REIMBURSEMENT INCENTIVES FOR HOSPITAL QUALITY COMPETITION IN AN OLIGOPOLISTIC INDUSTRY: THE ROLE OF THE HEALTHCARE LABOR MARKET

Alorbi Genevieve and Dai Chifeng

Southern Illinois University, Department of economics (galorbi@siu.edu)

1.1 INTRODUCTION

According to Vitalari (2016), "The U.S. healthcare industry is in a state of flux. Rocked by divisive politics and entrenched interests, the industry is a strange brew of economic inefficiency, breakthrough science, startling technologies, and dramatic geographical variation in costs and clinical outcomes. It is an industry that is highly respected, but also an industry that ranks among the least of its peers in eight developed nations."

Today's healthcare delivery system is comprised of many actors with varied stakes and interests within the industry. Consequently in many counties, the health industry has quickly assumed a dominant position commercially. According to the Bureau of Economic Affairs (BEA) news release document on Gross Domestic Product (GDP) by industry for first quarter 2016; Construction, healthcare, social assistance and retail trade were the leading contributors to the increase in U.S. economic growth in the first quarter of 2016. Health care and social assistance specifically increased by 3.8 percent and real gross output per industry measure for the sector increased in total by 7.3 percent. Furthermore, according to employment projections for 2014 to 2024 by Bureau of Labor Statistics (BLS), Healthcare occupations and industries are expected to have the fastest employment growth and to add the most jobs between 2014 and 2024.

The major stakeholders of the healthcare industry constitute consumers of health care, providers of health care, health care institutions, pharmaceutical companies, health technology companies, health insurance companies and the government which is principal payer of health care. While providers and other healthcare workers may have genuine altruistic motive of providing quality healthcare to consumers of care, the other players in the industry may be found wanting in this objective. Indeed the profit motive of some of the actors within the healthcare industry may have contributed to increasing cost of providing healthcare and in response to these escalating costs of providing care, there have been huge waves of consolidations through mergers and acquisitions within the industry.

For instance it was reported that, there were 1,299 mergers and acquisitions in the health care sector in 2014 at a value of $387 billion, which was a record high (Phillips, L. 2015, Health Care M&A News). The pharmaceutical sector was reported to have accounted for 55 percent of spending and 14 percent of deal volume in 2014, which drove much of the increase of mergers and acquisitions between 2013 and 2014 up by 26% (US health services deals insights by PWC). Altogether for the year, there were 79 hospital mergers and 58 physician practice groups merged or were purchased in 2014 (American Hospital Association, Dafny, L.). Due to the wave of mergers and consolidations within the industry, the health industry is currently best described as one that is oligopolistic in behavior with few dominant firms competing against each other.

As will be expected of huge and powerful industries, the quest for profits has resulted in the health care industry being plagued with soaring costs of care and declining quality of health care provision. According to a publication by the commonwealth fund titled U.S. healthcare from a global perspective by Squires and Anderson (2015) which drew upon data from the Organization for Economic Cooperation and Development and other cross-national analyses to compare health

care spending, supply, utilization, prices, and health outcomes over 13 high-income countries: Australia, Canada, Denmark, France, Germany, Japan, Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the United States. In 2013, the U.S. was found to have spent far more on health care than any of the other countries. These spending were due to greater use of medical technology and higher health care prices, rather than more frequent doctor visits or even hospital admissions. In spite of this huge spending, Americans were found to have poorer health outcomes, including shorter life expectancy and greater prevalence of chronic conditions.

Indeed this plaque of rising costs and poorer health outcomes captures one of the greatest concern of researchers and government policy makers. The U.S. government has therefore focused policies and resources on the double mandate of cutting cost of care and improving quality of health care through the various demand side and supply side actors within the health industry. One of the biggest of such policies was the switch from Cost reimbursement to a Prospective Payment System (PPS), which had as one of its numerous objectives the aim to cut down unnecessary healthcare utilization. Agencies such as "The Agency for Healthcare Research and Quality's (AHRQ)" have been mandated by the U.S. Department of Health & Human Services with the mission is to produce evidence based research to make health care safer, provide better quality, accessibility, equitability, and affordability of care (AHRQ).

