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The Effect Of Health Expenditure And Other Determinants On Health Outcomes

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THE EFFECT OF HEALTH EXPENDITURE AND OTHER DETERMINANTS ON HEALTH OUTCOMES

by

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This thesis, submitted by Yi Liu in partial fulfillment of the requirements for the Degree of Master of Science in Applied Economics from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done, and is hereby approved.

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This thesis is being submitted by the appointed advisory committee as having met all of the requirements of the Graduate School at the University of North Dakota and is hereby approved.

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ABSTRACT

A major question in determining health policy is to what extent the additional health care expenditure yields benefits in the form of improved health outcomes. However, establishing relationships between them is very complex, because there are numerous factors besides health expenditure that could contribute to health outcomes, and some data especially individual level nutrition and exercise data, are nearly impossible to gather. Another difficulty involves which indicator we should choose to measure health outcomes.

This study examines life expectancy, all-cause age adjusted mortality rates and infant mortality as the "output" of the health care system, and health expenditure, various life-style, education and sociological factors as "inputs". Econometric analyses are conducted on a state level panel data set for the 12 mid-west states in the United States over an eleven-year period from 1999 to 2009. A set of state-level socioeconomic, demographic and lifestyle variables is also examined to determine their effect on health outcomes.

The empirical results indicate that increases in health care expenditure are associated with statistical significantly large improvements in infant mortality and all-cause age adjusted mortality, but appears have no significant effects on life expectancy. The findings are generally consistent with those of several previous studies. First stage income elasticity results indicate that health is not a luxury good.

CHAPTER I

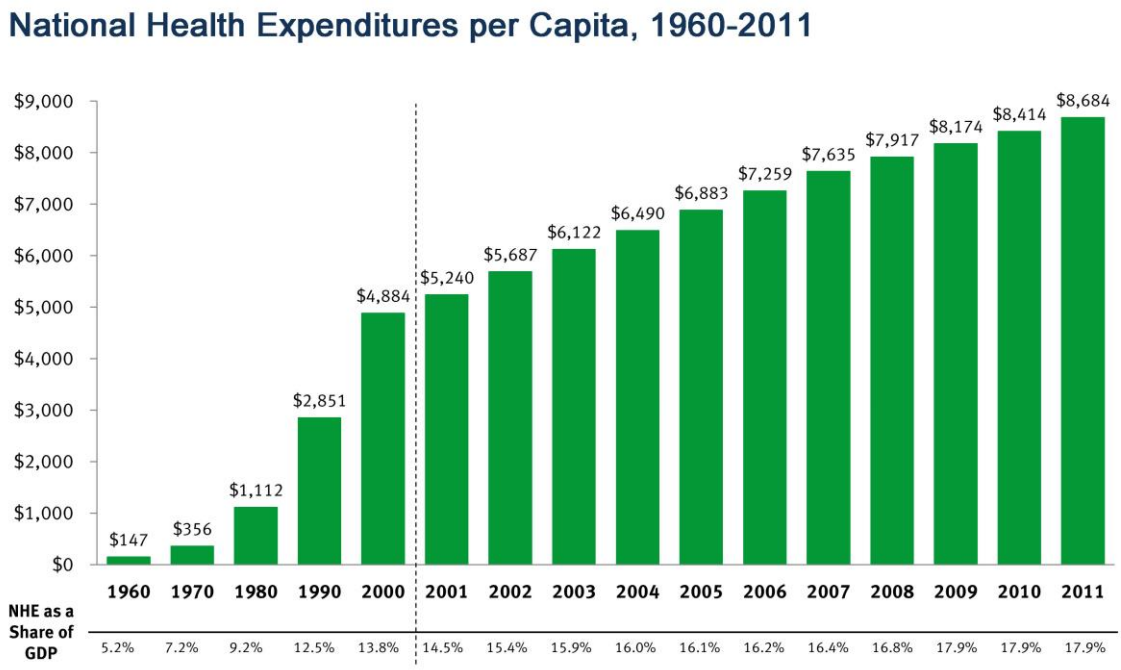
INTRODUCTION

Health expenditures in developed countries have been growing much more rapidly than their economics in recent years. There has been a constant increase in annual average, total health care spending per capita of about 8.1% between 1975 and 2005. In contrast, real GDP growth over the same period has averaged about 3.2%. (US Centers for Medicare and Medicaid Services) The National health expenditures in the United States is $2.7 trillion in 2011, over ten times the amount of $256 billion spent in 1980. National health expenditure per capita also increased from $1,100 in 1980 to $8,680 in 2011. (US Centers for Medicare and Medicaid Services, NHE fact sheet). The rate of growth in recent years has slowed relative to the late 1990s (3.9% from 2010 to 2011), but is still expected to grow faster than national income over the foreseeable future. Addressing this growing burden continues to be a priority in health economics. Moreover, the economic development in United States has slowed in recent years resulting a higher unemployment rate and lower personal income. The national health expenditure as a share of GDP grew from 9.2% in 1980 to 17.9% in 2011. Per capita health expenditure in 2010 is $7910, 50% higher than Switzerland, the next-highest-spending country ($5270), and 140% above the OECD countries' median. (OECD health data 2010).These conditions are the reason why health researchers, policy makers as well as health providers pay more attention now than before on health care spending and affordability.

