been substantial policy interest in whether the provision of health coverage to pregnant women affects access to prenatal care and birth outcomes. Prior studies suggested that poor birth outcomes might be related to limited access to prenatal care (Joyce 1999; Haas et al. 1993). To improve access to health care for economically disadvantaged, public policies were targeted at expanding Medicaid eligibility. In their study on the impact of expanding Medicaid eligibility on prenatal care access for pregnant women, Dubay et al., found substantial and statistically significant declines in the rate of inadequate prenatal care among women with large increases in Medicaid enrollment. However, some uninsured pregnant women may be eligible for Medicaid but not enrolled. The cost of care continues to construct a barrier to obtaining timely prenatal care and consequently more adverse outcomes for pregnant women and infants. Beckman et al., in their study of women who sought prenatal acre after the 20th week of gestation, found the cost of care to be a major barrier to seeking early prenatal care (Beckmann, Buford, and Witt 2000). Other studies concluded that ability to pay was primary cause for women initiating late prenatal care (Strickland and Strickland 1996; Rogers and Schiff 1996) . And in a study by Melnikow and Alemagno of women who had received no prenatal care or inadequate prenatal care, women with no health insurance were more than five times more likely than insured women to skip or delay care (Melnikow and Alemagno 1993).

In addition to financial barriers, however, there are non-financial barriers to care that present challenges to improving rates of early and adequate prenatal care among women,

such as mother's age, lack of education and obesity, while the latter is the cause for adverse birth outcomes but not limited access to prenatal care which will be presented in my model.

Other Variables in the Model

In 1988 the Institute of Medicine conducted a detailed review of the literature dealing with determinants of the inadequate receipt of prenatal care, and consequently poor birth outcomes (Medicine 1988) . In addition to race, the institute identified mother's age, lack of education and lack of insurance as key determinants for limited prenatal care access and adverse birth outcomes. In the following, we'll talk about how every determinant has been presented in literature.

CHAPTER THREE

THE THEORETICAL MODEL

The presence of endogeneity causes inconsistent estimates of the regression, and the estimates can no longer be given a causal interpretation. Terza et al. (2008) in her study on approaches to correcting for endogeneity bias in nonlinear models, concluded that endogeneity could be remedied through a two-stage regression process in which the endogenous variable is regressed in the first stage on a set of exogenous variables. In the second stage regression estimation, the endogenous variable is replaced by its first stage predictor.

As reviewed in chapter two, most previous studies examined the relationship between prenatal care and PAMC using a single-equation regression model. This technique neglects the fact that a pregnant woman may have information regarding her health endowment which may influence her decision on accessing prenatal care access. Furthermore, they tend to underestimate the effect of prenatal care due to the endogeneity of the variable. In the current study the problem is remedied through the construction of a simultaneous equation model applying a three-stage least squares technique. In the first stage, the prenatal care equation is regressed on mother's socio-economic and demographic characteristics and price of prenatal care which is represented by insurance coverage. In the second stage, the predicted value of prenatal care is used to estimate the birth outcome equation.

The three-stage estimation model was introduced by Zellner an Theil in 1962, and combines two-stage least squares (2SLS) with seemingly unrelated regressions (SUR) (Zellner and Theil 1962). This estimation is used when there is pairwise error correlation.

If the error term are not correlated, the two-stage least squares (2SLS) and three-stage least squares (3SLS) coefficients will be identical (Belsley 1988). Hence, I use 3SLS, in case the error terms across equations are correlated.

Simultaneous Equation Model:

Let us consider the following simultaneous equation model:

PNCV = f (PAMC, age, race, education, BMI, Insurance) (1)

PAMC = f (PNCV, age, race, education, BMI, Behavior) (2)

where PNCV is the number of prenatal care visits made by the mother during her pregnancy and PAMC is potentially avoidable pregnancy complications. Equation (1) hypothesizes that the number of prenatal care visits PNCV is a function of the mother's characteristics such as maternal age, race, and BMI as well as the incident of PAMC. Equation (2) hypothesizes that PAMC is a function of mother's characteristics as well as the number of prenatal care visits (PNCV) made by the mother during her pregnancy period.

It is worth noting that the number of prenatal care visits is correlated with mother's characteristics, since these factors affect her access to prenatal care. Such an interaction between prenatal care and mother's characteristics can bias the estimated effect of prenatal care on PAMC (Joyce 1994). Additionally, researchers argued that complicated pregnancies entail more prenatal care visits (Conway and Deb 2005a; Liu 1998; Warner 1998), i.e. the number of prenatal care visits is affected by increased maternal complications. To account for the extra use of prenatal care, several previous researchers using the single-equation approach used the onset of prenatal care, i.e., the

trimester in which the mother started prenatal care rather than the number of visits to avoid the endogeneity problem of prenatal care visits(Conway and Deb 2005a; Liu 1998; Warner 1998). However, this may lead to misspecification of the model, because it does not take into account subsequent prenatal care visits.

To correct for this endogeneity, this study estimates both equations simultaneously in a three-stage least squares framework that includes predicted rather than observed values of prenatal care visits and PAMC in the estimation process. This is an important improvement that distinguishes the economic model of prenatal care impact in this study from those estimated by non-economists.

In the first stage, prenatal care visits and PAMC are regressed on the same set of exogenous variables (age, education, BMI), while in the second stage, prenatal care visits is regressed on the same set of exogenous variables with the predicted rather than observed values of PAMCs. PAMC is regressed on the same set of exogenous variables in addition to predicted rather than observed values of prenatal care visits. To illustrate, let the first stage of the Simultaneous Equation model consist of the following equations in the reduced form:

$$\widehat{PNCV} = f\ (age, race, education, BMI) \tag{3}$$

$$\widehat{PAMC} = f\ (age, race, education, BMI) \tag{4}$$

This completes the first stage. In the second stage, predicted rather than observed predicted values of prenatal care visits and PAMC are included in the equations:

$$\widehat{PNCV} = \alpha_1 + \alpha_2\widehat{\text{PAMC}} + \alpha_3\text{age group} + \alpha_4\text{education level} + \alpha_5\text{race} + \alpha_6\text{prepreg BMI} + \alpha_7\text{insurance} + \omega_i \quad (5)$$

$$\widehat{\text{PAMC}} = \beta_1 + \beta_2\widehat{PNCV} + \beta_3\text{age group} + \beta_4\text{education level} + \beta_5\text{race} + \beta_6\text{prepreg BMI} + \beta_9\,\text{Behavior} + \upsilon_i \quad (6)$$

Caution here that insurance is not included in the pregnancy complications equation, since it has no direct effect on complications. It operates on maternal pregnancy complications through its impact on prenatal care. Note, too, that the variable behavior which captures the mother's consumption of tobacco or alcohol, and is not included in the prenatal care equation as such a behavior causes the mother to have pregnancy complications but may not necessarily lead to increased prenatal care access. The two equations are, therefore, exactly identified. This Simultaneous Equations model has been used by many researchers to evaluate the effect of prenatal care on birth outcomes such as low birth weight (Conway and Deb 2005b) and preterm birth (Wehby et al. 2009).

