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The Relationship Between Healthcare Spending And Gross Domestic Product: A Study From A Sample Of African Countries

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THE RELATIONSHIP BETWEEN HEALTHCARE SPENDING AND GROSS DOMESTIC PRODUCT: A STUDY FROM A SAMPLE OF AFRICAN COUNTRIES

by

STEVEN H. ADDO

DISSERTATION

Submitted to the Graduate School

of Wayne State University,

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for the degree of

DOCTOR OF PHILOSOPHY

2016

MAJOR: ECONOMICS

Approved By:

Advisor Date

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Signature

Signature
DEDICATION

To the loving memory of my mother, Ethel Louise Addo, without whose love, encouragement and support the achievement of this success would not have been possible. To my wife, Vivian, and all children, for their patience, sacrifice and encouragement.
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CHAPTER 1 INTRODUCTION

The relationship between a nation’s expenditure on health care and its gross national income has attracted much attention in the health economics literature. Research interest in this relationship has been heightened by the observation that for many countries, aggregate health care expenditures have tended to grow over time at a rate faster than the rate of growth of gross domestic product. This observation, when considered together with empirical evidence from mainly developed economies of the OECD, has led many researchers and policy makers to view health care as a luxury good; that is, that the elasticity of demand for health care exceeds unity. When taken together with other evidence from empirical research that has found gross domestic product to be the most important determinant of health care expenditures, the view of health care as a luxury good poses the bleak implication that efforts at health care cost containment may be largely beyond the reach of policy.

From a policy perspective, two main considerations underlie the keen interest that has evolved around understanding the determinants of health care expenditures. A review of these two features will be instructive as to the rationale for this research and its contribution to the literature.

1.1 Objectives and Challenges of Health Systems

Many health care systems have the objective to provide universal access to health care, both in terms of the population covered and in terms of the range and quality of care provided. The Alma Ata Declaration of the International Conference on Primary Health Care (1978), provided the basis for this objective. The declaration identified health care as a fundamental human right and set a goal of health for all by the year 2000. It further identified Primary Health Care as the best approach for achieving universal access to essential health services, and urged
signatories, world governments and funding agencies to embrace the concept and to support its wide adoption in all countries, with immediate emphasis on developing countries.

Many countries subsequently incorporated explicit goals for universal coverage in their national health policies. Others that have not made such explicit commitments to universal coverage have nonetheless pursued objectives to encourage broad access, with explicit commitments to provide essential health care to vulnerable, impoverished and underprivileged groups. The objective of universal health care delivery has involved a careful balancing of efforts at efficient, cost-effective health care provision with an imperative to protect individuals and families from catastrophic financial consequences due to episodes of illness. This is accomplished through health financing that allows for the pooling of health and financial risk across the population. In practice, health systems have employed a myriad of health financing schemes, ranging from tax-funded systems of national health insurance to systems of private health insurance with employer and/or individual mandates to provide or purchase health insurance in lieu of payments into a national pool, or various shades and combinations of these.

Methods for health care provision have similarly varied across health care systems. Many developing countries and countries that adopted tax funded national insurance schemes utilize systems of publically funded and operated hospitals, health facilities and health care personnel. Other systems allow for private but publically regulated provision. In practice, most health systems employ some combination of public provision and private but regulated provision to foster competition with the aim to achieve efficiencies in cost and delivery.

Efforts at providing quality health care have produced mixed results across countries and regions. Prior to the adoption of health care reform in 2010 the United States implemented a system of private health insurance for the majority of its population. Affordability was achieved
through employer-provided group insurance, which allowed for cost savings by pooling across large groups of employees. Tax funded government insurance programs provided health care coverage for vulnerable groups. Among these were Medicare, the government tax-funded health insurance program for the elderly, and Medicaid, which provided health insurance for poor individuals and families. The Children Health Insurance Program (CHIP), a federal-state partnership, provided health insurance for children, and in some cases pregnant women, from families with income too high to be eligible for Medicare. Despite the availability of these health insurance programs, 16.3 percent of Americans, about 49.9 million people, were without health insurance and therefore access to health care in 2010\(^1\). Prominent among the causes of lack of access to health care for many Americans was the relatively high cost of health care. The US ranks first among comparable industrialized nations in measures of spending on health care. In 2010 health care spending accounted for 17.6 percent of U.S. GDP. Total expenditures were $2.6 trillion, amounting to $8,402 per person in 2010\(^2\).

While the U.S. consistently ranks first among health systems in expenditures on health care, rankings of health care system performance and health outcomes regularly place the U.S. unfavorably when compared to countries of similar economic status. In a World Health Organization ranking of 191 health systems, the U.S. placed 37\(^{th}\) for overall performance\(^3\). U.S. life expectancy at birth in 2013 was 78.8 years, 1.7 years less than the OECD average of 80.5. On yet another measure of health outcomes, the U.S. infant mortality rate was 5 deaths per thousand live births, 1.2 deaths above the OECD average of 3.8\(^4\). Relatively high health care spending

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2 Health Care Costs: A primer, Kaiser Family Foundation, May 2012
4 Health at a glance 2015: OECD indicators
coupled with unsatisfactory measures of health outcomes has spurred a debate among health practitioners and policy makers about waste and inefficiencies in the U. S. health care delivery system.

Compounding the problems with U.S. health care delivery outlined above are concerns about budgetary implications of projections regarding the solvency of the tax-funded health insurance programs that provide coverage for about 152 million Americans. The Congressional Budget Office estimates that federal government spending on health care rose from 2 percent of GDP in 1985 to about 5.5 percent in 2016, and is projected to be as much as 8.9 percent of GDP by 2045. Excess cost growth, defined as the growth rate of health care spending per person relative to the growth rate of GDP per person, adjusted for demographic changes, will average about one percentage point between 2016 and 2046. With regards to the Hospital Insurance Trust Fund, which is funded by dedicated payroll taxes and which pays benefits under Medicare Part A, the CBO projects that expenditure from the trust fund will outstrip receipt in 2020, and the fund will become exhausted by the year 2026.\(^5\)

In the United Kingdom, health care is universal. It is provided to all residents, in most cases, at no cost at the point of use. The National Health Service (NHS), which oversees the provision of health care, is funded from general taxation. It maintains a network of hospitals, doctors and other care providers and in limited cases procures care from independent and private providers. Private health care and insurance exists alongside the NHS, and is utilized by about 10 percent of the population, often for care or services in addition to what is covered by the NHS or to reduce wait times for referral services.

\(^5\) Congressional Budget Office: The Long term Budget outlook 2016
The British health care system is often held out in international comparisons as a model of quality and efficiency in health care delivery. Patient and public engagement and feedback are explicit requirements of the functioning of the health care delivery system; and the NHS is internationally regarded for its innovation and leadership in the tools of monitoring and evaluation. Annual patient surveys of the quality of care provided by the NHS regularly puts ratings at very good or excellent in upwards of two thirds of patients surveyed.

Expenditures on health care, on a per capita basis and as a share of GDP are on the lower end in comparison to other countries of similar social and economic status. Per capita health care spending in 2012 was $3,289, lower than the OECD average of $3,484. This spending amounted to 9.3 percent of GDP, the average for the OECD. The United Kingdom therefore is able to provide a high quality and efficient health care at lower costs than average among developed countries.