An interesting question to examine in this paper is, "Is it really worth it?" This question has become a central interest in the context of health care cost-containment in most developed countries in the past few decades. Prior studies have come to find ambiguous answer to this question. The reason? It's very difficult to isolate the contribution of health services from other inputs. There is no control group providing comparable data in absence of health care within a country. Prior studies in expenditure-outcome analysis are also affected by the heterogeneity in cross-country data or the use of analytical method that did not take the endogeneity of the health care spending variable into consideration and often suffered from omitted variable bias.

This paper uses detailed state-level health care expenditure data gathered from the U.S. Center for Medicare & Medicaid in conjunction with state specific health outcome indicators to investigate the relationship between health care expenditure and health outcomes. The study is based on annual data collected from the 12 mid-west states (Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin) in the United States over an eleven years' time span from 1999 to 2009. Instrumental techniques are used to reduce the likelihood of cross correlation between health expenditure and health outcome variables. In addition, this study also includes a wide variety of economic, socio-demographic and lifestyle factors that may help to explain health outcome.

Figure 1 shows the national health expenditure per capita from 1960 to 2011. NHE share of GDP are also shows in this figure.



NOTE: According to CMS, population is the U.S. Bureau of the Census resident-based population, less armed forces overseas and their dependents.

SOURCE: Kaiser Family Foundation calculations using NHE data from Centers for Medicare and Medicaid Services, Office of the Actuary, National Health Statistics Group, at http://www.cms.hhs.gov/NationalHealthExpendData/ (see National Health Expenditures by type of service and source of funds; file nhe11.zip); Gross Domestic Product data from Bureau of Economic Analysis, at http://bea.gov/national/index.htm#gdp (file gdplev.xls).

Figure 1 National Health Expenditures per Capita, 1960-2011

All analyses in this paper focus on the relationship between some key determinants and different measures of health outcomes. The health care expenditure parameter is of central interest. Moreover, state income per capita is often used by policymakers and the public as an overall index of well-being or standard of living, so it will also be interesting to investigate the relationship between state income per capita and health outcomes.

The paper is organized as follows: first, I will start with a brief review of the Grossman's theory of health care production and what other researchers' finding in this domain, followed by their empirical approaches and summary of their key findings. Next, the research questions are proposed and presumed answers are discussed. The summary statistics of the data are then described in detail, the source of which can be found in the

Appendix. I then describe the estimation method and econometric model used in my empirical analyses, using life expectancy, all-cause and infant mortality as the dependent variables, followed by a detailed report of the empirical results, including explain their economic and sociological implications. Finally, some ideas are presented, together with some insights for future researches.

CHAPTER II

THEORY AND BACKGROUND

In the past studies that tried to find connection between health care expenditures and some measure of health outcome, there are two approaches adopted. The first approach is grounded in the work of Grossman who is the first one to construct a model of demand for health capital of an individual. He proposed his health production theory in his1972 paper. It defines health as a commodity, which individuals will wish to consume and maximize, subject to one's budget constraint. Grossman's model views each individual as both a producer and a consumer of health. Individuals are assumed to invest in health production with market goods and their own time until the optimal level of investment in health occurs ---- the marginal cost of health production equals the marginal benefit of improved health status (Grossman 1972a).

The theory states that investment in health is a process in which medical care is combined with other factors to produce 'new health', which is inherited and deteriorates over time. Health is viewed as a kind of durable capital stock and depreciates with age at an increasing rate at least after some stage in the life cycle and can be increased by investment. These "investment" include a number of endogenous and exogenous variables or characteristics such as education, income, health care, nutrition and other environmental or socioeconomic variables that have an impact on an individual's health.

Grossman proposed a number of formulations in his model; (Grossman 1972a). one in particular (Equation 1) is of high relevance in this study:

Equation 1

$$lnH_i = \alpha lnM_i + \beta E - \tilde{\delta} i - ln\delta_0$$

Where H_i is the stock of health for individual *i*, M_i is health care received by the individual, *E* is education measured in years, and last two terms represent health capital depreciation rate terms. Since lnM_i and $ln\delta_0$ are likely to be correlated with each other. Ordinary least squares estimation may be biased. The above equation is better suited to be estimated with two-stage least squares by first fitting the demand curve for health care (equation 4-7' from (Grossman 1972a)):

Equation 2

$$lnM_i = B_{WM} lnW + B_{EM} lnE + B_{iM} i + \varepsilon$$

Then using the predicted values of medical care expenditure (lnM_i) to estimate the health production function (equation 1). In equation 2, W represents wage rate (income per capita in aggregate study) and ε is the error term. Education is a specifically named variable since Grossman emphasized the importance of education in health production (Grossman 1973; Grossman 2000; Grossman 2005)

The model above essentially describes health production at the micro level. Although the model above may seems to be fundamental. There are a lot of explanatory variables that we can add into this model. As Grossman says "In general, medical care is not the only market goods in the gross investment function, for inputs such as housing, diet, recreation, cigarette smoking and alcohol consumption influence one's level of health. Since these inputs also produce other commodities in the utility function, joint production occurs in the household." (1972b footnote 3), For the variable that can represent health status, life expectancy at birth, infant mortality rate and all-cause age

adjusted mortality rate are often used in prior studies.