The concerns of the industry together with various policy reforms has also spearheaded great theoretical and empirical healthcare policy research related to reimbursement and quality of health care provision. Huge efforts have been made by researchers to conceptualize quality and overtime many studies have come out with various measures to capture quality of care in order to identify the right actors through which to enhance proper healthcare at the right cost. Various strands of

this research have evolved overtime including studies focusing on Healthcare Quality Competition among providers, Health Insurance Costs and Quality, Reimbursement Systems and Quality of Care, just to list a few. One aspect that has received very little attention within this literature, to which this study seeks to contribute, is the relationship between healthcare labor supply and quality of healthcare provision. In our paper we build a model that bridges the gap between these two strands of literature by establishing a theoretical framework that builds upon previous studies on reimbursement incentives for quality competition in regulated markets. We do this by explicitly modelling the health labor market and how it affects supply of quality and incorporate it into the framework of a hospital Cournot competition, to show how quality choice will be directly influenced when there is a shortage of health personnel and a regulated reimbursement system. The next section of this paper aims to provide a detailed literature review of studies within this field and how this motivates our study.

1.2 LITERATURE REVIEW AND MOTIVATION

The quality of care literature that focuses on provider quality competition springs from the idea that, a more competitive environment should lead to an increase in the choice of a firms quality. Studies from this literature were adopted into healthcare by early researchers such as Allen and Gertler (1991), Pope (1989) and Held and Pauly (1983) from studies on the airline and taxi industry where there was price regulation so that firms competed based on quality of services provided[1]. A detailed review of the provider quality competition literature is provided by Gaynor (2006) as well as by Gaynor and Town (2011). They conclude that theoretical studies on the impact of competition on quality seem to have a consensus when prices are regulated. Whenever the price is set above the marginal cost of production, competition will lead to quality and consumer welfare being greater.

The empirical literature related to these theoretical findings are comprehensively reviewed by Romano and Mutter (2004), Gaynor (2004, 2006), Propper et al. (2006), Vogt and Town (2006), Gaynor and Town (2011), Cooper et al. (2011). They report that the bulk of previous studies had focused their study on the link between market structure and hospital behavior and quality of care was usually measured as the mortality rate (for example: Kessler and McClellan 2000; Gowrisankaran and Town 2003; Kessler and Geppert 2005; Propper et al. 2004; Cooper et al. (2010a, 2011); Gaynor et al. 2012; and Bloom et al. 2015). While the theoretical studies seem to follow a trend in their findings, the evidence presents otherwise. For example, while Kessler and McClellan (2000) and Tay (2003) find a positive effect of competition on quality, Gowrinsankaran and Town (2003) find a negative effect, Shen (2003) finds mixed effects, and Shortell and Hughes (1988) and Mukamel et al. (2001) find no effects.

More recent empirical work such as Bloom et al. (2015) find a positive correlation between competition and hospital management quality, and a correlation between higher management quality and lower AMI mortality. (Cooper et al., 2010a) also studying the effects of competition on patients' length of stay in hospital and Gaynor et al. (2012) who looks at the effect of competition on AMI mortality and trust-level overall mortality both use Difference in Difference related methodologies and find that higher competition is associated with better hospital performance.

Although with such mixed findings, the literature on provider quality competition has generally provided profound model implications and extensive evidence on how quality of care may be affected by providers. The literature demonstrates how factors that act to increase provider quality competition and those that results in a reduction in competition, tend to influence the provider's choice of healthcare quality. A criticism of the previous empirical literature on provider quality

competition in a regulated reimbursement system however, which is of interest to our study is that, the regulated price itself was not included in their model. An exception though is Shen (2003) who examined the impact of financial pressure from reduced Medicare reimbursements and HMO permeation on mortality from AMI, controlling for the hospital's competitiveness. The market structure used was a measure of whether there were five or more hospitals within a 15 miles radius of that hospital. Market structure was then interacted with a measure of the change in the Medicare price and the change in HMO penetration. The results indicated that there were direct effects of Medicare price and HMO penetration on mortality, however there were no direct effects of market structure. The change in Medicare price was found to affect mortality negatively.

Closely related to the idea of the inclusion of the regulated price in empirical studies on quality of healthcare provision is the broad strand of research devoted to the effect of reimbursement systems on quality of healthcare provision. This literature has looked into various policies that aim to affect cost and quality of care provision through various demand and supply side agents within the healthcare industry.