The Double-Hurdle Complication:

Many researchers examined access to prenatal care and its effectiveness in one-step econometric model (Cameron et al. 1988; Conway and Deb 2005b; Wehby et al. 2009) without segmenting the process into a decision step and frequency of use part. This study follows researchers who modeled the demand or access for health services by separating it in two independent processes: the decision to contact a physician and the intensity in the use of services (Manning et al. 1987; Pohlmeier 1995; Gerdtham 1997; Deb 1997). In the two-step model framework, often referred to as Hurdle model or Cragg model (Cragg 1971), the individual, in this case the pregnant mother decides whether or not to seek prenatal care and then, second stage, the frequency of prenatal care visits is

determined. Empirically, following Mullahy (1986), the first stage takes the form of logit model that predicts access to prenatal care, conditioning on the characteristics and demographics of the mother (Mullahy 1986). Then, in the second stage, a count data model is used to estimate the frequency of use.

In this study, the Poisson model will be used in the second stage, since it is the simplest count data model to use in which the variable of interest takes on non-negative values. One significant advantage of the hurdle model is that it allows for a more disaggregated analysis. In effect, I can separate the determinants of access from those of the frequency of visits.

The Hurdle model will have the following equations:

$$PNC = \gamma_1 + \gamma_2 \text{age group} + \gamma_3 \text{education} + \gamma_4 \text{race} + \gamma_5 \text{BMI} + \epsilon_i \quad (7)$$

$$\text{PNCV} = \delta_1 + \delta_2 \text{age group} + \delta_3 \text{education} + \delta_4 \text{race} + \delta_5 \text{BMI} + \delta_6 \text{Insurance} + \delta_7 \text{ PAMC} + \omega_i \quad (8)$$

Equation (7), the PNC equation, represents the factors that determine the mother's decision to demand prenatal care, which is estimated through Logit. Equation (8), the PNCV equation, represents the number of visits made by the mother during her pregnancy period till delivery, and would be estimated through Poisson conditional upon the mother's decision to access prenatal care.

In general, let y_i be a random variable, in this study it is the number of prenatal care visits. This variable is assumed to be of a Poisson distribution with parameter λ, and can take the values 0, 1, 2…e.t.c. Thus the probability density function is:

$$\Pr(Y_i = y_i) = \frac{l^{-\lambda}\lambda_i^{y_i}}{y_i!}, \qquad y_i = 0, 1, 2, 3 \qquad (9)$$

The parameter λ_i can be expressed as a function of variables vector X_i which contains maternal demographics and socio-economic characteristics.

A positive level of prenatal care visits is observed only if the mother decides to access prenatal care. This Hurdle process is estimated by combining a dichotomous model for the count being zero or positive and a truncated-at-zero model for strictly positive outcomes. Let $\theta_1 = (\Gamma, \sigma_1^2)$ and $\theta_2 = (\Delta, \sigma_2^2)$ denote the parameter vectors of the two stages. Then the likelihood function for the hurdle specification is given by:

$$L = \prod_{i=\Omega} Pr\{y_i = 0|x_i\,\Gamma, \sigma_1^2\}^{1-d}\,(1 - Pr\{y_i = 0|x_i\,\Gamma, \sigma_1^2\})^{d} \times \prod_{i=\Omega_1} \frac{Pr\{y_i|x_i\,\Delta, \sigma_2^2\}}{Pr\{y_i \geq 1|x_i\,\Delta, \sigma_2^2\}}$$

where the first product is the likelihood for the binary process (decision to have prenatal care, versus no prenatal care) defined over the total population, and the second product is the likelihood of the truncated-at-zero Poisson model (defined over the sample of mothers with positive visits counts)(Pohlmeier 1995). The binary variable d takes the value of one if prenatal care is accessed, and zero otherwise. The reported estimates for prenatal care visits will be used in the Simultaneous Equation estimation process and results will be compared to those reported in the three-stage least squares regression.

$$\widehat{PNCV} = \eta_1 + \eta_2\widehat{\text{PAMC}} + \eta_3\text{age group} + \eta_4\text{education level} + \eta_5\text{race} \qquad (11)$$

$$+\eta_6\text{prepreg BMI} + \eta_7\text{insurance} + \varrho_i$$

$$\widehat{\text{PAMC}} = \theta_1 + \theta_2\widehat{\text{PNCV}} + \theta_3\text{age group} + \theta_4\text{education level} + \theta_5\text{race} \quad (12)$$

$$+\theta_6\text{prepreg BMI} + \theta_9\,\text{Behavior} + \varsigma_i$$

The Blinder-Oaxaca Improvement:

The Blinder-Oaxaca Decomposition method is a popular technique in labor economics to study many outcome differences between diverse gender and ethnicity groups (Blinder 1973a; Oaxaca 1973a). Recently the model has been applied to many different studies like access to primary and mental health care (Freiman and Cunningham 1997), prescription drug use (Gaskin et al. 2006), and health insurance coverage (Hargraves and Hadley 2003) among race/ethnicity groups. The main purpose of the decomposition model is to split the differences in outcomes into two components, an observed part that is due to structural differences between the reference and comparison group, and unobserved part that may reflect cultural differences, discrimination or language barriers.