Like health systems in other developed countries, British health care is beset with concerns about its long term viability in view of rising costs and funding pressures. A demographic shift towards an aging population will mean additional costs associated with an increase in the number of people with chronic illnesses. Lifestyle choices leading to an increase in alcohol use, smoking and obesity will be associated with rising prevalence of conditions like diabetes and cardiovascular disease. The resulting rise in demand for health care are expected to lead to rising costs in excess of funding. The NHS faces a funding deficit of 30 billion pounds by 2020. The government has pledged increased budgetary funding of 8 billion pounds per year, leaving 22 billion pounds per year to be covered through productivity and efficient gains.

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7 OECD Health Statistics 2014
The problems that characterize health care in the cases discussed above are challenging, but these pale in comparison to the situation in Africa. The continent lags the rest of the world by significant measures in nearly all international comparisons of the common benchmarks of health status and outcomes. The state of health care infrastructure, health workforce, and financing can only be described as rudimentary, at best.

By some account, the poor state of health in Africa and the enormous challenges faced by countries in delivering adequate health care can, in part, be attributed to Africa’s geography. Africa is predominantly tropical, and its tropical climate is particularly suitable for the ecology of infectious diseases. Sachs and Bloom (1998) provide the following illustration of the link between tropical climate and disease ecology for the case of malaria, traditionally one of the biggest causes of morbidity and death in Africa. The mosquito species anopheles gambiae is the most important vector of falciparum, which in turn is the most virulent form of plasmodium, the parasite that causes malaria. Anopheles gambiae is indigenous to and more prevalent in sub-Saharan Africa than in other tropical areas. Additionally, the latency period of plasmodium inside its vector is temperature dependent, being much shorter the higher the ambient temperature. Thus in tropical areas, the latency period of plasmodium is much shorter relative to the life span of the mosquitoes that are vectors of the parasite. The mosquitoes are therefore much more likely to become infective before they die in tropical climates than they are in temperate ones.

Data from the World Health Organization (WHO) indicate that average life expectancy at birth in Africa in 2015 was lowest at 60.0 years, below the global average of 71.4 years. The under-five mortality rate was the highest among the WHO regions at 81 per 1000 live births, as compared to the world average of 43. Infectious and communicable diseases that have largely been

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8The latency period is time it takes for a mosquito to become infective after it absorbs plasmodium from an individual infected with malaria.
contained in other regions of the world continue to be major causes of death in Africa. In 2012, the leading causes of death were HIV/AIDS related deaths, which accounted for 11.5 percent of all deaths in Africa, and 70 percent of all HIV/AIDS related deaths worldwide; lower respiratory tract infections, including pneumonia, influenza and bronchitis, 11.5 percent; diarrheal diseases, 6.7 percent; malaria, 5.9 percent and stroke, 4.4 percent (Africa Check, 2014).

As dire a picture of the health status of much of Africa as the above exposition depicts, the state of the health infrastructure that must respond to these challenges is equally disconcerting. As the WHO reports, Africa, with more than 24% of the global burden of disease, has access to just 3% of health workers and less than 1% of the world’s financial resources. Hospital bed density in 2009 was lowest in Africa, at 10 per population of 10,000, as compared to 63 per 10,000 in Europe. There were just 2 physicians per population of 10,000 in Africa, compared to 13 per 10,000 worldwide and 32 per 10,000 in Europe (World Health Statistics, 2009). These numbers clearly fall short of requirements to address health needs in Africa. Kinfu et al (2008) examine whether current preservice training can improve the shortage of health workers, taking into account population increases and attrition to the health workforce from various sources. They conclude that current preservice training are insufficient to maintain numbers even at their current levels.

Improvements in Africa’s health outcomes and the state of its health infrastructure will require significant additional investment, but current trends are not encouraging. Health care spending, both per capita and as a share of GDP, tends to be much lower in Africa as compared to other regions, and fall short of what is required to meet the challenges of health care delivery. Average per capita total healthcare spending in the region in 2014 was $306, compared with an OECD average of $3,734, and $9,403 for the US. This however masks the large disparity in spending across countries. The Central African Republic spent $25 per person on health care, the
lowest in the region, while Equatorial Guinea recorded the highest spending per capita, $1,163. Average share of GDP spent on health care was 6 percent, compared to 9.28 percent for the OECD and 17.14 percent for the US.

The share of total government spending that goes to health care is sometimes cited as a measure of the extent to which the government prioritizes health care. In 2014, the average share was 10.05 percent, also masking a large variation among countries. The Eritrean government spent just 3.6 percent of its budget on health care, while at the higher end, the figure for Malawi was 16.77 percent. Just four of the fifty-two countries, Ethiopia, Malawi, Gambia and Swaziland, had health share of government budget at or above 15 percent, as stipulated by the Abuja declaration of 2001. As a final note of the greater health risks that Africans in general face, out of pocket spending remains a high proportion of health care spending. It amounted to 33.30 percent of total health care spending in 2014, compared to the OECD average of 19.16 percent and 11.05 percent for the US. Thus, Africans, with their meager financial means, bear a disproportionate share out of pocket spending for health care, which further impedes access to health care and exposes them to greater risks of financial catastrophe from episodes of illness.

The review presented above reveal a salient point, that health systems around the world have a monumental responsibility for delivering health care to their people, and face serious challenges in this endeavor. Whether it be about extending access and improving outcomes for the value of spending in the US, solvency and quality concerns in the UK, or infrastructure and public health issues in Africa, various reforms, restructuring and other responses will be required if health systems are to be adequately positioned to deliver quality care for the long term. A careful mix of significant additional funding, efficiency gains and cost savings will be essential.

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9 Heads of States of the African Union (AU) met in Abuja, Nigeria in April 2001 and pledged to allocate at least 15 percent of each country’s budget to the improvement of health care.
requirements to these efforts, and this leads to the second major concern that has spurred interest in the relationship between healthcare spending and GDP, namely, health care cost. Health care is expensive, and costs tend to rise over time. This tendency has significant implications for efforts at health care reform.

### 1.2 The Rising Cost of Healthcare

Figure 1.1 shows total health care spending per capita for the United States, the OECD countries and Africa for the period 1995 to 2014. In all three regions, health care spending per capita rose over the referenced period. Average growth rates were 4.90 percent for the United States, 5.21 percent for the OECD region, and 4.94 percent for Africa. These increases occurred amid the challenges to health care the three regions experienced as discussed earlier in this chapter. A more vivid indication of the burden of rising spending on health systems can be seen in Figure 1.2, which shows health care spending as a share of gross domestic product. The three regions have all seen rising shares of health care expenditures in GDP, an indication that health care spending has been rising at a rate faster than the growth of GDP. For the United States, the share of health care spending in GDP rose from 13.89 percent in 1995 to 17.41 percent in 2014, while for the OECD region the average share rose from 7.29 percent to 9.28 percent in the same period. For Africa, the average share of health care spending in GDP rose from 4.78 percent to 6.08 percent between 1995 and 2014. As has been pointed out in the literature, growth rates of health care spending in excess of GDP are unsustainable in the long term, as a nation cannot indefinitely commit ever larger shares of its resources to health care without a sacrifice of other services that may also be important for the wellbeing of its people\(^\text{10}\). But as can be seen in Figure 1.3 below, rising shares of health care in GDP has been the norm. The figure shows the growth rates of the

\(^{10}\) See, for example, Kotlikoff and Hagist (2005)
share of health care spending in GDP for the three regions, a measure of the excess growth of health care spending over GDP growth. With few exceptions this variable has been positive during the period, particularly for the United States and the OECD region, indicating increasing shares of healthcare in GDP.