The established "extremes" of provider reimbursement in health care are Fee-For-Service (FFS)/Cost Reimbursements at one end, where payments are related to the volume and intensity of specific medical services, and Capitated/Fixed payments at the other end, where payments are fixed prospectively per patient, irrespective of the intensity or cost of services provided. Systems of provider reimbursement, which have been mostly used within healthcare sector will generally move away in sequence from the fee-for-service method of payment in terms of cost reimbursement to Per-diem payments, to Episode-of-care payments, to Multi-provider bundled to episode-of-care payments, to Condition-specific capitation payments, and finally to Capitation system where payment is fixed.

There are several variables that contribute to the overall cost of a patient's care and a reimbursement type may either accommodate these cost or not. Cost of care burdens may vary greatly depending on the design of the payment scheme. The FFS system generally pushes a greater amount of total care expenditure to the payer, since the payer takes up the burden of reimbursing the provider for the direct service of care. Under capitation however, the provider is charged with total care of the patient, here payment is made for the conditions and episodes of care. Any extra episode of care to the patient would be borne by the provider. Janeba, (2008). The cost of patient care depends the number of processes per a service, number of services provided per episode of care, number of episodes of care per a condition and which ultimately depends on the number of conditions per patient (Miller 2007). The risk of cost burden shifts from payer to provider as one moves down the payment sequence from FFS towards Full capitation. Janeba, (2008)

This cost allocation and sharing burden is sometimes exploited by a reimbursement policy to either manage the cost of care or incentivize quality of healthcare provision in the healthcare sector. Both the intended and unintended consequences of such policy on demand and supply side agents of the sector have contributed significantly to defining the scope of the health economic literature that focuses on reimbursement incentives and quality of care. The theoretical literature in this field has modeled how various forms of provider reimbursement could impact costs, treatment intensity and volume as well as quality of care. Previous studies include; Hodgkin and McGuire(1994), Rogerson(1994), Dranove (1987), Ellis and McGuire(1986, 1987, 1990, 1996).

Ellis and McGuire (1986) model the behavior of a single provider whose utility depends on a weighted sum of provider profits and patient benefits. They show that if the first-best quantity of services can be achieved then in general it will be through a mixed payment system, which is a lump sum payment and a variable payment that is a proportion of costs. In Ellis and McGuire

(1990), they extend their (1986) model, to show that when patients and providers bargain over the level of services, the optimal payment system should minimize demand side cost sharing such that payment system should not be fully prospective nor fully cost-based.

Other studies have included within their modelling, the competition of health providers for patients. For instance, Pope (1989) studies inter-hospital non-price competition in the Medicare prospective system and finds that competition leads to an increase in quality and a reduction in managerial slack. He also finds that the quality aspect of competition can be improved if a part of the cost incurred is reimbursed. Ellis (1998) studies how reimbursement incentives influence both the intensity (quality) of health services and choice of patients, when patients differ in severity of illness. Looking at three provider strategies creaming, skimping and dumping. He finds that cost-based payments leads to overprovision of services which is referred to as creaming, to all types of patients. Furthermore, prospectively paid health providers cream low severity patients and skimp high severity patients.

The empirical literature studying the impact of payment systems on quality of care has been met with varied results depending on the methodologies adopted. For instance Dranove (1987), found that when there are gains to specialization, payment incentives to improve quality will lead to specialization in health care. Frank and Lave (1989) studied the effect of the shift from cost based to prospective payment on how long psychiatric patients stay in the facility. Their results indicated that stay increased for patients who had less severe cases but decreased for more severe patients.

McClellan (1997) uses variance decompositions, to assess prospective and retrospective cost sharing. He reviews the incentives created by PPS in practice and finds that PPS involves restricted and decreasing cost sharing with hospitals. Reimbursement incentives were found to vary very much across diagnoses, demographic groups, and types of intensive treatments.

Newhouse (1996) finds that competition between health care providers that are not reimbursed full cost of treating patients will take the form of cost reducing and quality enhancing competition or less desirable forms such as avoiding unprofitable patients and competition to increase demand for more profitable patients whose treatments are less than the costs. In an extensive review of the literature, he argues that under more general assumptions (heterogeneous patients, imperfect agency, uncertainty about the hospital costs) a pure prospective payment system will not be optimal. Instead a mixed reimbursement system will be optimal in such circumstances.