This study compares the observed and unobserved differences in prenatal care access and experiencing PAMC among non-Hispanic black, non-Hispanic white, and Hispanic women, where Hispanic is the reference group. This is achieved through estimating separate Hurdle-three-stage least square regressions of the number of prenatal care visits and of the PAMC for every race/ethnicity group. For simplicity, the reduced form of the two simultaneous equations is presented.

$$\overline{PNCV_i} - \overline{PNCV_h} = \bar{X}_i\delta_i - \bar{X}_h\delta_h \quad (13)$$

$$\overline{PAMC_i} - \overline{PAMC_h} = \bar{X}_i\beta_i - \bar{X}_h\beta_h \quad (14)$$

where subscript i denotes non-Hispanic black or non-Hispanic white women or other race, and h denotes Hispanic women, $\overline{PNCV_i}$ and $\overline{PNCV_h}$ are mean values of prenatal care visits for every ethnicity group and Hispanics respectively, $\bar{X}_i$ and $\bar{X}_h$ are vectors of the means of the characteristics for every ethnicity group and Hispanics, and δ_i, δ_h, β_i and β_h are least squares estimates of coefficient vectors. After adding and subtracting $\bar{X}_h \delta_h$ and $\bar{X}_h \beta_h$ in each equation respectively, then rearranging terms, the equation are presented as follows:

$$\overline{PNCV}_i - \overline{PNCV}_h = (\bar{X}_i - \bar{X}_h)\,\delta_h + \bar{X}_i(\delta_i - \delta_h) + [(\delta_i - \delta_h)(\bar{X}_i - \bar{X}_h)] \quad (15)$$

$$\overline{PAMC}_i - \overline{PAMC}_h = (\bar{X}_i - \bar{X}_h)\beta_h + \bar{X}_i\,(\beta_i - \beta_h) + [(\beta_i - \beta_h)(\bar{X}_i - \bar{X}_h)] \quad (16)$$

The first term on the right hand side of each equation is the difference in prenatal care access and difference in experiencing PAMC, respectively, due to differences in predictors, i.e. maternal characteristics which include maternal age, education, BMI, and insurance coverage (endowment effect). The second term measures the contribution of differences in the coefficients (coefficients effect). The third term in equation (15) and equation (16) is the difference in mean maternal characteristics interacted with estimates of Hispanic women characteristics (interaction).

Data Source and Relevant Variables

The dataset for this analysis was derived from the Memphis Birth Certificate Database, which presents the most complete accounting of all births in the State and a wide selection of socio-demographic variables for each mother and baby.

Birth Certificate data rovide valuable information on maternal and perinatal health. They serve health policy research, program planning, and evaluation. In 1989, the

National Center for Health Statistics recommended changes to the birth certificate form with an ultimate goal to increase the reliability and completeness of the reporting of each birth (Dobie et al. 1998).

Birth certificate data can be a valid and accurate source for birth analyses. The data are gathered in hospitals within a few days of the delivery, transmitted to the state's bureau of vital statistics generally via a computer program (Starr and Starr 1995), and shared nationally through the National Center for Health. The large datasets enable researchers and individuals to evaluate trends in maternal and infant health. In fact, some view birth and infant death certificates as a backbone of maternal and child health epidemiology in the United States. Birth certificates provide key information about the child's parents, the mother's use of prenatal care, complications and events during pregnancy, and the newborn's status (Buehler, Prager, and Hogue 2000).

Birth certificates for all states are very similar (Northam and Knapp 2006). They have two parts. One part provides demographic information about the parents and infant including the baby's name, address, gender and race. The second part contains data on maternal and infant health variables, including maternal health conditions, prenatal care, obstetric interventions, and fetal abnormalities. The last part provides information on previous pregnancies, infant birthweight and the number of prenatal visits. Several studies discussed and proved the reliability and validity of Birth Certificate data. In the following section, I'll discuss studies on reliability of the data and studies on validity of the data.

Reliability and Validity of Birth Certificate Data

Reliability

Reliability pertains to consistency of variables (Powers 1995). Some studies used different statistical techniques, such as percent agreement, in comparing two or more data sources for reliability. Schoendorf et al. (1993) compared 9,953 maternal surveys with birth certificates and reported high agreement for race, maternal age, and prenatal care (Schoendorf et al. 1993). Also, Buescher et al. (1993) compared birth certificates and medical records of 395 cases in 42 North Carolina hospitals. On one hand, birthweight, Apgar score and delivery method showed high agreement which supports the reliability of those variables; while tobacco use, and obstetric procedures reported less agreement and therefore, less reliability for those variables (Buescher et al. 1993).

Validity

Validity pertains to the extent to which the operationalization of a variable fits its construct (Powers 1995). Many previous studies carried out the validity assessment by choosing to compare medical records, registry data, or mother interviews against birth certificate data. One study compared reports of 46, 637 Women Infants and Children (WIC) program participants in Tennessee from 1975 to 1984 with birth certificate data (Gayle et al. 1988). The authors concluded that maternal reports of birthweight were a valid source of infant birthweight information. Another study used a small random sample of 440 birth certificates in New York State and compared them with medical record reviews done by one registered nurse (Roohan et al. 2003). The authors concluded that most of the information provided on birth certificates is accurate.

Some other studies concluded that the reliability and validity of the birth certificate data vary from item to item (Clark, Fu, and Burnett 1997; Reichman and Hade 2001; Gore et

al. 2002). However, in general, most previous studies proved the reliability and accuracy of data.

For the purpose of this study, I use 2004-2006 data for Memphis/Shelby County, TN, because substantial change in the variables compiled occurred following 2003, so databases for previous years are not compatible with 2004 and later years.

Relevant Variables

The birth certificate data is rich of maternal socio-demographic characteristics that can affect maternal access to prenatal care or her experiencing PAMCs. As most studies do, I include in the analysis mother's age, level of education, ethnicity, pre-pregnancy BMI, behavior which includes mother's consumption of tobacco or alcohol, and health insurance coverage. These socioeconomic and demographic variables have been identified by previous literature to affect health care access and PAMCs (Waidmann and Rajan 2000; Hargraves and Hadley 2003). Ethnicity is defined as Black, Hispanic, and White, with other groups coded as other, such as Asians and American Indians were included in the "other" category. Maternal age is represented through dummy categories for ages 18-24, 25-29, 30-35, and over 35 years. Education was categorized as mothers with no high school degree, no college degree, bachelor degree and graduate studies

It is worth noting that women's self-selection behavior in seeking prenatal care can be a major source of dispute. One can argue that women who receive more prenatal care are also healthier and have better health behavior (i.e. favorable selection), and the effectiveness of prenatal care may be overestimated. Conversely, if women receive more prenatal care because of poorer health conditions during pregnancy (i.e., adverse selection), then the effectiveness of prenatal care may be underestimated (Liu 1998). This

study tends to minimize such an estimation bias by including mother's pre-pregnancy BMI as an approximate health status indicator. BMI is categorized as follows: underweight (below 18.5), normal (18.5-24.9), overweight (30-34.9), and obese (over 35).