A number of explanations have been put forth for the tendency of health care spending to rise over time. The most prominent explanation identifies the rising use of advanced medical technology and new medicines as a leading cause. Other studies point to the use of fee-for-service methods of medical service reimbursement as an important source of health care cost growth, given
its inherent lack of incentives for physicians to control costs. Still other studies point to the increased use of insurance and other health care financing mechanisms that significantly reduce the cost to the user at the point of service, providing an incentive for overuse. All of the aforementioned explanations for rising health care costs lead to higher utilization per person, irrespective of demographic group. In many countries, on the other hand, there is a tendency for a demographic shift toward an aging population over time. As older people use more medical care, this demographic shift has also been identified as a source of growing health care spending.

An explanation for rising health care costs that draws on consumer preference theory posits that health care is a technical luxury, with an income elasticity greater than 1. In this view, rising health care spending in excess of GDP growth is inevitable as countries undergo economic growth.
Studies that have examined the determinants of health care spending have consistently found a significant and often predominant role for income, after controlling for the other factors including those discussed above. Less conclusive has been the size of the income effect. While most studies have found elasticities at or above 1, a few have found elasticities below 1.

Finally, what is true for overall health care spending appears to be true of government spending on health care. Figure 1.4 shows general government health expenditures as a share of general government expenditures, 1995 to 2014. The share has risen for all three series over the referenced period. The growth rate of government health care spending as a share of total government expenditures increases sharply toward the end of the period for the United States and the OECD average, highlighting the budgetary and solvency issues with projections for
government sponsored health care programs discussed earlier. With Africa, on the other hand, there is a slowdown in the growth of government health care spending share, and even a decline in government spending on health care. This apparent deprioritizing of health care is the opposite of what is prescribed given Africa’s health care challenges and as mandated by the aforementioned Abuja declaration.

The picture presented in this review of health care systems and spending is one of a need for expansion of services, increased population coverage and plugging of budgetary and other funding holes for the long term viability of health care delivery systems across countries; all at the same time as health care spending rises and takes up increasing shares of available resources.
Orszag and Ellis (2007) observe that the evidence does not show that higher health care spending produces better health outcomes. Cost containment and efficiency gains will clearly have to be part of any efforts at reforming or reorganizing health care systems to deliver more and better services to more people.

The research that has evolved around the question of what determines the level and behavior of health care spending is an attempt at making a contribution to cost containment and reform of health care delivery. As already mentioned, a persistent theme in the literature that this line of research has produced is that gross domestic product is a significant, and in some studies the biggest, determinant of health care spending, at least at the aggregate level. Furthermore, there is a debate as to the size of the income elasticity of health care expenditures, with many studies finding an elasticity greater than 1. As these studies mostly cover wealthy countries, and in particular countries of the OECD, it is of interest to inquire if similar findings would be arrived at from a study of a sample of countries of a different socio-economic background and level of development than OECD countries.
CHAPTER 2 LITERATURE REVIEW

The lack of theoretical basis for the determinants of health care expenditures has given rise to an active area of research attempting to provide empirical evidence as to the nature of the relationship of health care expenditures to its determinants. Much of this effort has been concentrated at explaining these relationships for countries of the Organization for Economic Cooperation and Development (OECD), largely because these are the countries for which reliable data have historically been available. The results to date are mixed, but a consensus appears to be building around a number of key findings. First, it appears from the evidence that the major determinant of per capita health care expenditures is GDP per capita. Newhouse (1977), using data on a cross section of 13 OECD countries, found that 92 percent of the variation in per capita health care expenditures could be explained in terms of variation in per capita GDP. Subsequent research has largely provided support for this finding.

With GDP per capita having been found to play the major role in determining per capita health care expenditures, a strand of research has focused on empirically estimating the parameters of the relationship. The evidence here again is mixed, but the prevailing view emanating from this research is that the income elasticity of health care expenditure exceeds unity, implying that health care is a luxury (Kleiman (1974), Newhouse (1977), Gerdtham, Sogaaard et al. (1992)). The evidence is however not conclusive, with other studies finding an elasticity of unity Hitiris and Posnett (1992), and still others finding a coefficient of less than unity (Parkin, McGuire et al. (1987)). These estimates are based on cross-sectional analyses of a small number of countries, which have been criticized for the resulting small size of the data set (Parkin, McGuire et al. (1987), Hitiris and Posnett (1992)). Efforts to address the issue of small sample size have involved the use pooled and time series data to increase the sample size. Hitiris and Posnett (1992) use pooled time
series observations on 20 OECD countries to obtain a sample size of 560. Their results confirm a strong positive relationship between per capita health care spending and per capita GDP, with an income elasticity of around unity.

The use of pooled and time series data has shifted the focus of research to determining the sensitivity of results to assumptions about the time series properties of the data. Hansen and King (1996) find that both per capita health expenditures and GDP have unit roots and are not cointegrated. They therefore suggest that previous studies of pooled and panel data that found strong relationships between these variables might show a spurious relationship. Blomqvist and Carter (1997) also find evidence of unit roots in per capita health care expenditures and GDP, but in contrast to Hansen and King (1996), they find evidence of a cointegrating relationship, with a long run elasticity of around unity. Gerdtham and Lothgren (2000) provide evidence that generally support these findings. In contrast, McCoskey and Selden (1998) use panel unit root tests to reject the presence of a unit root in either per capita health care expenditures or per capita GDP. Their results are however sensitive to the inclusion of a time trend in their estimation equation.

Estimates of the relationship between per capita health care expenditures and per capita GDP and the size of the income elasticity have also been found to be sensitive to both the model specification and the estimation methods used. However not as much research has been directed at assessing the sensitivity of the results to the sample of countries, largely due to the unavailability of reliable data. In particular, there is sparse evidence of the nature of the relationship between health care expenditures and GDP for African countries. An early effort at bridging this gap in the literature is provided by Gbesemete and Gerdtham (1992). Their cross-sectional study of a sample of 30 African countries for 1984 found that GNP per capita has the largest impact on per capita health care expenditures, with an elasticity at around unity. Murthy and Okunade (2009)
reach similar conclusions in their cross-sectional study of 44 African countries using 2001 data, in addition to finding a significant role for foreign aid in determining health care expenditures. In contrast to these cross-sectional studies, Jaunky and Khadaroo (2008) use time series techniques on a panel of 28 African over 1991 – 2000. They conclude that health care expenditures per capita and GDP per capita are nonstationary and cointegrated, with an elasticity greater than unity for public health care expenditures and about unity for private health care expenditures.
CHAPTER 3 A MODEL OF HEALTH CARE DETERMINATION

As has been noted in previous studies, there is no firm theoretical basis as to the determinants of a country’s total health expenditures. It seems reasonable, however, that expenditures would be constrained by the total amount of resources the country has available for spending on all needs. The most comprehensive measure of resources a country has for meeting current needs is its gross domestic product (GDP). We would therefore expect GDP per capita to be a determinant of total healthcare expenditures. Additionally, we would expect factors that influence the demand and supply of health care to be influential in the determination of healthcare expenditures. On the demand side, demographics and disease ecology would be important, while on the supply side, we would expect the characteristics and institutional arrangements for health care delivery and financing to influence a country’s total health care expenditures.