Other studies closely in line with the niche of reimbursement systems, focus their studies on variations in performance due to marginal increases in the intensity of competition related to changes in reimbursement systems and their related impact on quality of service provided. These studies include; Ma and Burgess (1993), Wolinsky (1997), Brekke et al (2006) and Matsumura and Matsushima (2007), and more specifically to the healthcare setting include; Calem and Rizzo (1995), Gravelle (1999), Gravelle and Masiero (2000), Brekke et al (2007) and Karlsson (2007). As can be expected, the findings within this literature are also constituted of diverse findings.

Generally empirical studies on reimbursement systems have presented diverse findings, but some results suggest that policy incentives that aim at discouraging excess utilization through demand and supply side variables in order to deal with high cost of care have only resulted in the worsening the quality of care. For instance, management in their bid to cover high cost of operation would only find smarter ways to compromise the volume and quality of services being provided while finding loopholes in the system that aid them to receiver higher claims. As exemplified in findings from studies on payment systems, when cost reimbursement systems are used this gives providers the incentive to over-provide services, while the fixed payment scheme results in under provision

Ellis (1998). Furthermore, the risk of financial burdens is pushed to the payer under FFS whiles under capitation the risk of financial burdens lies on the provider.

The literature reviewed in this study demonstrates that government policy and indeed policy research is still a long way from finding the solution to this double mandate of health care cost containment and improvement of quality of care. One sector that could be a very influential instrument in this mandate that might have been overlooked by research and policy is the healthcare labor market. Due to the increase in health care demands over time, the health workforce has seen enormous growth in size and is expected to even expand further. According to the American Nurses Association (ANA), 30 states are currently projected to have an annual growth rate of 15 percent or more Registered Nurses (RN) growth rate in the coming years. Given that health care work is heavily labor intensive it is surprising that theoretical models of reimbursement systems and quality competition have not yet incorporated or directly modelled the health labor market into their theoretical framework.

This is because although a reimbursement policy might aim at stimulating quality healthcare through provider competition, there could be unintended consequences such as increases in operation costs which were not captured by the reimbursement policy. Specifically when patients' outcomes are sensitive to service quality that is tied to medical labor, additional costs due to high labor wages may be incurred by the provider when they invest in quality, this is more so when medical labor is scarce in supply. There may also be provider costs spillover effects to other providers when there is quality competition among healthcare providers in their bid to respond to reimbursement incentives.

The purpose of this study is therefore, to consider all of the above possibilities in an effort to contribute to the research that seeks to propose solutions to the problems faced by the healthcare

industry. In this paper therefore, we propose that the standard model of reimbursement incentives for quality competition, does not address a key feature of the health industry: the shortage in supply of medical labor which may result in high labor costs during provider quality competition. We consider the impact of such constrained inputs on the impact of quality choice among providers. We further analyze the spillover effects of this constraint to other healthcare providers.

Our hypothesis is that is if regulated price leads to non-price competition by pushing providers to compete in order to increase demand for their services through quality investments, then given that in order to gain a unit of patient care outcome the provider needs to invest in service quality that is tied to labor, then the incentive to invest in quality may be constrained by the marginal increase in cost of providing care. Previous studies that conclude that a FFS system will lead to over investment in quality and over-provision of services may therefore be flawed in a way, since providers may not be able to entirely over-invest in quality as they ideally would have in the absence of the labor constraint.

Furthermore, there should be spillover costs to other providers as one provider invests in quality; since a unit of service provided will shoot up average cost of investing in quality for every other health provider (as the price of labor goes up), therefore reducing overall amount of quality that could ultimately have been provided. Therefore a providers' choice of quality of health may no longer be determined fully by the change in the regulated payment, but also by the additional cost incurred by investing in quality.

Given that the industry is already plagued by high health care costs; which some studies show has led to creaming, skimping and dumping of certain patients (Ellis 1998), the possibility of this additional high cost of health workforce labor could aggravate the cost faced by hospital

management and might lead to further compromising of quality of health care provision as they find more ways to outsmart the payer so as to cover such high costs of care.

It is with this motivation that this paper seeks to exploit the possibility of setting up a model that would explicitly model the health labor market and how it affects supply of quality and incorporate it into the framework of a hospital cournot competition, to show how quality choice will be directly influenced when there is a shortage of health personnel and a regulated reimbursement system. We expect that because of the shortage of health labor supply, there will be an increase in cost of providing quality, hence reimbursement incentives for quality investments might not be able to attain their full impact.