The different types of insurance coverage are Medicaid/Tenncare, Private Insurance and Self pay. The self-pay category includes values for unknown payment which were fewer than 3% of the population. Finally, the maternal behavior variable is a dummy indicator representing maternal consumption of either alcohol or tobacco, or both. Descriptive statistics of the core variables and the empirical regression results are provided in the following chapter.

CHAPTER FOUR

PARAMETER ESTIMATES AND INTERPRETATION OF RESULTS

With chapter three having presented the econometric model and the relevant variables used in this study, this chapter presents the construction and estimation of the Simultaneous Equation model and the Hurdle model. The Simultaneous Equation model is modeled using three stage least squares (3SLS) technique. As previously mentioned in chapter three, this estimation technique has been introduced by Zellner an Theil in 1962, and combines two-stage least squares (2SLS) with seemingly unrelated regressions (SUR) (Zellner and Theil 1962). This estimation is used when there is pairwise error correlation. If the error terms are not correlated, the two-stage least squares (2SLS) and three-stage least squares (3SLS) coefficients will be identical (Belsley 1988). Hence, I use 3SLS, in case the error terms across equations are correlated. Refer to chapter three for a review of modeling procedures.

Table 1 reports descriptive statistics for all relevant variables used in the estimation process. The values are the percentage distribution of each variable for White, Black, Hispanic mothers and mothers of other races.

Hispanics seem to receive less prenatal care than mothers other races, however, they are the least likely ethnicity group to experience PAMC. More black mothers are getting pregnant than white and Hispanic mothers (younger than 24 years). Hispanic mothers are most probably to drop out of college than white and black mothers. White mothers and mothers of other races are more likely to get a bachelor degree or presume graduate studies than Hispanic or black mothers. Percentages of women in the two highest BMI categories are higher for Black and Hispanics. A substantially large

percentage of Black and Hispanic mothers were covered by Tennncare. Compared to Hispanic mothers, black mothers were more likely to get pregnant at younger age and have high BMI; however, they are less likely to drop out of school or smoke. Compared to Hispanic and Black mothers, White mothers are less likely to get pregnant at younger age or have obesity, and more likely to have bachelor degree and be covered by private insurance.

Table 1. Memphis /Shelby County, 2004-2006, Percentage Distribution (N=32,472)

	Black N=19,400 (59.7%)	**White N=10,000 (30.8%)**	**Other Race N=1,073 (3.3%)**	**Hispanics N=1,999 (6.16%)**
Inadequate Prenatal care visits (<6)	21%	5%	8%	30%
PAMC	19%	7.5%	5.9%	7.0%
Age				
Under 18	8.4%	1.5%	1.3%	5.6%
Age 18-24	48.0%	23.2%	15.1%	39.9%
Age 25 – 29	23.1%	30.6%	31.5%	27.1%
Age 30 – 35	14.8%	32.5%	37.5%	20.7%
Age over 35	5.7%	12.3%	14.6%	6.8%
Education				
HS no degree	32.3%	9.6%	10.8%	62.0%
College no degree	55.6%	37.7%	30.1%	28.6%
Bachelor degree	9.6%	37.5%	32.7%	7.3%
Graduate Studies	2.5%	15.2%	26.4%	2.2%
BMI				
Underweight	6.5%	7.6%	14.4%	6.6%
Normal	38.6%	52.5%	58.7%	48.4%
Overweight	25.5%	21.7%	18.6%	28.6%
Obese	29.5%	18.3%	8.3%	16.5%
Insurance				
Medicaid/Tenncare	76.7%	22.8%	23.4%	54.2%
Private Insurance	22.1%	75.0%	69.7%	16.9%
Self-pay	0.6%	1.4%	4.9%	28.2%
Tobacco use	54.6%	53.3%	53.4%	60.0%

Following the estimation procedure described in chapter three, I apply the 3SLS estimation tecnique available from Stata to the sample data and the results are presented in Table 2. In the first stage I estimate the effect of predicted PAMC among other mother's characteristics such as age, level of education, pre-pregnancy weight and type of insurance on prenatal care visits (PNCV). The statistically significant estimates for ethnicity demonstrate that Black women are twice more likely than Hispanic women to receive prenatal care and less likely than Black women.

Table 2. Three-stage Estimation for Simultaneous Equations Model

	PNCV		**St. Dev.**	**PAMC**		**St. Dev.**
PNCV	-		-	-0.0134	***	0.0018
PAMC	-19.1181	**	7.8158	-		-
Ethnicity/ Hispanics						
Black	2.0839	***	0.7983	0.1094	***	0.0069
White	1.7569	***	0.2959	0.0521	***	0.0079
Other race	1.1843	***	0.4059	0.0485	***	0.0136
Age/ age 25-29						
Under 18	1.2944	***	0.4803	0.0602	***	0.0097
Age 18-24	0.3452	***	0.1284	0.0114	**	0.0051
Age 30 – 35	0.2149		0.2148	0.0129	***	0.0057
Age over 35	0.4276		0.3579	0.0353	***	0.0078
Education/ Bachelor Deg.						
HS no degree	-1.5284	***	0.3872	0.0122		0.0099
College no degree	-0.4700		0.2285	0.0113		0.0067
Graduate studies	-0.2699		0.2217	-0.0143		0.0084
BMI/ Normal						
Underweight	0.0638		0.1743	0.0050		0.0077
Overweight	0.6269	***	0.1465	0.0182	***	0.0049
Obese	1.6734	***	0.3794	0.0573	***	0.0051
Insurance/Private Ins.						
Medicaid/Tenncare	-2.2169	***	0.3666	-		-
Self-pay	-2.5132	***	0.1691	-		-
Tobacco use	-		-	0.0081	**	0.0039

PNCV: Prenatal care visits. PAMC: Potentially Avoidable Maternity Complications
***significant at 1%, **significant at 5%

women to receive prenatal care. Age leads to a significant increase in the probability of having prenatal care visits only for women less than 18 years and more likely to

experience PAMC. There is a significant inverse relationship between prenatal care visits and women, who dropped out of high school or college. Higher BMI was associated with increasing prenatal care visits; while women on Tenncare or with no insurance were inversely associated with prenatal care visits.

In the second equation where PAMC is regressed on predicted values of prenatal care among other maternal characteristics, I included predicted prenatal care visits and excluded insurance hypothesizing that insurance affects PAMC indirectly through prenatal care. As expected, PAMC is inversely related with the number of prenatal care visits. Since Black and White women are more likely to have prenatal care visits than Hispanic women, they are less likely than Hispanic women to have PAMC. Age is significantly and positively associated with PAMC compared to women of age 25-30. Having graduate studies is negatively related to experiencing PAMC, while being overweight, obese or smoking during pregnancy significantly increases the probability of experiencing PAMC.