Previous studies have found GDP per capita to exert the greatest influence on per capita health care spending. Newhouse (1977) found in a bivariate regression that more than 90 percent of the variation in per capita medical expenditure could be explained by variation in per capita GDP in a sample of 13 OECD countries. Hitiris and Posnett (1992) confirmed this finding using pooled time series and cross sectional data from an expanded list of 19 countries. They found that per capita GDP explained upwards of 91 percent of the variation in per capita health care spending.

Leu (1986) argues that increased public provision and financing of health care services should be associated with higher health care expenditure. Increased public provision, he argues, lessens competition and reduce incentives for cost minimization. Additionally, bureaucrats in public institutions act as budget maximizers, increasing provision to maximize their own welfare. Finally, public financing lowers the cost to users of health care services and may lead to overuse. Culyer (1989) emphasizes methods of reimbursement for medical services as relevant for cost
containment. He proposes that retrospective reimbursement, such as fee for service methods of payment are likely to see higher overall expenditure per head, whereas systems that use prospective reimbursement would tend to lower tendencies for cost inflation.

Demographic and health status variables that affect the demand for health care have also featured prominently in the existing literature. Gertham et al. (1992) include the proportion of the population age 65 and above and the degree of urbanization of the population as measures of health care utilization, and the female labor force participation ratio as a measure of the substitution of informal for formal care. They however find these variables to be statistically insignificant in their most preferred model. Gbetemese and Gerdtham (1992) found the percentage of births attended by medical staff to be statistically significant for the determination of health care expenditures. Three other demographic and health status measures included were however found to be insignificant, namely, the crude birth rate, the degree of urbanization and the percentage of population under 15 years of age.

Previous studies have also addressed the issue of the appropriate functional form for the estimating equation. Most studies employ the double-log functional form in which both total health expenditures per capita and gross domestic product per capita are entered as natural logs. This practice is not only convenient for its tractability in this line of research, but it allows for the interpretation of the coefficient estimates as elasticities. Using OECD data, Parkin et al. (1987) demonstrate that results can be sensitive to the functional form of the estimating equation, noting that different functional forms can support competing theories using the same data. They therefore urge caution in empirical examination of health care spending as it relates to functional form. Gertham et al. (1992) address the issue of functional form within the framework of the Box-Cox
transformation. Their results provide evidence in favor of the double-log functional form against three alternatives, namely, the linear, exponential and semi-log functional forms.

Guided by results from previous research, I assume that health care expenditures per capita is determined by a country’s GDP per capita, as well as other variables that describe or proxy for characteristics of the health care delivery system and demographic characteristics of the country, and the relationship is expressed using the double-log functional form:

\[ HCE_{it} = \beta_0 + \beta_1 GDP_{it} + \gamma'X_{it} + \varepsilon_{it} \]  

(3.1)

In this equation, \( HCE_{it} \) is the log of health expenditure per capita, \( GDP_{it} \) is the log of gross domestic product per capita and \( X_{it} \) is a vector collecting all other factors that may affect health care expenditures per capita. The novelty in this study is to observe that, for the population under study, health care expenditures may be an important determinant of GDP per capita. This observation, taken together with equation (1), would suggest that health care expenditure and gross domestic product are jointly determined in the data. If this holds true, failure to account for the endogeneity of GDP per capita would result into simultaneity bias in estimates of the parameters of equation (3.1).

The neoclassical growth model, extended to human capital, postulates a production function of the form

\[ Y_{it} = K_{it}^\phi H_{it}^\phi (E_{it}L_{it})^{1-v-\phi} \]

where \( Y_{it} \) is GDP, \( K_{it} \) is the capital stock, \( H_{it} \) is the stock of human capital, \( E_{it} \) is an efficiency parameter that determines the productivity of labor and \( L_{it} \) is the labor force. The term \( EL \) is interpreted as efficient units of labor. The growth empirics literature often proxies the stock human capital by measures of education attainment and health status of the work force. To make the measure of human capital relevant to this study I use the stock of health capital in the country
as the measure of human capital. The production function above thus relates gross domestic product to the stock of health capital in the country. For the purpose of the analysis in this paper, however, it would be more convenient to express the production function as relating gross domestic product to total health care expenditures. I therefore assume that the stock of health capital in a country accumulates with the level of health care expenditures, and specify an accumulation process of the form:

\[ H_{it} = H_{it-1}(HE_{it})^\eta \]

where \( HE_{it} \) is current health care expenditures and \( \eta \) is a parameter measuring the efficiency with which health care spending is transformed into health capital stock. I use the multiplicative form to exploit the log transformation of the variables I use in the model. Taking logs of the production function and the health accumulation equation, and using the accumulation equation to substitute the log of health care expenditures for the log of health capital stock in the production function, I derive, after some algebra, an equation of the form

\[
\ln \left( \frac{Y}{L} \right)_{it} = \alpha_0 + \alpha_1 \ln \left( \frac{HE}{L} \right)_{it} + \alpha_2 \ln \left( \frac{K}{L} \right)_{it} + \alpha_3 \ln L_{it} + \alpha_4 \ln H_{it-1} + u_{it} \tag{3.2}
\]

The variables \( \ln \left( \frac{HE}{L} \right)_{it} \) and \( \ln \left( \frac{K}{L} \right)_{it} \) in equation (3.2) are the same as \( HCE_{it} \) and \( GDP_{it} \) respectively in equation (3.1). I therefore use common notation in the health care expenditure equation (3.1) and the production function (3.2) to express a two-equation system of the form:

\[
HCE_{it} = \beta_0 + \beta_1 GDP_{it} + \gamma'X_{it} + \epsilon_{it}
\]

\[
\begin{align*}
GDP_{it} &= \alpha_0 + \alpha_1 HCE_{it} + \alpha_2 \ln \left( \frac{K}{L} \right)_{it} + \alpha_3 \ln L_{it} + \alpha_4 \ln H_{it-1} + u_{it} \tag{3.3}
\end{align*}
\]

If measures of the per capita stock of physical capital and the population are available and are believed to be uncorrelated with the error term in equation (1), \( \beta_1 \) can be consistently estimated by
using these variables as valid instruments for per capita GDP in the health care expenditure equation (3.1).
CHAPTER 4 DATA

Data on total health care spending, gross domestic product and national populations are from the global health expenditure database of the World Health Organization. The WHO updates the database annually, with data obtained from publicly available reports from national governments, private sector sources and international organizations. Data on national capital stocks are available from the Penn World Tables, version 8.1. Both the Global health expenditure database and the Penn World Tables present data in a manner as to make them internationally comparable. However, the WHO cautions that country data may still differ in terms of definitions, data collection methods, population coverage and estimation methods used. Total health care expenditures and gross domestic product are measured in constant 2005 purchasing power parities. National capital stocks are measured at current purchasing power parities. The data consists of annual observations on 42 African countries for 1995 to 2011.
CHAPTER 5 METHODS AND ESTIMATION

5.1 Tests of Stationarity

The time series nature of the data raises the question of whether the data are stationary. As is well known, ordinary least squares estimates from nonstationary data result into spurious regressions, in which a significant effect is found even if the variables are independent. Taking first differences of variables that are $I(1)$ results into stationary data on which regression procedures can produce consistent estimates of population parameters.