1.3 BACKGROUND OF THE MEDICAL WORKFORCE SECTOR

Healthcare services are produced with physician time, nurse time, other labor inputs, material inputs, non-material inputs as well as capital. A health provider will use any of these inputs until the marginal revenue product equals the marginal costs in a perfectly competitive environment. Health care services are however very heavily labor intensive and the healthcare labor market however happens to be very heavily regulated. Regulation is effected through licensing occupations, subsidizing medical education, encouraging labor to locate in underserved areas, and sometimes explicitly restricting entry.

Studies have shown that there are market failures such as the problem of information asymmetry; meaning consumers will not be able to determine the quality of services provided by medical labor (Arrow, 1963), that justify regulation of medical markets. Considerable research has been committed to the implications of such regulation for the health industry. Regulation has been

found to ensure the optimal number, quality, specialty mix, and equitable geographic distribution of health professionals.

In the United States for instance, the Liaison Committee on Medical Education, which consists of the Association of American Medical Colleges (AAMC) and the American Medical Association (AMA), accredits U.S. medical schools. Because it is difficult for a student who attends a non-accredited medical school to practice medicine in the US, the number of U.S. medical schools is essentially determined by physician organizations. Specialty associations in the US determine how many residents can train in each specialty, and therefore determine the flow of new entrants. Self-regulation by non-governmental medical labor organizations is common in many other countries. For example, the Medical Council of India, the Korean Institute of Medical Education, the General Medical Council (UK), the Netherlands Flemish Accreditation Organization, and the Japan University Accreditation Organization, approve curricula and accredit medical schools in their respective countries.

Some of the findings of studies in relation to regulation are that, licensing screens out low-quality providers which increases the quality of labor inputs as well as the quality of medical services provided. Nonetheless, it restricts supply, creates rents, and increases the expected returns to quality-enhancing training. Other studies find that the higher licensed wage will encourage firms to substitute capital and non-licensed labor for licensed labor where possible. Health labor regulation along with higher wages for licensed labor, will increase output costs, output prices, and reduce the quantity consumed. (eg. Akerlof;1970, Leland;1979, Kleiner and Kudrle;2000).

According to Nicholson and Propper(2012) the existing empirical studies generally provide a pessimistic assessment on the welfare effects of licensing in medical labor markets. These studies conclude that licensing is associated with restricted labor supply, an increased wage of the licensed

occupation, rents, increased output prices, and no measurable effect on output quality. Kleiner (2006) summarizes the literature on the effect of licensing on earnings as follows: "For the higher-education and higher-income occupations working mainly in the quasi-private sector, like physicians, dentists, and lawyers, licensing appears to have large effects (on earnings) through either limiting entry or restricting movement to the state."

Some studies have investigated whether money is important for the supply of labor decisions. The idea is that if wages are determined by market forces, then labor shortages and surpluses will be self-correcting. This implies labor will relocate, enter/leave occupations, shift between specialties, and respond to higher wages by working more. For instance, studies on decisions of entry into specialty choice (Sloan 1970; Bazzoli 1985; Gagne and Leger 2005, Bhattacharya 2005) present the evidence that suggests that, money is not the most important determinant of specialty choice. Previous studies that have focused on Nurses' Labor Supply; as summarized by Shields (2004), also show that: "With respect to the likely impact of increasing the RN wage rate, very large increases in wages would be needed to induce even moderate increases in nurse labor supply since the RN wage elasticity is unresponsive". Borjas (2000), finds a wage elasticity for nurses to be about 0.30.

Indeed there have been reported shortages of medical labor in the U.S. (Buerhaus et al., 2009) record a shortage of registered nurses that began in 1998 and lasted for 10 years, at its peak in 2001, 13 percent of hospital RN positions were vacant. Norway, the United Kingdom, Canada, Australia, and South Africa have all experienced nurse shortages during the 2000s (Shields 2004). Since 2000 there have been many studies concluding that the U.S. has or soon will have a physician shortage—18 reports from states, medical societies, and hospital associations, and 19 reports from medical organizations since 2000 (Iglehart 2008).