The model discussed above considers the utilization of prenatal care as a one-step process without distinguishing between the decision to use prenata care and the frequency of use. However, health economists have long realized that health care utilization is a two-stage process. In the first stage the mother decides whether or not to use prenatal. After the first visit the professional opinion of the physician and the mother's health status play a significant role in deciding the number of subsequent visits. The relationship has often been described as one between agent and principal. One significant advantage of the Double-Hurdle model is that it allows for a more disaggregated analysis by separating the determinants of access from those of the frequency of visits. The purpose

is to determine whether this implies that the contact and the frequency decisions need to be modeled as two different stochastic processes.

The Results of the Double-Hurdle Model

The Participation Hurdle. The response variable for the first hurdle is a binary response of prenatal care-did the mother have prenatal care or not. The dependent variable is binary, and therefore it is modeled using a binary logit regression. # of mothers had access to prenatal care.

The Utilization Hurdle. The second hurdle is the amount of prenatal care used, i.e. the number of prenatal care visits. Prenatal care visits is a discrete variable that can take only positive integer values. More precisely, the variable presents mothers who had single or multiple prenatal care visits. This character of the dependent variable calls directly for the application of count data models. A widely used count data model is based on the Poisson distribution. Table 3 sets out the results of the Hurdle model.

Generally, results from the Hurdle model show which variables prevent access and which limit the number of visits. In regards to age, women above 30 significantly seek less prenatal care, probably because most of them had experience from previous pregnancies, and they also have limited number of visits, nevertheless the results are not statistically significant.

As far as for ethnicity, all ethnicity groups significantly seek prenatal care, while only White women have significantly increasing number of visits. This evidence suggests that it is a cultural aspect associated with ethnicity, including attitudes and perceptions in

Table 3. The Double-Hurdle Model Estimates

	PNC		St. Dev.	$\widehat{PNCV}$		St. Dev.
PAMC			0.0251	-0.0795	***	0.0054
Ethnicity/ Hispanic						
Black	0.1733	***	0.0320	-0.0043		0.0090
White	0.5104	***	0.0388	0.0691	***	0.0093
Other race	0.4141	***	0.0722	-0.0004		0.0127
Age/ age 25-29						
Under 18	0.1973	***	0.0395	-0.0133		0.0100
Age 18-24	0.0998	***	0.0235	0.0004		0.0048
Age 30 – 35	-0.0672		0.0292	-0.0093		0.0050
Age over 35	-0.1391	***	0.0397	-0.0124		0.0068
Education/ Bachelor Deg.						
HS no degree	-0.7519	***	0.0401	-0.1751	***	0.0070
College no degree	-0.4242	***	0.0378	-0.0593	***	0.0052
Graduate studies	0.2494	***	0.0936	-0.0002		0.0069
BMI/ Normal						
Underweight	-0.0574	*	0.0349	0.0040		0.0073
Overweight	0.0633	***	0.0232	0.0341	***	0.0045
Obese	0.0995	***	0.0236	0.0719	***	0.0045
Insurance/ Private Ins.						
Medicaid/Tenncare	-		-	-0.2435	***	0.0048
Self-pay	-		-	-0.2476	***	0.0136

PNC: Prenatal care indicator. PNCV: Prenatal care visits.
***significant at 1%, **significant at 5%, *significant at 10%

regards to modern medicine or health services that may be playing the major role in preventing women from having adequate number of prenatal care visits.

Also, having an appropriate insurance coverage can be the cause for these disparities. The model shows, that women who are on TennCare or not insured are less likely to have adequate care visits. As far as for PAMC, evidence shows that it is significantly affected by the number of prenatal care visits rather than the decision to acquire prenatal care.

Mother being overweight or obese strongly affects the access and the number of visits. On the other hand, having no high school degree or bachelor degree strongly affects access and the number of visits negatively. This evidence suggests that less

educated mothers lack the income to afford insurance and have the adequate prenatal care.

In order to obtain a better assessment of the effect of having prenatal care visits on reducing or preventing PAMC, it is of great importance to combine the Hurdle model with the Simultaneous Equation model. I use predicted values of prenatal care visits -obtained from the Hurdle model- in the Simultaneous Equation model. The estimates of the combined models are presented in Table 4.

Table 4. Three-stage Estimation for Simultaneous Equations Model after applying Double-Hurdle model

	$\widehat{PNCV}$		St. Dev.	$\widehat{PAMC}$		St. Dev.
$\widehat{PNCV}$	-		-	-0.1730	***	0.0212
$\widehat{PAMC}$	-0.0795	***	7.25E-08	-		-
Ethnicity/ Hispanic						
Black	-0.0043	***	8.44E-09	0.1208	***	0.0082
White	0.0691	***	3.88E-09	0.0657	***	0.0093
Other race	-0.0004	***	3.80E-09	0.0422	***	0.0133
Age/ age 25-29						
Under 18	-0.0133	***	4.41E-09	0.0534	***	0.0096
Age 18-24	0.0000	***	1.19E-09	0.0087	*	0.0051
Age 30 – 35	-0.0093	***	1.99E-09	0.0204	***	0.0056
Age over 35	-0.0124	***	3.31E-09	0.0370	***	0.0076
Education/ Bachelor Deg.						
HS no degree	-0.1751	***	3.76E-09	0.0156		0.0095
College no degree	-0.0593	***	2.18E-09	0.0138	**	0.0065
Graduate studies	-0.0002	***	2.12E-09	-0.0168	**	0.0083
BMI/ Normal						
Underweight	0.0040	***	1.60E-09	0.0046		0.0076
Overweight	0.0341	***	1.39E-09	0.0196	***	0.0049
Obese	0.0719	***	3.56E-09	0.0594	***	0.0051
Insurance/ Private Ins.						
Medicaid/Tenncare	-0.2435	***	3.46E-09	-		-
Self-pay	-0.2476	***	2.70E-09	-		-
Tobacco use	-		-	0.0107	***	0.0038

PNCV: Prenatal care visits. PAMC: Potentially Avoidable Maternity Complications
***significant at 1%, **significant at 5%, *significant at 10%

obtained from the Hurdle model- in the Simultaneous Equation model. The estimates of the combined models are presented in Table 4.