I use two tests of unit roots to test for nonstationarity of the log of total health care expenditures per capita and the log of GDP per capita. The first is the Augmented Dickey-Fuller (ADF) test, which is based on the regression

$$\Delta y_{it} = \alpha_i + \delta t + \beta_i y_{i,t-1} + \sum_{j=1}^{p_i} \rho_{ij} \Delta y_{i,t-j} + \epsilon_{it}$$

where $y_{it}$ is observed over $T$ time periods across $N$ countries. The null hypothesis is $H_0 : \beta_i = 0$ against the alternative that the data is trend stationary, $H_1 : \beta_i < 1$. The $t$-statistic for this test follows a nonstandard distribution that has been tabulated in Fuller (1976). As McCoskey and Selden (1998) point out, when the time dimension is relatively short, adding lags to the ADF regression results into a loss of observations as the number of parameters to be estimated increases. The resulting loss of degrees of freedom can cause the ADF test to have low power.

To increase the power of the test, I follow the lead of other studies that utilize a panel unit root test to exploit the panel nature of the data. The power of the IPS test (Imp, Paesaran et. Al., 2003) increases as the cross sectional dimension gets larger. The IPS test is based on the average of $t$-statistics from the country-by-country ADF tests:

$$\bar{t}_{NT} = \frac{1}{N} \sum_{i=1}^{N} t_{it}(p_i)$$
where $t_{it}$ is the ADF $t$-statistic for country $i$ when $p_i$ lags are used in the country specific ADF regression. The null hypothesis $H_0: \beta_i = 0$ for all $i$ is tested against the alternative $H_1: \beta_i < 0$ for a subset of the $N$ countries. Failure to reject the null is evidence that the panel series is $I(1)$ around a linear trend.

### 5.2 Test for Cointegration

One method of determining the existence of a long run relationship between per capita total healthcare expenditures and GDP per capita is to test for the existence of a cointegrating relationship. If the two variables are integrated of order 1, as evidenced by findings in this paper, then a cointegrating relationship exists if a stationary linear combination of the two variables can be found. Formally, let $HCE_i$ be the log of total health expenditures per capita and $GDP_i$ be the log of GDP per capita. Then, under the assumption that $HCE_i$ and $GDP_i$ are both $I(1)$, a cointegrating regression can be expressed as:

$$HCE_i = \beta_0 + \beta_1 t + \beta_2 GDP_i + u_i$$  \hspace{1cm} (5.1)

Equation (5.1) would be a valid cointegrating relationship if $u_i = HCE_i - \beta_0 - \beta_1 t - \beta_2 GDP_i$ is a stationary variable. A test for stationarity of $u_i$ is therefore a test of whether $HCE_i$ and $GDP_i$ are cointegrated.

To test for cointegration between total healthcare expenditures per capita and GDP per capita I apply the residual-based test for cointegration proposed by Engle and Granger (1987). The test is based on applying the Dickey-Fuller $t$-test for stationarity to the residuals $\hat{u}_i$ from the OLS estimates of equation (1):

$$\Delta \hat{u}_i = \delta \hat{u}_{i-1} + e_i$$

If the errors in the Dickey-Fuller equation, $e_i$, are believed to be serially correlated, then a sufficient number of lags of the regressand $\Delta \hat{u}_i$ should be added to the equation to make the errors serially
uncorrelated. The test in this case is the Augmented Dickey-Fuller test. Under the null hypothesis, $H_0: \delta = 0$, the errors $\hat{u}_t$ are nonstationary, and therefore $HCE_t$ and $GDP_t$ do not cointegrate. The test is therefore a test of no cointegration. Failure to reject the null is evidence of the lack of a long run relationship between total healthcare expenditures per capita and GDP per capita.

A caveat to using tests of cointegration to determine long run relationships between total healthcare expenditures per capita and GDP per capita is that the brevity of the time dimension of the data in this study makes inferences from results of such tests unreliable. As is well known, the power of tests of stationarity declines the smaller the number of observations in the data. With just 17 observations per panel, the test outlined above is likely to have low power. This would result in a tendency for the test to fail to reject the null hypothesis if it is indeed false. Thus, the potential low power of the Dickey-Fuller test in this exercise is likely to lead to findings of no long run relationship. This is likely to be an artifact of the data, however, as it seems intuitive that there must be a long run relationship between healthcare expenditures per capita and GDP per capita. Numerous studies outlined in the literature review section of this paper have found strong evidence of such relationship. A finding of no cointegration would therefore not preclude the use of other methods to establish the relationship, if any, between total healthcare expenditures per capita and GDP per capita. Regardless of the results, the cointegration exercise is interesting in that it sheds light from an alternative data set on an issue of much debate in the existing literature.

5.3 Model Estimation

The data contain seventeen-time series observations on each country in the sample. The small sample size would render unreliable any coefficient estimates from country-specific time series regressions that rely on methods that are only asymptotically valid. To improve the reliability of the coefficient estimates, I utilize an estimation procedure that exploits the panel
nature of the data. The generalized method of moment (GMM) estimator allows for the estimation of coefficients on endogenous variables\(^{11}\). The procedure can be applied to panel data to estimate the average effect of an endogenous variable on a dependent variable in a sample of countries over a period of time. For the multiple equation version of the GMM estimator, consider the equation

\[ y_{im} = z'_{im} \delta_{im} + \varepsilon_{im} \quad (m = 1, 2, ..., M; i = 1, 2, ..., n) \]

The equation specifies a system of \(M\) equations on observation \(i\), where \(n\) is the sample size. \(y_{im}\) is the dependent variable for observation \(i\) in equation \(m\). \(z_{im}\) is an \(L_m\) dimensional vector of possibly endogenous regressors, and \(\delta_{im}\) is an \(L_m\) dimensional vector of coefficients to be estimated. \(\varepsilon_{im}\) is the error term in the equation \(m\). Imposing common coefficients across all \(M\) equations (\(\delta_{im} = \delta\)), the system of equations becomes

\[ y_{im} = z'_{im} \delta + \varepsilon_{im} \]

Common coefficients imply that each equation \(m\) has the same number of regressors, so \(L_m = L\). Let \(x_{im}\) be a \(K_m\) dimensional vector of instruments for equation \(m\). Then the GMM estimator is based on the sample analogue of the population orthogonality conditions

\[ E(x_{im} \varepsilon_{im}) = E(x_{im}(y_{im} - z'_{im} \delta)) = 0 \]

The expression above specifies a system of \(K_m\) linear restrictions of the form

\[ E(x_{im} y_{im}) - E(x_{im} z'_{im} \delta) = 0 \]

These \(K_m\) linear restrictions must hold for each equation \(m\). Therefore the system of \(m\) equations has \(\sum m K_m\) orthogonality conditions. To collect these orthogonality conditions in a single system, define \(\sigma_{xy}\) to be the \(\sum m K_m\)-dimensional vector collecting moment conditions \(E(x_{im} y_{im})\) from all