The second approach, adopted in this study, also considers health as a production function like the first one but uses an aggregate, macro level approach. Health outcomes are viewed as 'output' of the entire health care system, with variations being explained by the 'inputs' to that system. These inputs involve health care expenditure, medical care resources as well as a number of life-style and environmental variables. This approach is more often adopted by researchers who base their researches at aggregate level such as state, province and country level. These two approaches have no clear cut distinction. They are both viewed as production functions, which mean the estimation method is similar and there is a degree of overlap as many variables used in these two functions are the same. Binary variables describing personal choices in the first approach are usually expressed with percentage rate in a specific area in the second approach. For example, the percentage of college and high school of a state or country is use to substitute the personal education attainment measured in years. Income per capita is often used to be a proxy for individual wages and family income. The second approach is used in this study due to the adoption of macro-level data in the production function. The approach in this study generally follows that used in previous studies on the English program data (Martin, Rice, and PC Smith 2008), including the use of Instrumental Variable (IV) in two-stage least squares (2SLS) analyses to account for potential correlation between expenditures and outcomes.

CHAPTER III

EMPIRICAL LITERATURE REVIEW

There is a vast literature that tries to find connection between health care expenditures and other related explanatory variables on some measure of health care outcome, whether it's mortality rates or life expectancy at certain age. There are also studies that address health outcomes in relation to economic growth. These studies were conducted in many countries, including the United States, Canada, Europe, other OECD countries, and developing countries. Referenced below are some key representative findings in this research area.

Grossman's (1972) original analysis used NORC (National Opinion Research Center) data, with dependent variable representing positive health. Grossman found that the education and income coefficients are positive and significant, indicating better health with more education and higher income. He also found, in 2SLS analysis, that the elasticity of health stock with respect to medical care is positive and about 0.2. The positive sign of the elasticity indicates that as medical care increases, personal health stock also increases. The magnitude of the elasticity, however, suggests that the response is relatively small. Hadley investigated aggregate impacts using county-level Medicare expenditure data (Hadley 1982a) and age-gender-race specific categories of 45-plus year olds. The results show that, increased medical care expenditures reduce mortality in all categories. Hadley et al. (2011), use IV estimation method, finds that a positive and

statistically significant relationship between medical spending and better health status of Medicare beneficiaries.

Cremieux et al. (1999) uses province specific Canadian panel data for 1978-1992 and show that lower health spending is associated with a statistically significant increase in infant mortality and decease in life expectancy while controlling for gender, race, physicians per capita, income, education, population density, poverty percentage, alcohol and tobacco consumption, and nutritional intake. The nutritional variables (per capita spending on meat and fat) was rarely been examined in past studies probably due to data availability. Number of physicians is also significant in improving all outcomes. The data in Cremieux (1999) is homogenous compared with the international studies. They claim that it is the first time in the health outcome determinants analysis that economic, socio-demographic, nutritional and life style variables are analyzed using reasonably homogenous data. The results of their paper rely on generalized least squares, which does not account for potential endogeneity of health spending.

Other researchers have done studies in the OECD counties. Cross-country studies using pooled OECD country data investigate the relationship between aggregate health care spending, other health determinants and health outcome. They came up with various results. In these researches, the relationship between health care expenditure and health outcome has proved inconclusive, partly because of data heterogeneity inherent to international analysis since health care measures have definitional and methodological differences.

Shaw et al. used cross section analysis with lagged variables with data from 19 OECD countries in four years (1980, 1985, 1990, 1997).Their finding is that

pharmaceutical expenditure led to increase life expectancy at middle and advanced ages (60 and 65 (elasticities of 0.028 and 0.031, respectively)). GDP per capita is positively related to life expectancy at age 60 and 65 (elasticities of 0.03 and 0.055, respectively). Other estimated coefficients of health care expenditures are non-significant in their study. Grubaugh and Rexford (1994) use a general panel data (from 1960-1987) for 12 (non-United States) OECD countries. Ordinary least squares multiple regression are used in this empirical study. Significant coefficient variables for infant mortality are: number of physicians (-0.302), GDP (-0.0386), time trend (-0.145), tobacco use (0.145) and alcohol consumption (0.099). Ruhm (2006) used panel OECD data over the 1960–1997 periods to examine the relationship between macroeconomic conditions and mortality rate. They include a large variety of independent variables including demographic characteristics, environmental factors and lifestyle variables and poverty rate. The main finding is that total mortality and deaths from several common causes rise when labor markets strengthen while controlling for year effects, location fixed-effects. Unemployment is negatively and significantly related to total mortality. Specifically, they found that a1% point decrease in the national unemployment rate is associated with growth of 0.4% in all-cause mortality. They use public social expenditure as a share of GDP as a proxy of social insurance systems, and found that these effects are particularly profound for countries that have weak social care systems.

Or (2000), used a panel data from 1970-1972 for OECD countries. He pointed out that the global measure of population's health status has some limitations. "Especially in the industrialized countries, mortality rate are heavily influenced by the relatively higher number of deaths at older ages and not very sensitive to the relatively few deaths

occurring among the young." He used standardized, gender-specific Potential Years of Life Lost (PYLL) to measure the health status of a country's population. For cross-country comparisons, the number of PYLL is expressed as rate for 100 000 population. This is a unique approach to measure health status as PYLL is weighted according to their prematurity preceding an age limit – 70 in his study. The death of an infant (70 life-years lost) will be given fourteen times the weight given to the death of a person aged 65 (5 years lost). The conclusion was health expenditure is statistically significant on health for women in term of PYLL (-0.18 in log) and insignificant for men. However, these studies exhibit certain level of heterogeneity problem largely because definitions and methodology differ across countries. Genetic differences between populations can lead to very different health outcome even if their spending is similar. Beyond data measurement differences the conversion of monetary rate is always problematic.