The results show the importance of this combination where almost all independent variables are significantly associated with prenatal care visits and PAMC. Generally, PAMC and prenatal care visits are negatively correlated, as expected. As far as for ethnicity, Black women and women of other race are less likely to have prenatal care, however, they are more likely to experience PAMC. Less educated women receive inadequate prenatal care and in return more likely to experience PAMC. On the other hand, women doing graduate studies, less likely to experience PAMC, despite having less prenatal care visits. This might be due to the fact that they, as students, lack having a job that pays for their insurance to afford adequate prenatal care; however, they have enough knowledge to make them less likely to experience PAMC.

As far as for mother's BMI, obese and overweight women are significantly more likely to experience PAMC despite significantly having increased number of prenatal care visits. This might be due the fact that obesity entails many diseases that cannot be prevented through increased prenatal care visits. Finally, mothers using tobacco during pregnancy or being above 30 years old is significantly associated with increased probability of experiencing PAMC.

It is worth noticing that for some variables, the expectant negative relationship between PAMC and prenatal care visits, i.e. for some mothers having increased prenatal care visits did not reduce their probability of experiencing PAMC. For White mothers, they had significantly more prenatal care visits, and experienced more PAMC compared to Hispanic mothers. Also, underweight, obese and overweight mothers had significantly

increased prenatal care visits, and had significantly higher probability of experiencing PAMC. This suggests that there are other factors that could be affecting the probability of experiencing PAMC. These factors could be observable, as I could hypothesize that these unexpected results are due to structural differences between different ethnicity groups. However, there are unobserved factors that could be causing this contradiction in our results, such as cultural differences, discrimination or language barriers for minority groups.

For instance, Hispanics are known to keep the language of their childhood, which is Spanish, some of them are illiterate both in English and Spanish (Poma 1987). Unaware of U.S. traditional institutions, processes and services, Hispanics –among many minority groups- are unfamiliar with the way health care is delivered in the country, which results in difficulty in getting access to adequate medical care. Due to these conditions, it is of great importance to examine disparities closely, and to determine to what extent the disparities could be attributed to observed factors and to unobserved factors. Hence, I further apply the Blinder Oaxaca model which is a decomposition model to compare the observed and unobserved differences in prenatal care access and experiencing PAMC among non-Hispanic black, non-Hispanic white, and Hispanic women, where Hispanic is reference group.

The Blinder Oaxaca Model

In Stata, I apply the Blinder Oaxaca model, where Hispanic women are the three parts. The first part (endowments) reflects the reference group, and White, Black women and women of other race are combined in one group. The results are presented in Table 5.

Table 5. Decomposition Model for Prenatal Care Visits

	Hispanic/ Other Races	
	PNCV	
	points	% of Y_i-Y_h
Other race	10.1443	
Hispanic	8.1025	
Overall difference	**2.0418**	**100**
Endowments	1.4761	72.2937
Coefficients	0.4008	19.6312
Interaction	0.1649	8.0751

Detailed Contributions

	Endowments		Coefficients		Interaction
PAMC	-0.0816	***	0.0206		0.0227
Age					
Under 18	0.0009		-0.0087		-0.0005
Age 18-24	-0.0042		-0.0844		0.0026
Age 30 – 35	-0.0010		-0.0079		-0.0003
Age over 35	0.0020		-0.0313		-0.0065
Education					
HS no degree	0.6806	***	-0.4811	*	0.2943
College no degree	-0.1584	**	-0.0886		-0.0626
Graduate studies	0.0210		-0.0077		-0.0193
BMI					
Underweight	0.0000		0.0003		0.0000
Overweight	0.0040		0.1224		-0.0197
Obese	0.0722	***	-0.0251		-0.0131
Insurance					
Medicaid/Tenncare	-0.1151		0.3306	*	0.0183
Self-pay	1.0558		0.0532		-0.0512

***significant at 1%, **significant at 5%, *significant at 1%

The decomposition output reports the mean predictions by Hispanic and their differences in the first panel. The mean of prenatal care visits for Hispanic is 8.1, and 10.14 for other races/ethnicity groups, yielding a gap in visits of 2.04. This gap is divided into mean of visits for Hispanics if they had the same characteristics as other ethnicity groups. The increase of 1.47 indicates that differences in endowments account for 72% explained differences in the visits gap. The second term (unexplained part) quantifies the change in visits when applying the other races' coefficients to Hispanic

characteristics, which accounts for 19% of that gap. The third part is the interaction term that measures the simultaneous effect of differences in endowments and coefficients. The next part shows how the different maternal characteristics contribute to endowments, coefficients and interaction.

In the second panel, dropping out of high school and being on Tenncare significantly present the major part of unexplained effects. Dropping out of high school is a significant reason for Hispanic women having less prenatal care visits, while being insured by Tenncare leads to having more prenatal care visits for Hispanic mothers.

Table 6 presents the decomposition results for Potentially Avoidable Maternity Complications (PAMC). A value of -0.01 is obtained for the total effect of endowments in reducing maternity complications, while prenatal care visits are the largest part of endowments. For Hispanic mothers, less prenatal care visits is significantly responsible for Hispanic mothers experiencing more complications. Focusing on discrimination, the total difference in complications between Hispanic mothers and mothers of other races are 0.077, of which 62% are unexplained and can be attributed to discrimination. Dropping out of high school or college, and being obese are significant contributors in the coefficient effect and significantly increase the probability of experiencing complications for Hispanic women. On the other hand, prenatal care visits significantly reduce complications for Hispanic mothers.

In tables 5 and 6, I applied the Blinder Oaxaca model using actual values of maternity complications (PAMC) and prenatal care visits (PNCV). However, as previously argued, using actual values will lead to biased and underestimated coefficients

Table 6. Decomposition Model for PAMC

	Hispanic/ Other Races					
	PAMC					
	points	% of Y_i-Y_h				
Overall difference	**0.077**	**100.00**				
Endowments	-0.012	-15.59				
Coefficients	0.106	137.40				
Interaction	-0.017	-21.80				
Detailed Contributions						
	Endowments			**Coefficient**		**Interaction**	
Prenatal care visits	-0.0079	***		-0.0262	**	-0.0066	**
Age							
Under 18	0.0001			0.0017		0.0001	
Age 18-24	-0.0001			0.0058		-0.0002	
Age 30 – 35	0.0001			0.0000		0.0000	
Age over 35	0.0004			0.0005		0.0001	
Education							
HS no degree	-0.0036			0.0394	***	-0.0241	***
College no degree	-0.0011			0.0157	**	0.0111	**
Graduate studies	-0.0017			0.0002		0.0004	
BMI							
Underweight	0.0001			-0.0006		-0.0001	
Overweight	-0.0004			0.0046		-0.0007	
Obese	0.0019			0.0074	***	0.0039	**
Tobacco use	0.0002			0.0083		-0.0008	