For example, according to the U.S. Department of Health and Human Services, The number of primary care physicians is projected to increase from 205,000 FTEs in 2010 to 220,800 FTEs in 2020, an 8 percent increase, however the total demand for primary care physicians is projected to grow by 28,700, from 212,500 FTEs in 2010 to 241,200 FTEs in 2020, a 14 percent increase. Without changes to how primary care is delivered, the growth in primary care physician supply will not be adequate to meet demand in 2020, with a projected shortage of 20,400 physicians. While this deficit is not as large as has been found in prior studies, the projected shortage of primary care physicians is still significant.

Acemoglu et al, (2009) explains that given that the demand for medical labor is derived from the demand for health, the demand for labor will be pro-cyclical. Labor supply, however, will respond slowly to the income-induced demand changes for several reasons: training periods are often long, the flow of newly trained labor is usually small relative to the stock of labor, and administered prices may prevent the market signals from reaching eligible labor. In their study of the effect the prospective payment system in the U.S. that increased the price of labor relative to capital, Acemoglu and Finkelstein (2008) show that the capital-to-labor ratio subsequently increased as the policy spurred the adoption of expensive medical technologies. Additionally, hospitals responded by increasing their nurse skill mix.

With this brief background on the health labor market it is easy to discern that regulation will indirectly result in limited supply of medical labor leading to high cost of labor. Given that health care production is very labor intensive this means that reimbursement incentives that seek to enhance quality of service provision may be restricted through the impact on costs of production and spillover effects to other healthcare facilities. In line with all these caveats, we make a huge attempt to extend the existing literature by incorporating these scenarios into the model of

reimbursement incentives that aim promote quality of care competition with the objective to obtain a suitable model that will capture the health industry more comprehensively in order to be able to better inform policy aimed at improving quality of health care provision.

1.4 THEORETICAL MODEL

Consider a simple model of cournot competiton similar to Kestoot and Voet (1998), where hospitals compete in both quantity and quality. Assume a duopoly market of two symmetric health providers; hospital *1* and *2*, who produce differentiated health services, however the characteristics of the healthcare provided is subject to the choice of the hospital.

Healthcare demand

Let demand for hospital *i*'s services be described as follows

$$q_i = \gamma - dq_j + bx_i - \alpha x_j - p \qquad\qquad i, j = 1 \; or \; 2 \;\; and \;\; i \neq j$$

Demand (q_i) for hospital *i*'s services, is determined by "x_i" the quality level that hospital *i* invests in, "x_j"the "quality level" hospital *i*'s rival (hospital *j)* invests in, "*p*" the out of pocket fees, charged directly to patients and the amount or quantity of healthcare provided by hospital *j* denoted "q_j". "*b*" captures how sensitive demand is to hospital "*i*'s quality of healthcare service. If demand is sensitive to quality improvements, then hospital demand will be boosted by quality improvements; $b > 0$.

The term αx_j is used in the model to capture the "quality competition" between hospital *i* and its rival *j*. The idea is that in the absence of hospital price competition, the hospitals, have strong incentive to engage in "non-price competition"; here in captured by the notion of "quality competition" so as to increase demand for its services. The hospital can therefore decide to invest in quality improvements of different kinds above that minimal level of quality, below which it is

considered a malpractice. Quality improvements in this paper focuses on the hospital's investments in healthcare workers in order to provider better quality of healthcare.

The parameter "*d*" measures the impact of an increase in the quantity of hospital *j's* demand on hospital "*i's*" demand, depending on the relationship between the extent of substitutability of hospital "*j*'s" health care services for hospital "*i*". Although hospitals are perceived to provide one type of service, the nature of services are assumed to be differentiated, hence can be perceived as imperfect substitutes. When $d > 0$ hospital services are considered as "imperfect substitutes" and when $d < 0$, hospital services are considered as "imperfect complements".

Healthcare Supply and Costs

Output supplied by hospital "*i*" is measured by services provided. Health care services are produced with physician time, nurse time, other labor inputs, material inputs, non-material inputs as well as capital. A health provider will use any of these inputs until the marginal revenue product equals the marginal cost in a perfectly competitive environment. The health sector is generally considered to be heavily labor intensive (Gaynor and Town 2011). Hospital's will need health care workers to produce quantity as well as quality. Since price restraints hardly lead to price competition by hospitals, competition is usually demonstrated in overall quality level of the output of healthcare produced, Douglas and Miller (1974)

Quality levels in the healthcare sector can be related to care items for patient comfort known as "material quality" or care items related to patient outcomes also known as "technical quality". Material quality relates to comfort items such size of room, beds, availability of TV in waiting areas and in patient rooms etc. On the other hand, technical quality relates to use of high-tech equipment, technical skills of surgeons, hiring of qualified medical staff, degree of professionalism of medical staff etc. This paper focuses more on technical quality improvements related to medical

labor. That means care items that will directly relate to patients' outcomes. Quality of care outcomes such as the hiring of qualified health workers, degree of professionalism, length of waiting times as well as focus on care of patients such as sterility of materials, timely and accurate delivery of drugs, timely and accurate diagnosing of patients in the labs, among others.