\(^{11}\) See Hayashi (2000)
Let $\Sigma_{xz}$ be a stacked $\sum_m K_m \times L$ matrix collecting the matrices $E(\mathbf{x}_{im} \mathbf{z}_{im}')$ from all $M$ equations. The $\sum_m K_m$ orthogonality conditions can therefore be written as

$$\sigma_{xy} - \Sigma_{xz} \delta = 0$$

To derive the sample analogue to these orthogonality conditions, let $s_{xy} = \frac{1}{n} \sum_1^n \mathbf{x}_{im} \mathbf{y}_{im}$ and $S_{xz} = \frac{1}{n} \sum_1^n \mathbf{x}_{im} \mathbf{z}_{im}'$ be the sample analogues of $\sigma_{xy}$ and $\Sigma_{xz}$ respectively. Then the sample analogue of the orthogonality conditions is

$$s_{xy} - S_{xz} \delta = 0.$$  

Notice the dimension of the matrix $S_{xz}$ is $\sum_m K_m \times L$, and in general, $\sum_m K_m \neq L$. As such, matrix $S_{xz}$ is in general not a square matrix and not invertible. As a result, there is no $\delta$ that solves $s_{xy} - S_{xz} \delta = 0$. If this difference cannot be set exactly to zero, it must be possible to find a $\delta$ that sets the difference as close as possible to zero. The GMM estimate $\delta$ of the population parameter $\delta$ is the $\delta$ that minimizes the difference $s_{xy} - S_{xz} \delta$ in the following sense: Let $W$, called a weight matrix, be a positive definite matrix of dimension $\sum_m K_m \times \sum_m K_m$. The GMM estimate minimizes the quadratic form

$$Q = [s_{xy} - S_{xz} \delta]^{-1} W [s_{xy} - S_{xz} \delta]$$

If $W$ is chosen such that $W = S^{-1}$, where $S$ is a block matrix whose $S_{mh}$ block is

$$\frac{1}{n} \sum_1^n \epsilon_{im} \epsilon_{ih} \mathbf{x}_{im} \mathbf{x}_{ih}',$$

for $m=1,2,\ldots,M$ and $h=1,2,\ldots,M$, then we obtain the efficient GMM estimator.

In the implementation of these methods, I estimate 17 equations ($M=17$), one equation for each year 1995 – 2011. When the variables are in logs, the equations are of the form

$$LTHE_{it} = \beta_0 + \beta_1 LGDP_{it} + \epsilon_{it}, \quad i = 1,2,\ldots,42; t = 1995,1996,\ldots,2011$$

$LTHE_{it}$ is the log of per capita total health care expenditures, and $LGDP_{it}$ is the log of per capita gross domestic product. $\epsilon_{it}$ is an error term. I allow for heteroskedasticity and serial correlation
in the errors, and therefore report standard errors that are robust to both. For each country and year, I use the log of the capital to labor ratio \((LCK_{it})\) and the log of the population \((LPOP_{it})\) as instruments for \(LGDP_{it}\). \(LPOP_{it}\) is a proxy for labor input. Finally, I impose the cross equation restriction that \((\beta_0, \beta_1)'\) are the same in each equation. This is because I am interested in the average effect of \(LGDP_{it}\) on \(LTHE_{it}\) over the sample period for the sample of countries.

If either \(LTHE_{it}\) or \(LGDP_{it}\), or both are \(I(1)\), the above would represent a spurious regression. I therefore first difference the data and run the following specification:

\[
d.LTHE_{it} = \beta_1 d.LGDP_{it} + \epsilon_{it}, \quad i = 1,2,...42; t = 1996, 1997,...,2011
\]

differencing the data causes a loss of one observation, so the system now consists of 16 equations. In this specification, I use the growth rates of \(LCK_{it}\) and \(LPOP_{it}\) as instruments.
CHAPTER 6 RESULTS

6.1 Summary Statistics

Table 6.1 presents country means of the dependent and explanatory variables, where the averages are taken for the period 1995 to 2011. Average GDP per capita ranges from $528.76 in the Democratic Republic of Congo to $20,355.08 in Equatorial Guinea. While a few countries have GDP per capita that place them among the wealthy countries of the world, in reality the level of income inequality is so high that wealth is concentrated among a small minority elite, and the majority of the population have living standards and access to essential services that are no better than those in poorer countries.

Average spending on healthcare ranges from as little as $18.33 in the Democratic Republic of Congo to $642.29 in the Seychelles. Average share of government spending in total health care spending generally tends to hover somewhat below the 50 percent mark. Out of pocket spending tends to make up a higher share of the remaining spending than is found in wealthy countries. The figures for average percentage of the population over sixty-five reflects two facts; life expectancy is less than sixty-five, and the demographic shift towards older population that is often observed in developed countries has not materialized in Africa.

6.2 Unit Root Results

Table 6.2 contains results from country-by-country ADF unit root tests as well as the result of the IPS panel unit root test on the panel of 42 countries. As indicated in the table, only in four cases can the null of a unit root be rejected for the log of real GDP per capita (lGDPpc). For the log of total health care expenditures per capita (lTHEpc_PPP), the null of a unit root was rejected in just 7 cases. These results provide evidence of unit roots in both the GDP and healthcare expenditure series, as other studies have found.
Table 6.1

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>THEpc_PPP</th>
<th>GDPpc</th>
<th>GGHE_THE</th>
<th>tb</th>
<th>urb</th>
<th>O65_</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola</td>
<td>169.72</td>
<td>4,141.93</td>
<td>54.09</td>
<td>266.18</td>
<td>34.74</td>
<td>2.41</td>
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<td>Benin</td>
<td>60.95</td>
<td>1,385.33</td>
<td>48.26</td>
<td>80.29</td>
<td>39.38</td>
<td>2.91</td>
</tr>
<tr>
<td>Botswana</td>
<td>499.61</td>
<td>10,297.99</td>
<td>64.50</td>
<td>764.65</td>
<td>53.82</td>
<td>3.10</td>
</tr>
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<td>Burkina Faso</td>
<td>62.25</td>
<td>1,059.36</td>
<td>48.06</td>
<td>67.65</td>
<td>20.27</td>
<td>2.69</td>
</tr>
<tr>
<td>Burundi</td>
<td>44.75</td>
<td>609.13</td>
<td>37.17</td>
<td>235.12</td>
<td>8.97</td>
<td>2.77</td>
</tr>
<tr>
<td>Cameroon</td>
<td>97.12</td>
<td>2,091.91</td>
<td>23.63</td>
<td>283.35</td>
<td>47.34</td>
<td>3.35</td>
</tr>
<tr>
<td>Cape Verde</td>
<td>181.80</td>
<td>3,880.15</td>
<td>76.13</td>
<td>156.18</td>
<td>55.89</td>
<td>5.31</td>
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<td>Cote d'Ivoire</td>
<td>150.07</td>
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<td>26.54</td>
<td>302.12</td>
<td>45.74</td>
<td>2.89</td>
</tr>
<tr>
<td>DRC</td>
<td>18.33</td>
<td>528.76</td>
<td>20.79</td>
<td>326.94</td>
<td>36.57</td>
<td>2.90</td>
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<td>Djibouti</td>
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<td>2,023.14</td>
<td>65.38</td>
<td>619.82</td>
<td>76.67</td>
<td>3.25</td>
</tr>
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<td>Egypt</td>
<td>363.19</td>
<td>7,531.81</td>
<td>40.74</td>
<td>23.53</td>
<td>42.90</td>
<td>5.01</td>
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<td>Equatorial Guinea</td>
<td>588.61</td>
<td>20,355.08</td>
<td>70.61</td>
<td>108.00</td>
<td>38.92</td>
<td>3.50</td>
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<td>Ethiopia</td>
<td>28.55</td>
<td>659.81</td>
<td>51.76</td>
<td>362.82</td>
<td>15.45</td>
<td>3.15</td>
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<td>179.53</td>
<td>50.43</td>
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<td>45.89</td>
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<td>32.18</td>
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<td>23.06</td>
<td>332.00</td>
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<td>42.15</td>
<td>292.94</td>
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<td>Lesotho</td>
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<td>58.02</td>
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<td>2.94</td>
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<td>54.82</td>
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<td>72.06</td>
<td>30.74</td>
<td>3.11</td>
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<td>113.47</td>
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<td>5.50</td>
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<td>327.47</td>
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<td>2.79</td>
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<td>95.00</td>
<td>17.59</td>
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<td>108.71</td>
<td>55.99</td>
<td>4.40</td>
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<td>82.23</td>
<td>1,776.48</td>
<td>43.56</td>
<td>146.76</td>
<td>40.89</td>
<td>3.15</td>
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<td>Seychelles</td>
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<td>16,366.43</td>
<td>88.39</td>
<td>21.10</td>
<td>50.80</td>
<td>7.29</td>
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<td>Swaziland</td>
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<td>940.18</td>
<td>22.29</td>
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<td>Tanzania</td>
<td>49.95</td>
<td>1,051.51</td>
<td>47.07</td>
<td>214.00</td>
<td>24.10</td>
<td>2.94</td>
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<td>1,152.80</td>
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<td>71.18</td>
<td>34.30</td>
<td>2.82</td>
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<td>53.73</td>
<td>26.06</td>
<td>64.20</td>
<td>6.91</td>
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<tr>
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<td>2,414.67</td>
<td>44.00</td>
<td>625.18</td>
<td>36.66</td>
<td>2.82</td>
</tr>
</tbody>
</table>