***significant at 1%, **significant at 5%, *significant at 1%

due to endogeneity of prenatal care. By using actual values, I will neglect the fact that a pregnant woman may have information regarding her health endowment (e.g. genetic makeup) that may influence her decision to prenatal care access. To solve this problem in the models before I applied Simultaneous Equation model, where I applied predicted rather than actual values of prenatal acre visits and complications. However, combining the Oaxaca command with Three Stage Least squares is not supported in Stata 12. Hence, I applied the Two Stage Least Squares (2SLS) technique to the Oaxaca Model manually, by regressing prenatal care visits and complications on mother's characteristics applying Poisson and Logit regressions, respectively. Then I use the PNCV_hat (predicted values

Table 7. Decomposition model for predicted Prenatal Care Visits

	Hispanic/ Other Races	
	PNCV_hat	
	% points	% of Y_i-Y_h
Overall difference	**0.132**	**100.000**
Endowments	0.112	84.960
Coefficients	0.017	13.003
Interaction	0.003	2.037

Detailed Contributions						
	Endowments		**Coefficients**		**Interaction**	
PAMC	-0.0061	***	-0.0004	***	-0.0004	***
Age						
Under 18	0.0000		-0.0005	***	0.0000	
Age 18-24	0.0000		-0.0010	***	0.0000	
Age 30 – 35	-0.0001		0.0002	**	0.0000	
Age over 35	-0.0002	**	0.0000		0.0000	
Education						
HS no degree	0.0664	***	-0.0084	***	0.0051	***
College no degree	-0.0120	***	-0.0035	***	-0.0025	***
Graduate studies	0.0000	***	0.0000		0.0000	
BMI						
Underweight	0.0000		0.0001		0.0000	
Overweight	-0.0016	***	-0.0019	***	0.0003	***
Obese	0.0062	***	-0.0016	***	-0.0008	***
Insurance						
Medicaid/Tenncare	-0.0073	***	-0.0135	***	-0.0007	***
Self-pay	0.0671	***	-0.0018	***	0.0018	***

***significant at 1%, **significant at 5%, *significant at 1%

of prenatal care visits) and PAMC_hat (predicted values of maternity complications) obtained from the regressions in the Oaxaca model. The results are presented in tables 7and 8.

Table 7 shows the decomposition for predicted prenatal care visits. A value of 0.112 is obtained for the differences in endowments, which accounts for 85% of total differences between Hispanic mothers and mothers of other race. This can be interpreted as the increase in the number of prenatal care visits if Hispanic women had the

demographic same characteristics as women of other races. Dropping out of high school and being uninsured are significant and large contributors to differences in endowments.

Table 8. Decomposition Model for predicted PAMC

	Hispanic/ Other Races					
	PAMC_hat					
	points		% of Y_i-Y_h			
Overall difference	**0.500**		**100**			
Endowments	-0.397		-79.303			
Coefficients	1.009		201.599			
Interaction	-0.112		-22.296			
Detailed Contributions						
	Endowments		**Coefficients**		**Interaction**	
Prenatal care visits	-0.1875	***	-0.2586	***	-0.0652	***
Age						
Under 18	0.0016		0.0150		0.0009	
Age 18-24	-0.0003		0.2200	***	-0.0067	
Age 30 – 35	0.0013		-0.0099		-0.0003	
Age over 35	0.0067	*	-0.0092		-0.0019	
Education						
HS no degree	-0.3482	***	0.1100		-0.0673	
College no degree	0.1044	***	-0.0053		-0.0038	
Graduate studies	0.0086		0.0039		0.0098	
BMI						
Underweight	0.0004		-0.0018		-0.0002	
Overweight	-0.0132	***	-0.0015		0.0002	
Obese	0.0366	***	0.0429	***	0.0224	***
Tobacco use	-0.0072	*	-0.0037		0.0004	

***significant at 1%, **significant at 5%, *significant at 1%

Almost, all mother's characteristics are significant, but small, contributors to the endowment effect. Mother's age, dropping out of college, doing graduate studies, being overweight or insured under Tenncare and having complications, are responsible for less prenatal care visits for Hispanic mothers than mothers of other races. The unexplained gap between Hispanic mother and mothers of other ethnicity groups accounted for 13% of overall differences, of which being on Tenncare accounts for the greatest bulk of the

unexplained gap. Again, almost all maternal characteristics are significant contributors to unexplained differences between ethnicity groups. In table 8 a detailed decomposition of predicted maternity complications is presented, where the explained gap is the greatest bulk of overall differences between ethnicity groups. Complications present the largest contributor to endowments gap, and it shows that women of other races have more visits than Hispanic women, and in return significantly less complications. Also, dropping out of high school or college, being overweight or obese, and smoking during pregnancy are significant contributors to the endowment gap. Dropping out of college and being obese are significantly responsible for greater gap in experiencing complications between women of ethnicity groups and Hispanic women. Prenatal care visits are the greatest contributor to the unexplained part of the gap in complications, displaying that less prenatal acre visits are responsible for widening the gap in experiencing complications between mothers of other races and Hispanic mothers. A summary of the results and conclusion is presented in the following chapter.

CHAPTER FIVE

CONCLUSION

With the research undertaken in the previous chapters, these concluding remarks address the final objective of this study, namely to drive health policy implications that address disparities in prenatal care access and the consequences of poor access on experiencing complications. This study aims at analyzing the effect of prenatal care in preventing Potentially Avoidable Maternity Complications (PAMC). Though some past studies examined this relationship, nevertheless, they failed to address the endogeneity problem prevailing in prenatal care. The results based on the Birth Certificate Data of Shelby County, Tennessee, that there is strong inverse relationship between adequacy of prenatal care and Potentially Avoidable Maternity Complications. Based on Laditka et al. (2005) as point of departure, this study further expands the relationship between prenatal care and PAMC indicator first by correcting for endogeneity of prenatal care that is entailed in one single equation regression models. If this endogeneity is not controlled for, it will result in a biased and underestimated effect of prenatal care on pregnancy complications. This study corrects for this problem by applying the Simultaneous Equation model, using predicted rather than observed values of prenatal care visits and PAMC along with controlling for various mother's characteristics. Most of the variables presenting the mother's characteristics were significantly associated with prenatal care visits. Applying the Simultaneous Equation model, and controlling for prenatal care endogeneity, displayed the greater magnitude of the effect of increased prenatal care visits on reducing Potentially Avoidable Maternity Complications (PAMC) compared to previous studies on this relationship.