With these considerations in mind we are interested in modelling the supply side of the healthcare market to reflect how the regulated reimbursement system that aims at stimulating healthcare quality, does so when there is a shortage of health personnel resulting in high labor costs. We are also interested in how the choice of one hospitals quality level will affect the overall labor market with regards to cost spillovers which will have an impact on the rival firms choice of "quality" and "quantity" of healthcare.

The idea is that hospitals act as oligopsonists in the labor market, in a cournot model where hospital compete in quantity and quality (For example see Boal and Ransom 1997; Bhaskar et al. 2002; Staiger 2010; and Cutler et al, 2010 for reviews). In our model hospitals compete for patients by indirectly competing for health labor. Thus employers will prefer that the supply of labor does not become more inelastic (less elastic) as there arises more intense competition for labor. However because of quality competition; a hospital will only attract quantity if it invests in quality, implying hiring an additional unit of labor. This comes with a cost spillover effect due to the shortage of labor; with the accompanied implication of an increase in market wage depending on how inelastic the supply of labor tends to be. A cost function of hospital *i's* production of q_i quantity of health care can be modeled in a simple form as $C(q_i) = c_i q_i$ where c_i is the marginal cost and $i = 1,2$.

We assume that quality is produced by the amount of labor used. Thus if the hospital wants to produce x_i amount of quality it needs l amount of labor. The hospitals marginal cost depends on the amount of quality it chooses which depends on the amount of labor(l) that it employs times

the wage rate; $c_i = f(w, l) = lw$. Now let the quality production function be defined as $x_i\ (l) = l/a$. The parameter *a* denotes how productive labor will be and the marginal product of labor by implication of the production function will be *1/a*. So depending on the amount of quality the hospital chooses to invest in, it will need ax_i amount of labor. Depending on quality of care it wishes to invest in, the hospital will face a marginal $mc(x_i) = ax_i$w. The total cost function will therefore be $C(x_i) = q_i\ (ax_i\ w) + F$

Labor Demand

The total labor demand needed to produce health care in both hospitals; assuming similar production functions for hospital *i* and *j* will be

$L = ax_i q_i + ax_j q_j \qquad\qquad i\ , j = 1\ or\ 2\ \ and\ \ i \neq j$

Thus total labor demand (L) depends on the amount of labor demanded by hospital *i* and *j* and the total amount of healthcare services q_i produced in both hospitals.

Labor Supply

As the literature has indicated, the supply of labor in the healthcare market is not very sensitive to wage rate. This with many other factors affecting the health labor market has contributed to health care industry being plagued with episodes of shortages in labor supply of health care workers over the years. The labor supply curve is therefore inelastic so that in order to obtain more labor, the hospital has to pay higher wages. We capture this information by depicting an upward sloping labor supply curve represented as;

$W = m + n\ L$

"*W*" is the labor wage rate. "*m*" determines the intercept of the labor supply function, "*n*" determines the steepness of the slope of the labor supply curve. By incorporating the labor supply

function into the hospitals cost; hence objective, function, we are able to adequately model the shortage of labor supply (high labor cost) and can observe the spillover effects on costs of rival firms. This is because in order to improve quality of care, the hospital hires labor which will result in *n* amount of increase in the wage rate(*W*) depicting how *n* captures the high labor costs due to a labor shortage. $\frac{dL}{dW} * \frac{W}{L} = \frac{1}{n} * \frac{W}{L}$ provides a measure of how elastic the labor supply is . As *n* increases, for a given *m*, the labor supply is more inelastic (less elastic)