The results from the country-by-country ADF tests should be taken with caution. The shortness of the time dimension of the data, together with the inclusion of a time trend in the augmented regression would cause the ADF test to have low power in this instance. I therefore also ran the IPS panel unit root test, which is supposed to provide increased power as the cross sectional dimension of the data increases. The result from the IPS test conforms with the ADF results for both the GDP and total healthcare series. This provides additional evidence that both series have unit roots.

6.3 Results from Cointegration Tests

Table 6.3 below presents test statistics from the Engle-Granger country by country tests for cointegration. The critical values for the test, as tabulated in MacKinnon (1990, 2010) are -5.432, -4.422 and -3.963 for the 1%, 5% and 10% significance levels respectively. The null of no cointegration can be rejected for just 7 of the 44 countries in the sample at a 5% significance level. At the 10% significance level, the null can be rejected for just 5 countries. The results therefore provide overwhelming evidence against the existence of a long relationship between total healthcare expenditures per capita and GDP per capita. This conforms with some existing studies, but as mentioned above, the results must be viewed with suspicion due to the low power of the test in this study.

6.4 Results from Model Estimation

On the basis of the results from the unit root tests I enter total health care expenditures and GDP per capita as first differences in all regressions. I estimate eight models of the relationship between total health care expenditures and gross domestic product per capita. Model 1 is the GMM estimate as explained in chapter 5, where the model is estimated without an intercept. Model 2 adds an intercept to the equation in Model 1. Model 3 and Model 4 are the
Table 6.2
Country-by-country ADF Tests and Panel IPS Test

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>lGDPpc_t-stat</th>
<th>lGDPpc_p-value</th>
<th>lTHEpc_PPP_t-stat</th>
<th>lTHEpc_PPP_p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola</td>
<td>-3.584</td>
<td>0.0312</td>
<td>1(0)</td>
<td>4.934</td>
</tr>
<tr>
<td>Benin</td>
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IPS -1.2694 0.1021 1(1) -0.2994 0.3823 I(1)

The 1%, 5% and 10% critical values of the ADF distribution are -4.38, -3.60 and -3.24. The tests were run with a trend and no lags.
Table 6.3

Test for Cointegration

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<th>COUNTRY</th>
<th>Z(t)</th>
</tr>
</thead>
<tbody>
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The 1%, 5% and 10% critical values are -5.432, -4.442 and -3.963. A linear trend is included in the first stage regression. No lag differences are included in the second stage regression.
fixed effects and random effects estimates respectively. These estimates have been used in previous studies and are included here for comparison purposes. Models 1 through 4 assume that all explanatory variables are exogenous, and are estimated without instrumental variables. Models 5 through 8 are as described for Models 1 through 4, except that GDP per capita is endogenous and is instrumented in the estimation procedures. In all models the dependent variable is the log of total health care expenditures per capita, measured at purchasing power parity. The explanatory variable of interest is the log of GDP per capita. I include as controls variables that are available and have been found in previous studies to be useful for explaining total health care expenditures. All variables are entered as log first differences:

- **THEpc_PPP**: total healthcare expenditures per capita
- **GDPpc**: Gross Domestic Product per capita
- **tb**: tuberculosis prevalence, measured as the number of cases/thousand
- **urb**: the percent of urbanization among the population
- **O65_**: the percentage of the population above age 65 years
- **GGHE_THE**: General government health expenditures as a share of total health care expenditures.

Table 6.4 presents estimates of the four models where all variables are treated as exogenous, and therefore no instrumental variables are used. An assumption made earlier in this paper is that health care spending and GDP are jointly determined in a system of simultaneous equations. The estimates in Table 6.4, when compared to estimates that correct for possible endogeneity due to simultaneity bias, would shed light as to the size of any bias in the coefficient estimates. In Model 1 all the explanatory variables are statistically different from zero at all significant levels except for the percentage of the population above sixty-five, which is
insignificant at all levels. The coefficient on the tuberculosis prevalence rate has a counterfactual sign. Taken at face value, the negative sign indicates that total spending on health care declines as the TB prevalence rises, contrary to what would be expected. The coefficient estimate on GDP is highly significant and of the expected sign. It implies an elasticity of 0.73, which is less than 1. The percentage of urban population in total population and the share of government spending on health care in total health care spending are both significant and of the expected sign. When an intercept is added in Model 2, GDP, urbanization and the government spending share remain significant and of the expected sign. The TB coefficient is still negative, and significant at the 10 and 5 percent levels, but insignificant at the 1 percent level. The population over 65 variable becomes significant but has the unexpected sign. In Model 3, the TB, urbanization and population over 65 variables are all insignificant at all levels, and of the wrong sign. The GDP and government share variables remain significant and of the expected sign. In Model 4, the GDP and urbanization variables remain significant and of the expected sign, but all other variables are insignificant. The encouraging feature of Table 6.4 is that in all models, the GDP variable is highly significant. The estimated elasticity is less than 1, and the 95 percent confidence interval lies entirely below 1 in the GMM models.

Table 6.5 presents coefficient estimates when GDP is treated as endogenous and instrumental variables are used to obtain consistent estimates. Model 5 presents results from a 16-equation GMM estimation model without intercept, as presented in Section 5.3 earlier. The GDP, urbanization and government share variables are all highly significant and of the expected sign. The GDP elasticity of health care spending is 0.71. This is less than 0.73, the elasticity estimated in Model 1, but the difference is statistically insignificant. The 99, 95 and 90 percent confidence intervals for the coefficient estimate of GDP per capita in Model 5 all enclose 0.73,
the estimate in Model 1. This analysis therefore does not provide strong evidence that for the sample of countries in this study, income and health care spending are simultaneously determined. This conclusion changes however when results from the fixed and random effects estimation are examined.