CHAPTER IV

DATA AND METHODOLOGY

The empirical analyses in this paper, as stated above, follows the theory that health is the 'output' of an aggregate production function which utilizes variables such as health care expenditure, income, education, environment, life-style, population density, and economic factors as the 'inputs'. The main goal is to investigate the determinants of health outcomes. Table 1 shows the major research questions and the corresponding predicted responses that might be answered in this paper.

Table 1 Research Questions and Predicted Outcome

Research Questions	Predicted Answers
What is the effect of state level health expenditure on health outcomes?	Increases in Health expenditure is expected to have positive impact on aggregate health outcomes
What is the impact of race and gender on health outcome	Increase in female and white percentage rate is expected to increase health outcome
The alcohol and tobacco consumption have long been known to have a negative effect on individual's health. Is the effect significant?	The increase of alcohol and tobacco consumption is expected to have a significant negative impact on health outcome
What are the impacts of socioeconomic status characteristics on health?	Higher income and education is expected to have positive impacts but may not be significant
How would teenage birth affect infant mortality and female life expectancy?	Increase of teenage birth would have a significant negative effect on both of the health outcomes
How would poverty level associated with health outcome	Health is expected to decline for those below the federal poverty level, poverty will affect infant mortality significantly
Will higher population density have a negative effect or positive effect on health out come	Rural living is likely to have a positive effect on health
Is the income elasticity greater than one or not? Is health care a luxury good at aggregate level?	Previous researches shows that healthcare is a luxury good at the macro level and a normal good at the micro level

This study uses aggregate state level panel data for the 12 mid-west states in the U.S. over an eleven-year period from 1999 to 2009. The indicators of health status are all-cause age adjusted mortality rates (death per 100,000) and infant mortality rates (death of infants under 1 year of age each year per 1,000 live births) from each state for the span of years, gathered form the National Center for Health Statics, as well as female and male life expectancy at birth gathered from Institute for Health Metrics and Evaluation. The most important explanatory variable is the state health expenditure per capita, which is gathered from Center for Medicare and Medicaid Services at U.S. Department of Health and Human Services. The other data are collected from multiple sources, by year and by state. These data sources include Behavioral Risk Factor Surveillance System, Center for Disease control and Prevention, and the U.S. Census Bureau, Please refers to the Appendix for detail. Some of the data collected from U.S. Census Bureau are projected intercensal data rather than measured data. Following Cremieux, the use of U.S. state level data reduce the inherent heterogeneity found in cross-country studies.

The choice of health outcomes is difficult. No single variable can fully describe the overall health of a population. Researchers have used mortality rates and life expectancy at birth to approximate population health status because they are considered the most reliable indicators in the literature. Infant mortality rates are used in this study as an indicator to measure the health and wellbeing of a nation, because factors affecting the health of entire populations can definitely impact the mortality rate of infants, as it is associated with a variety of factors such as maternal health, quality and access to medical care, socioeconomic conditions, and public health practices. Infants mortality rate is a

more representative and reliable health outcome than life expectancy, as the risk associated with child birth and life in the first year are reduced by better health care system. On the other hand, life expectancy and mortality rate is more attributed to social and environmental factors other than the health care system. Hence the dependent variables are female and male life expectancy at birth, all-cause age adjusted mortality rate and infant mortality rate by year and state. These variables are used after log-transformation to achieve more normalized distribution. The explanatory variables used in this study are:

Health care and economic variables:

Health expenditure per capita, gathered from Centers for Medicare & Medicaid Services including expenditures by providing state and by resident state. Health care expenditures based on the location of the provider are used in this analysis. All spending data are expressed in 2005 dollars. Overall state per capita personal income is also a determinant of health outcomes. It is calculated as total personal income divided by total midyear population estimates of the Census Bureau. Higher financial ability may increase the patient chance to get better treatment and expensive drugs that not covered by regular insurance. Greater financial resources, measure by each state's per capita income, will likely to improve the overall health.

Social and demographic variables:

The geographic characteristics of a state as well as the socioeconomic of its population are important determinants of a population's health. First, difference in population density is likely to affect health outcome. Density is determined as the population per square mile using U.S. Census Bureau data. Greater density may lead to

more affordable health care by lowering the unit price. This will lead to greater care for a given level of spending and therefor lower the mortality rate. Moreover, some previous studies indicate that greater distance from health care providers is a factor in reducing overall health. That means access to healthcare can be a problem in rural area. On the other hand, however, a high density may elevate stress and pollution, which could negatively contribute to health. Life expectancy in the rural area commonly exceeded which in the urban area (Hayward and Gorman 2004). The impact of population density on health outcome is also an interesting aspect to cover in this study.

The ability to use the available health care effectively is obviously an important factor. This ability is measured by the amount of education a person received. Higher education levels usually correlated with better health (Sorlie, Backlund, and Keller 1995; Hayward and Gorman 2004; Grossman 2000). Educated people are in general more aware of potential health threats, their current health status and when the appropriate time to seek remedy is. Uneducated people, however, are more likely to delay seeking care and use preventive services, resulting in more medical crises. While various education measures have been used in the past researches depending on availability or reliability, the percentage of people in a particular state who hold a bachelor degrees or equivalent is best and most reliable measure of education achievement. High school graduate percentage is also included in this study for reference.