Moreover, in this study I recognize the importance of of refining the current model and to separate prenatal care access into a two-step process, the decision to access prenatal care and the number of visits made by the mother during her pregnancy till delivery, namely the Hurdle model.

This technique, which is another key analysis in our study, helped to examine what extent do mother's characteristics affect her decision to access prenatal care and its frequency. Then I apply the predicted values of prenatal care visits from the Hurdle in the Simultaneous Equation model. The results show that this refinement improved the model greatly. All dependent variable displayed a significant relationship with prenatal care visits and PAMC. The model also displayed the negative relationship between prenatal care and PAMC, which suggests that access to adequate prenatal care should be improved, through addressing the various mother's characteristics that inhibit adequate use of prenatal care, to improve mother's and infant's health.

Nevertheless, the results show that some mother's characteristics did not display the negative relationship between increased prenatal care and reduced PAMC. For example, White mothers have significantly more prenatal care visits, and experience more PAMC compared to Hispanic mothers. The same applies to obese and overweight mothers. This result suggests the existence of other explained and unexplained factors that increase the probability of experiencing PAMC despite the increased use of prenatal care. Hence, I apply the Decomposition model determine to what extent the disparities could be attributed to observed factors and to unobserved factors.

In the Decomposition model, endowments presented the greater bulk of the gap in both, access and outcome. Education, Body Mass Index, and type of insurance, are

significant contributors to widening the explained differences between Hispanic mothers and mothers of other ethnicity groups. While dropping out of high school or college, and being overweight or obese, are the significant contributors to the gap in endowments.

Implication of the Results

Modeling access to prenatal care and PAMC as two stage process can provide better insight into how the U.S. health care system could evolve. The following are suggestions to implement relevant policy and public policies:

I. *The Hurdle Specification and the SEM*. The participation hurdle and the utilization hurdle results show that older mothers and mothers dropping out of high school or college have less access to prenatal care and less utilization of prenatal care services. Therefore, policies should be directed at raising awareness of the importance of prenatal care to pregnant women. Enhancing access at the participation level might reverse what appears to be inadequate care at the utilization level. After separating the prenatal care into a two-step process, and then applying the Simultaneous Equation model combined with the Hurdle specification.

Based on the combined models, ethnicity, and mother's education are found to be significantly associated with less prenatal care and more Potentially Avoidable Maternity Complications; while mother's Body Mass Index is associated with more prenatal care visits and more PAMC compared to mothers of normal weight. Public resources might therefore be invested in increasing Ethnicity groups' utilization of prenatal care and increase awareness of its importance. Similarly, if less education is associated with less prenatal care

visits and more complications, resources might best be expended here as well as the utilization level, where they could make an even greater impact. The negative participation level of insurance with prenatal care requires a re-assessment. If Tenncare is associated with less prenatal care visits, then this phenomenon must be further studied.

II. *The Decomposition Model*. This model displayed that differences in endowments (explained differences) between the various ethnicity groups presented the greatest bulk of the gap. Mother's education and BMI are significantly the greatest contributors to widening the gap between Hispanic mothers and mother of other races in accessing prenatal care and in being diagnosed with PAMC. Policy might focus more on encouraging or subsidizing these groups utilization level of prenatal care to reduce complications.

The Significance of the Study

This study is important for retrospective and prospective reasons. Retrospectively this study is one among the few studies that analyze the relationship between prenatal care and Potentially Avoidable Maternity Complications (PAMCs). The PAMC indicator is a recently developed indicator that is designed for application to large populations. It functions through the expectation that risks may be reduced through healthy behaviors that may often be promoted by prenatal care. It is useful for evaluating effects of programs such as Healthy Start, WIC, and policies designed to improve maternal health. It should be applied in more studies, as it provides another tool to study disparities in access to prenatal care, and to monitor progress toward the fulfillment of national health goals.

Moreover, this study uses the Memphis Birth Certificate Data, which is a very rich data that provides valuable information on maternal and perinatal health. Previous studies on prenatal care and its association with PAMCs used hospital administrative datasets which do not provide detailed individual socio-demographic information. This shortcoming leaves a gap in the maternal and child health literature. However, the Birth Certificate Data used in this study has information on race/ethnicity, age, educational attainment, insurance, as well as insurance, which are all factors that contribute notably to disparities.

Prospectively, this study helps to pave the way toward a role for health economics in emerging research on prenatal care and pregnancy complications. While medical researchers have examined this relationship to improve prenatal care and reduce complications, failing to recognize the endogeneity of prenatal care; economists have much more work to do in treating the presented endogeneity, and develop unbiased estimates of the effect of prenatal care on reducing complications. They are also responsible to interpret the results and what they men for the national, and international health. Health care expenditures are consuming a large portion of U.S. GDP, with health results that sometimes lack accuracy. Hence, insights on the relationship between prenatal care and PAMCs through an economic lens should not be ignored.

Limitations of the Study

Although our data provided valuable individual information, it also imposed several limitations. First the data did not allow me to identify Hispanics by subgroups which is an important limitation given the heterogeneity among Hispanic groups. Studies have shown that various Hispanic subgroups, such as Cuban Americans and Puerto

Ricans, differ substantially in demographic, social, and economic characteristics, and in other risk factors of prenatal care.

Second, the PAMC indicator relies on the validity and reliability of both, practitioner diagnoses and self-reported information. Diagnosis may vary among areas, hospitals, and practitioners. In some instances they could be biased, differentially associated with ethnicity, socio-economic status, payer, or other factors. Further research on the reliability and validity of PAMC indicator would contribute usefully to the improvement of the indicator.

Finally, the likelihood of mothers experiencing PAMCs can be attributed to unhealthy behavior prior to or during pregnancy. Lack of prenatal care reduces the likelihood that mothers will receive information about the importance of healthy behaviors. However, even reasonable access and use of prenatal care does not insure that pregnant women receive the advice needed about the importance of healthy behavior. So even though mothers could have had the adequate number of prenatal care visits, still researchers lack the knowledge about the content and quality of the visits. This will remain a major limitation to this study and future studies unless new prenatal care index is developed.

In general, this study addresses interesting and important topic, namely the determinants of prenatal care and its effect in reducing Potentially Avoidable Maternity Complications (PAMCs). It is my hope that the results and recommendations in this study will contribute to a deeper understanding and more accurate presentation of this relationship to inspire further research on the topic at hand.

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