The TB variable in Model 5 continues to be only marginally significant, and of the wrong sign. The population over 65 share is insignificant, as in Model 1, though of the expected sign. In Model 6, all variables are statistically significant, although the TB coefficient continues to be negative. The estimated income elasticity of health care spending rises significantly in Models 7 and 8, to 0.83 and 0.87 respectively. These are well outside of the widest confidence interval of

<table>
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<tr>
<th></th>
<th>Model 1</th>
<th></th>
<th>Model 2</th>
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<td>coeff.</td>
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<td>(p=0.46)</td>
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Dependent variable: First difference of the log of total health care expenditures per capita. All variables are entered as log first differences.
the estimate in Model 5, and also significantly higher than the estimates when GDP is treated as exogenous in Model 3 and Model 4, 0.67 and 0.69 respectively. Thus, in the fixed and random effects models, the estimates of the income elasticity rise by 24 and 28 percent respectively when GDP per capita is treated as endogenous and its effect is estimated using instrumental variables. This observation runs counter to the findings when the GMM estimation procedure is used, and provides some evidence that GDP per capita is endogenous in the total health care expenditure equation. The endogeneity, when not taken into account, introduces a downward bias in coefficient estimates of the effect of GDP on total health care spending.

The source of the discrepancy in the results on the possible endogeneity of GDP per capita in the health care spending equation is not well understood in this study, and should be a subject for future study. I note however two facts in support of the findings from the GMM procedure.

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</table>

Dependent variable: First difference of the log of total health care expenditures per capita. All variables are entered as log First differences.
First, the GMM estimates are more precisely estimated, as is evidenced from their smaller standard errors. On the other hand, the fixed and random effects estimates have confidence intervals that are very wide and encompass a wide range of possible estimates of the income elasticity. Endogeneity affects the unbiasedness of the coefficient estimates, not their efficiency. As all the estimation procedures were set up to be robust to various forms of heteroscedasticity and serial correlation, the greater efficiency of the GMM procedure provides more confidence in its estimates. Secondly, the Hansen J test of overidentifying assumptions show that the GMM models are well specified. These two taken together provide stronger evidence in favor of the estimates from the GMM procedures.

As this study has as its primary purpose estimating the size of the income elasticity of health care spending, the results indicate that in the sample of countries under study, GDP per capita has a significant impact on aggregate health care spending per capita, and that the income elasticity is less than 1. In the most preferred model, even the 99 percent confidence interval lies entirely below 1.
CHAPTER 7 CONCLUSION

This study is an attempt to contribute to the growing literature on the determinants of health care spending, particularly as it relates to the role of GDP per capita and the size of the income effect. A number of findings from the study could potentially be useful for fostering the ongoing debate that has accompanied this body of research.

The main finding from the study is that for the sample of countries and the time frame covered, GDP per capita plays a significant role in determining total spending on health care for a country. Of the five possible determinants of health care spending considered in this study, GDP per capita had the most significant influence, and its effect was the most robust across various specifications, a finding that accords well with evidence from the existing literature. Contrary to the dominant view from this literature, the income elasticity of health care spending was found to be significantly less than 1. Newhouse (1977) had speculated on health care as a luxury good based on his finding of an income elasticity significantly greater than 1. He proposed two implications of his findings, that health care spending at the margin buys “caring” rather than “curing”, and that countries choose the system of health care delivery on the basis of their wealth.

One way to interpret the findings in this study in light of the implications of Newhouse (1977) is to note that health care is not a homogenous commodity. Some components of health care produce improvements in physiological health, and there are elements of that have more to do with the subjective components that do not necessarily reduce morbidity or mortality. Countries may choose not just the system of delivery, but more crucially the mix of products and services according to their wealth. Indeed, a careful observation of health care systems would show that there is a higher concentration of advanced medical technology and nursing care for the elderly in
wealthy economies than in the poor economies of Africa, where medical technology is rudimentary and elder care is largely informal.

Presumably all countries choose care that improve physiological health. It is conceivable, however, that beyond a certain level of achievement of health status, spending on the subjective components become more important. Health outcomes in much of Africa are so poor as to impact not just upon the physical comfort and wellbeing of individuals, but to also pose impediments to socio-economic development. These societies may therefore choose a healthcare mix that delivers the biggest gains for the dollars spent. In such cases, the marginal dollar spent on healthcare may well improve morbidity and mortality. Improvements in health outcomes accumulate, however, and as health status become favorable societies may opt for more of the components of health care that have little to do with improving health outcomes. It might be the case that the marginal healthcare dollar buys quite a different product in Africa than it does in wealthier countries, and income has much to do with the determination this allocation. It would therefore not be surprising to find that healthcare is a necessity in Africa but a luxury in wealthier countries.

The findings on stationarity of healthcare spending and GDP support the prevailing view in the literature. These findings buttress the criticism by Hanson and King (1996) of studies that use the levels of these variables in time series and pooled regressions. Accordingly, researchers using these variables in their studies should enter them as differences rather than in levels.

The issue of whether health care spending and GDP are cointegrated is yet unsettled in the literature, and results from this study do little to provide clarity. While it is plausible that healthcare spending and GDP should have a long term relationship, this study finds contrary evidence. This may, however, have more to do with the data than underlying theory, as the
shortness of the time series in this study does not allow for the making of strong statements on time series analysis. It is hoped that more clarity on this issue would come from future studies as longer time series become available.

Finally, on the assumption made in this study of possible endogeneity of GDP in the healthcare spending equation, the findings provide weak evidence of no such endogeneity issues. In the preferred GMM estimation procedures used, no evidence was found of bias in the coefficient estimate of GDP per capita. However, this runs counter to findings from fixed and random effects models estimated in the study, which found some evidence of downward bias. These models appeared to be less efficiently estimated than the GMM models, which allowed them to accept a much wider range of possible values of the income elasticity of health care spending. I am therefore more inclined to conclude that no evidence of endogeneity was found in this study on the basis of the results from the GMM procedure.
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ABSTRACT

THE RELATIONSHIP BETWEEN HEALTHCARE SPENDING AND GROSS DOMESTIC PRODUCT: A STUDY FROM A SAMPLE OF AFRICAN COUNTRIES

by

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In this essay I estimate the elasticity of total healthcare expenditures with respect to gross domestic product. I also address the stationary properties of total healthcare expenditures and gross domestic product, and whether these measures are cointegrated. The empirical exercise uses a sample of African countries so that the estimates can be compared to those that have been made using data on OECD countries. To address the issue of possible endogeneity of GDP in the healthcare expenditure equation, I assume that total healthcare expenditures and gross domestic product are simultaneously determined, and using structural equations, I identify instrumental variables for GDP in the estimation equation.

I find that the income elasticity of healthcare expenditures is significantly less than 1, contrary to studies on OECD countries that have found elasticities at or greater than 1. I confirm that both healthcare expenditure and GDP are nonstationary, and find that these variables are not cointegrated. I decline to make definitive statements on the issue of cointegration because of the short time series I use in the study. On the basis of my findings I note that health care is not
homogenous, and I speculate that Africans choose a mix of healthcare products that actually reduce morbidity and mortality, which makes healthcare a necessity. This is in contrast to the OECD countries, where the mix of health care products has a high concentration of medical technology and advance medicines that confer clinical or psychological benefits that have little to do with improving physiological health, and hence is a luxury as has been found in previous studies.
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