Unemployment rate is undoubtedly a crucial factor in evaluating the economic environment in which a person lives. Because health insurance affects access to care and most people rely on getting insured through their employer. Even if unemployed people had private insurance, chances are they cannot use their insurance to the fullest because

of deductibles and co-payments. That may affect their health negatively. Higher employment attainment can affect health positively beyond financial considerations.

State Poverty percentage data, collected from U.S. Census Bureau, is a viable proxy for socioeconomic conditions. If the total family income is below a federal threshold, then all people in this family are considered living in poverty. The inability to purchase basic necessities, such as nutritious foods, housing, clean water or decent clothing and maintain good hygiene is expected to have a strong negative impact on a person's health.

In 2010, nine percent of all U.S. births were to teens (Hamilton et al., 2012). U.S. has the highest teenage birth rate of any industrialized country. Low maternal age has been found to increase the chance of preterm delivery and low birth weight (less than five and a half pounds) among other pregnancy complications. In 2007, the infant mortality rate for children born to teen mothers was significantly higher than the national infant mortality rate — 9.8 deaths per 1,000 live births versus 6.75, respectively. It was highest for teens younger than 15 years of age — 14.53 deaths per 1,000 live births. The rate for infants of mothers aged 15–17 years was 10.27 (Mathews & MacDorman, 2011). Moreover, teenagers are less likely than adults to receive adequate prenatal care. Because they are more likely to be poor, less educated, have less knowledge about child bearing and receive public assistance. Studies also show that countries in which girls are commonly married before reaching the adulthood have significantly higher rates of maternal and infant mortality. Though child marriage is not common in the United States, these findings are meaningful because they hold true for adolescent pregnancy, regardless of marriage. Teenage births percentage in this paper is calculated as the number of live

births to 14-19 year olds divided by the number of total live births each year in each state. Demographic data such as male/female percentage and black/white percentages are also included in this study.

Lifestyle variables:

Many behavioral characteristics are associated with health outcome, few are as important as tobacco and alcohol consumption. Tobacco consumption has long been known associate with higher rates of cardiovascular disease, lung disease and certain forms of cancer. According to the CDC, cigarette smoking causes 443,000 deaths annually in the United States (269,655 deaths among men and 173,940 deaths among women). Exposure to secondhand smoke causes nearly 50,000 deaths each year among adults. Alcohol consumption has also been linked to cause liver, cardiovascular diseases and neurological and psychiatric problems. The CDC estimate that 34,833 people died in the year of 2011 because of liver cancer and other diseases linked to drinking too much beer, wine and spirits.

These variables also are appropriate in estimating infant mortality rate as both tobacco and alcohol consumption by expecting mother or father can affect infant health. In some cases, fetal alcohol syndrome (FAS) may result if pregnant mothers consume alcohol. Tobacco and alcohol consumption may have a long-term effect on one's health. Due to the lack of data in earlier year, the contemporaneous tobacco consumption data is used as proxies for earlier data.

The alcohol consumption data used in this study are defined as the total annual volume of all kinds of alcoholic beverages in gallons per capita for ages 14 and older.

The tobacco consumption data in this study is defined as percentage of individuals that smoke cigarettes.

Table 2 reports the summary statistics of all variables used in this analysis.

Table 2 Summary Statistics

Variable	No. of Observations	Mean	Standard Deviation	Minimum	Maximum
Year	132	2004	3.174324	1999	2009
Dependent Variables					
All-cause Mortality Rate	132	804.348	68.286	652.1	945
Infant Mortality Rate	132	6.928	1.023	4.6	8.9
Male Life Expectancy	132	75.437	1.221	72.9	78.5
Female Life Expectancy	132	80.680	1.137	78.8	83.3
Explanatory Variables					
Health Expenditure per Capita	132	5524.769	1025.022	3790.099	7748.815
Income per Capita	132	32816.5	4357.875	23502	43502
Teenage Births %	132	9.871	1.496	6.26	13.45
Unemployment Rate %	132	4.808	1.767	2.6	13.4
College %	132	25.896	2.984	17.1	34.2
High School %	132	88.413	2.005	83.1	93
Population Density	132	91.722	78.560	9.03	257.2
Smoking %	132	21.986	2.761	16.5	27.6
Alcohol Use	132	2.291	0.286	1.796	2.758
Poverty (all age) %	132	11.067	1.785	6.9	16.1
Poverty (0-4 age) %	132	18.080	3.438	8	26.6
Female %	132	50.669	0.417	49.578	51.45
White %	132	88.522	4.327	79.111	96.190
Black %	132	7.609	4.903	0.62	15.57

Methodology:

The model used in this study is an aggregate function that examines our health indicators based on IV estimation with year fixed effects. A positive correlation between health expenditure and some form of health outcome does not necessarily indicted higher health care spending leads to better health. If a positive correlation remains after accounting for income and other confounding effects then we can conclude that health outcome and health care expenditures are related. The log-linear functional form is

chosen after taking account of the expected nonlinearities. This log transformation directly shows elasticity in the result of analysis, allowing comparison to previous studies.

All-cause mortality, infant mortality, and life expectancy are modeled as functions of economic socio-demographic, and lifestyle variables as well as the fixed time effect to control for the time trend. The basic model is:

$$lnH_{it} = \alpha_0 + \beta_i lnM_{it} + \gamma_i X_{it} + Y_t + \varepsilon_{it}$$

where the first independent variable M_{it} is the medical care expenditure in the state i in the year t; the second independent variable X_{it} is a vector of economic, socio-demographic, and lifestyle factors; Y_t is a vector of year fixed effects; α_0 is the intercept; ε_{it} is the error term. The dependent variable H_{it} is the health outcome measurement in the state i in the year t. Variables are log-transformed in these analyses because some explanatory variables have non-linear relationships with the dependent variable and log-transformation can not only capture the non-linearity but also produce data with more normalized distributions.

Two-Stage Least Squares Analysis

As stated earlier, the healthcare expenditure and health outcomes are likely to be correlated with each other if the health expenditure on health outcome is not structural and there are unobserved factors that has impact on health outcomes. If that is the case, we most likely have endogeneity present. (P-value in the first stage of mortality analysis indicates we can reject the null that the heath expenditure is exogenous). In order to derive consistent estimates, the solution is to use instrumental variable approach in two-stage least squares analysis to account for potential endogeneity of the health expenditure. The ideal instrument must satisfy two conditions: first, the variable used as instruments

must be correlated with the potential endogenous variable, in this case, health expenditure per capita. Second, the variable used as instruments must be exogenous which means it cannot be correlated with the error term in the primary regression. In conclusion, the instruments should not be correlated with health outcome variables except through the health expenditure variables.

A number of instruments including economic variables, medical cost variables are available. Among them, the CMS Dental Services Expenditure per capita is ideal to use as instrument, as it correlated with health expenditure but cannot directly affect mortality rate or life expectancy, which are used to measure health outcome in this analysis. Instrument must pass the test for relevance and weakness to be valid. The strength of the instruments can be directly assessed because both the endogenous covariates and the instruments are observable (Stock, Wright, and Yogo 2002). In the first stage regressions, the correlation between the exogenous variables and the instrument is examined. The result is that the dental expenditure per capita has a significant and positive coefficient on health expenditures. The null hypothesis in the first-stage F-test is that the instrument is irrelevant. The first-stage F-statistics exceed the baseline of 10 indicating that the null hypothesis that the instrument is weakly identified is strongly rejected.

CHAPTER V

RESULTS AND DISCUSTION

The major goal with these analyses was to examine the elusive connection between health care expenditure and health outcomes in the 12 mid-west states. In other words, the study looks to see if increases in health expenditure will lead to better health. Table 3 suggests that a strong correlation between health spending and outcomes exists in this particular data sample. This study also investigates other economic, lifestyle and socio demographic variables that may help to explain health outcome.

Table 3 Correlations between health care spending and health outcomes

Health indicators	**Correlation**
All-cause mortality	-0.6279
Infant mortality	-0.3128
Male life expectancy	0.5664
Female life expectancy	0.5008

As stated in the methodology part of chapter IV, the correlation between health expenditure variables and health outcome variables is very likely present. In the first stage regression, the instrument dental expenditure per capita has a significant and positive coefficient on health expenditures. This indicates that the instrument is valid and relevant. Further, the assumption of exogeneity of expenditure can be rejected in the all-cause mortality and infant mortality analyses by the results of Hausman test. That confirms the hypothesis that endogeneity is indeed present and the use of instrumental variables to account for this bias in these analyses is necessary. The two stage least

squares are run in STATA with 'robust' option, with which standard errors take into account issues concerning heterogeneity and lack of normality.

Table 4 2SLS all-cause mortality rate results

Dependent Variable: All-cause mortality rate			
			Number of Observations: 132
Variable	**Coefficients**	**Robust St. Error**	**Z value**
Health Expenditure per Capita	-0.408***	0.156	-2.61
Income per Capita	0.256	0.173	1.48
College %	-.0005372	.0013305	-0.40
High School %	-.0014387	.0023385	-0.62
Population Density	0.00190	0.00873	0.22
Smoking %	0.0133***	0.00229	5.78
Alcohol Use	0.0278**	0.0121	2.30
Poverty (all age)%	0.0234***	0.00817	2.86
Unemployment Rate	-0.00214	0.00343	-0.62
Female %	-0.0260	0.0247	-1.05
White %	-0.0110**	0.00428	-2.57
Black %	0.0131***	0.00249	5.25
Constant	7.316***	0.978	7.48
*** p<0.01, ** p<0.05, * p<0.1			

Table 5 2SLS infant mortality rate results

Dependent Variable: Infant mortality rate			
			Number of Observations: 132
Variable	**Coefficients**	**Robust St. Error**	**Z value**
Health Expenditure per Capita	-0.230***	0.0876	-2.63
Teen Birth Rate	0.0444***	0.0111	3.99
College %	-0.00572	0.00367	-1.56
High School %	0.00240	0.00642	0.37
Population Density	0.000231	0.000172	1.34
Smoking %	0.00455*	0.00510	1.89
Poverty (0-4 age)%	0.0146***	0.00394	3.71
Unemployment Rate	-0.00751	0.00669	-1.12
Female %	-0.244***	0.0421	-5.78
Black %	0.0215***	0.00362	5.93
Constant	15.23***	2.007	7.37
*** p<0.01, ** p<0.05, * p<0.1			

Table 4 and table 5 show the regression results of the mortality studies. Generally, statistically significant coefficients have their expected sign. After control for the other factors, state level health expenditure per capita has statistically significant (at the 1% level) negative effects on all-cause mortality rate as well as infant mortality. The mortality rate and health expenditure have been log transformed and accordingly, parameter estimates can be interpreted as elasticities. The 2SLS results suggest that a 10% increase in health care expenditure per capita leads to approximately 4.08% reduction in all-cause mortality and 2.3% reduction in infant mortality. Health expenditure per capita yields greater benefits in decreasing all-cause mortality rate than infant mortality rate. In conclusion, higher health expenditure per capita produces a positive impact on health in this model.

Income per capita has been shown to be correlated with health expenditures in many country level studies. But the relationship with income per capita and improved health outcomes has never been established in previous research. In this analysis, income per capita has no statistically significant effect on all-cause mortality rate. This finding is a little surprising because I would expect family with higher financial resources may have greater ability to pay for health services and drugs that are not covered by insurance.

Life style variables have the expected sign. Greater alcohol consumption and a larger percentage of smokers in the population of a particularly state both have statistically highly significant negative effects on infant mortality. Greater alcohol use does increase the mortality but the effects are not significant. Tobacco data is gathered from the annual CDC surveys by state of adults who responds as current smokers. A

larger percentage of tobacco use has negative and significant effects on health outcomes. These lifestyle variables effects on health outcome are very self-explanatory.

Poverty rate and unemployment rate are proxies for socioeconomic conditions. The result shows that a greater percentage of families living below the poverty level are significantly associated with higher all-cause mortality. This finding also hold true for infant mortality as well. Put simply, poorer mothers have smaller babies, and smaller babies are at a higher risk of early death. Unemployment rate, however, does not have statistically significant effect on mortality rate. Unemployment rate had hold pretty much constant until a sharp increase in 2009. Take the state of Indiana for example; the unemployment range between 5.3-5.9 from 2003 to 2008, but rose to 10.9% in 2009. Since unemployment rate have lagged effect on health outcomes, the time span investigated in this study could be too short to reveal the effect of the unemployment rate.

College and high school graduate percentage rate show mixed and insignificant results in these analyses, which means education is not a significant contributor to health. The implication of these results is that some education may be beneficial to health outcomes and some may not be. That's probably because the percentage rate of high school or college diploma in a particular state has very little insight into the nature of the education. For example, the quality of the school, teacher, course taken or the degree of education funding and that may impact longitudinal analyses of education.

Teenage birth rate has highly significant negative effect on infant mortality. This is to be expected since adolescent mothers tend to be poorer, less educated. Their pregnancies are usually unplanned and consequently receive less prenatal care than older mothers, from vaccines to vitamins that can protect the baby and her. Because of these

challenges, babies born to teen mothers are more likely to be low-birth weight and be born prematurely and to die in their first month.

States that have a higher percentage of women have a lower morality rate. Higher percentage of black population can negatively contribute to health. This finding is also statistically significant in the infant mortality analysis. This is not spurring, according to the CDC, non-Hispanic black women had the highest infant mortality rate in the United States in 2004 -- 13.60 per 1,000 live births, compared to 5.66 per 1,000 births among non-Hispanic white women. Previous studies indicate that non city-central areas and rural areas have better health than urban areas. That means two things: first, people in live in the rural area is generally healthier than people live in the urban area. Second, sicker people generally tend to be close to sophisticated medical resources, which can only be found in the city. In this study, population density doesn't have any significant effect.

The first stage income elasticity values are calculated as the ratio of percentage change in healthcare expenditure in demand to the percentage change in income. If the elasticity of demand is greater than 1, then health care can be considered as a luxury good. Since this is a log-transformed analysis, the results show elasticity directly. The results show the elasticity value is 0.877, which indicate that health is not a luxury good in aggregate level.

In the life expectancy study, the null hypothesis that health expenditure is exogenous is not rejected by the Hausman endogeneity test. The generally trend of increasing health care expenditure and improving health status make it difficult to identify a true relationship. I then use panel data with year fixed effect model instead of instrument variable method which could be more biased. Table 6 and table 7 shows the

regression results of the life expectancy study.

Table 6 Female life expectancy results

Dependent Variable: Female life expectancy			
			Number of Observations: 132
Variable	**Coefficients**	**Robust St. Error**	**t value**
Health expenditure per capita	-0.0138	0.0106	-1.31
Income per capita	-0.00233	0.00816	-0.28
Teenage birth %	-0.00463***	0.000799	-5.80
College %	0.0124**	0.00483	2.57
Population Density	0.000531	0.000839	0.63
Smoking %	-0.000827***	0.000296	-7.36
Alcohol use	-0.0176***	0.00239	-2.30
Poverty (all age)%	-0.000685**	0.000509	-2.55
Unemployment rate	0.00130	0.000714	0.96
Female %	0.00564**	0.00191	2.96
White %	0.000914***	0.000230	3.97
Black %	-0.00257***	0.000286	-8.99
Constant	4.534***	0.126	7.48
*** p<0.01, ** p<0.05, * p<0.1			
R-squared:0.951			

Table 7 Male life expectancy results

Dependent Variable: Male life expectancy			
			Number of Observations: 132
Variable	**Coefficients**	**Robust St. Error**	**t value**
Health expenditure per capita	0.0110	0.0190	0.58
Income per capita	0.00662	0.0245	0.27
College %	0.00194	0.00770	0.25
Population Density	-0.00237	0.00141	-1.69
Smoking %	-0.00194***	0.000530	-3.67
Alcohol use	-0.0188***	0.00553	-3.40
Poverty (all age)%	-0.00411**	0.00152	-2.70
Unemployment rate	0.00292	0.000718	1.07
Male %	-0.00980**	0.00372	-2.63
White %	-0.000591	0.000584	-1.01
Black %	-0.00220***	0.000412	-5.34
Constant	4.526***	0.568	7.97
*** p<0.01, ** p<0.05, * p<0.1			
R-squared:0.891			

Health expenditure per capita appears have no significant effects on female and male life expectancy. Teenage birth percentage has a significant negative effect on female life expectancy. Income per capita still has no statistically significant effect on health outcomes. The effects of other variables remain the same with the mortality analyses.

CHAPTER VI

CONCLUSION

The analysis examines the link between health care expenditure and health outcomes in the 12 mid-west states from 1999 to 2009 and extends previous researches by including the most recent health expenditure data. The health outcomes are qualitative and quantitative, only the latter can be evaluated by the available statistical and econometric techniques. Taking these factors into consideration, I collect data for several determinants and evaluate their effects on four conventional health outcomes indicators, female and male life expectancy at birth, all-cause mortality and infant mortality. Explanatory variables include economic conditions, social environments and consumption habits data. The results show that health care expenditure has a strong positive effect on the two forms of mortality rate investigated. A 10% increase in health care expenditure per capita leads to approximately 4.08% reduction in all-cause mortality and 2.3% reduction in infant mortality. Restricting the sample to 12 mid-west states reduces unobserved heterogeneity that can lead to a lack of significant relationship between health care spending and health outcomes. The findings in this study show that health care expenditures are among the most important factors in the lowing of all-cause mortality rate and infant mortality rate, but they make little contribution in the improvement of life expectancy. This result is broadly in line with previous researches on developed countries. Education attainment has been shown to improve health outcomes in several previous studies. In this analysis, the percentage of college graduates has only

effect female life expectancy and has no impact on other forms of health outcomes. One explanation about this inconsistency may be that education does not act on health in isolation from other factors. This makes it hard to assess its independent effects. There may be unidentified third variable that affects both education and health outcome and is not accounted for. Future studies could consider find an instrument for education as well.

The limitation of this study is that by aggregating to the state level likely masks some interesting detail about, counties, neighborhoods, and individuals. Moreover, the size of the sample did not permit me to test for the possible existence of any lagged effects; for instance, tobacco, alcohol consumption and environmental influences may take decades to show their impact on health outcome. Health care expenditure may also yield benefits beyond the current year. These lagged effects will be better analyzed if few more decades of data sample can be gathered. Furthermore, the model between health expenditure and outcomes may be potentially better specified if more explanatory data is available. For example, the data describing nutrition health measures such as family spending on both fat and meat, which is not collected on a per-state basis in the United States. Future researches in this area should also explore the possibility of including diet and exercise data as they undoubtedly have a large impact on health outcome.

APPENDIX

Description and sources of the data

Description of Dependent Variables		
Variable name	**Definition**	**Sources**
All-cause age adjusted mortality	Counts for all-cause mortality per 100,000	Centers for Disease Control National Center for Health Statistics
Cancer mortality	Age-adjusted rate per 100,000	Centers for Disease Control National Center for Health Statistics
Infant mortality	Counts for deaths of children under 1 year of age per 1,000 live birth	Centers for Disease Control National Center for Health Statistics
Female Life expectancy	Expected (in the statistical sense) number of years of life remaining at birth for female	Institute for Health Metrics and Evaluation
Male Life expectancy	Expected (in the statistical sense) number of years of life remaining at birth for male	Institute for Health Metrics and Evaluation
Description of Independent Variables		
Variable name	**Definition**	**Sources**
Alcohol use per capita	Per capita consumption of alcoholic beverages (in gallons)	National Institute on Alcohol Abuse and Alcoholism
Black %	Percentage of blacks in the state population	U.S. Census Bureau
Dental care expenditures per capita	Services provided by dentists, dental surgeons, and dental technicians	Centers for Medicare and Medicaid Services (CMS)
Education Level – Four year College or higher%	State-specific proportion of the population with a Bachelor's degree or higher	U.S. Census Bureau

Education Level – High School	State-specific proportion of the population with a high school degree	U.S. Census Bureau
Female %	Percentage of females in the state population	U.S. Census Bureau
Teen birth%	Live birth to 14-19 years old divided by all live birth	Centers for Disease Control National Center for Health Statistics
Health care expenditures per capita	State-specific sum of all private and public personal health care spending per capita	CMS
Income per capita	Income per capita	U.S. Dept. of Commerce, Bureau of Economic Analysis. Released March 2013.
Poverty%	Percentage of households at or below the federal poverty level	U.S. Census Bureau
Population density	State population density	U.S. Census Bureau
Tobacco use	Percentage of individuals that smoke Cigarettes in particular state	Behavioral Risk Factor Surveillance System
White %	Percentage of whites in the state population	U.S. Census Bureau

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