Reimbursement Schemes

As already discussed previously, payment schemes run from cost, through mixed, to fixed reimbursements. We model the payments schemes in a linear form of per patient cost of treatment as in Ellis and McGuire(1986, 1990), Ellis (1998) and Kestoot and Voet (1998). The linear reimbursement system includes the cost-based reimbursement, fully prospective payment and the mixed payment systems as special cases. We model the per unit of service patient reimbursement as follows

$$\Omega_i = R + r\ c[q_i(x_i)] \qquad where\ i = 1,2$$

Where Ω_i is the per unit service reimbursement, *R* is the lump sum reimbursement amount and *r* is the marginal or cost based reimbursement. $c[q_i(x_i)]$ is the per unit service cost to a provider of a quantity(q_i) of health care provided at level of quality (x_i). When *R*=0 and *r*=1 then we have cost based reimbursement. When *R* = 1 and *r* = 0 then it is fully prospective or fixed reimbursement. When $R > 0$ and $0 < r < 1$ we have a mixed payment system.

Hospital Objective

With cost reimbursement systems it was not very common for previous studies to model hospitals as profit maximizing (Newhouse 1970; Harris 1977), however with the introduction of prospective reimbursements profit maximization has dominated the scene (Pope 1989, Ma 1994). Alternatively given that the majority of hospitals have a not for profit status other goals may be incorporated into a model of hospital utility maximization whereby hospitals maximize profits and some patient benefits. In this case the hospital objective is modelled as a weighted sum of different goals, where the weights reflects the bargaining power of the different agents such as physicians, nurses, management (see e.g. Hodgkin and McGuire 1994; Chackley and Malcomsen 1998). However, for simplicity, but also consistent with several papers (Danzon 1982; Pope 1989; Ma 1994), we assume that the hospitals are profit maximizers with the objective function is defined as;

$$\pi_i = pq_i + \Omega q_i - C \qquad where\ i = 1,2 \qquad (1)$$

The hospital obtains revenue from the out of pocket payments made by patients for hospital care as well as from the reimbursement from the government based on the amount of services that it provides. Hence the hospital's aim is to maximize their profits by simultaneously and independently choosing the optimal level of quality and quantity given the revenues received from out of pocket payments and the regulated reimbursement schedule. This objective is subject to the cost function which captures the high costs of labor. By substituting the relevant elements from the model laid out in the previous sections we obtain;

$$\pi_i = (\gamma - q_i - dq_j + bx_i - \alpha x_j)q_i + Rq_i + r\ [qi(axi)w] - (axi\ w)qi - F \qquad (1a)$$

Now plugging in the input market and rearranging we obtain;

$$\pi_i = \left[\gamma + R - q_i - dq_j + bx_i - \alpha x_j - (1-r)ax_i m - n(1-r)\ (ax_i)^2 q_i - n(1-r)a^2 x_i x_j q_j\right]qi - F \qquad (1b)$$

In the Nash equilibrium hospitals independently and simultaneously choose quantity levels (q_i) and quality (x_i) so as to maximize their profits. The First Order Conditions for hospital i , $whereby\ \ i\ , j = 1\ or\ 2\ \ and\ \ i \neq j$

$$\frac{\partial \pi_i}{\partial q_i} = 0 \Leftrightarrow\ \ \gamma + R - q_i - dq_j + bx_i - \ \alpha x_j - (1-r)ax_i m - n(1-r)\ (ax_i)^2 q_i -$$

$$n(1-r)a^2 x_i x_j q_j - q_i - n(1-r)(ax_i)^2 q_i = 0 \qquad (2)$$

$$\frac{\partial \pi_i}{\partial x_i} = 0 \Leftrightarrow\ \ bq_i - m(1-r)aq_i - 2(1-r)na^2 x_i q_i^2\ \ -\ \ n(1-r)a^2 x_j q_i q_j = 0 \qquad (3)$$

The Second Order Condition is as follows;

$$f_{11}^{//}(q,x)\ = -4n(1-r)(a\ x_i)^2\ \ ,\ \ f_{22}^{//}(q,x)\ = -2n(1-r)(a\ q_i)^2 \qquad (4)$$

$$f_{12}^{//}(q,x)^2\ = [b - m(1-r)a - 4n(1-r)a^2 x_i q_i - n(1-r)a^2 x_j q_j]^2 \qquad (5)$$

From the second order condition, profit is maximized if o ≤ *r* <1 and as long as *b* is sufficiently high. Hence we place an upper bound on b.

From the first order condition it can be inferred that it is only optimal for a hospital to invest in quality if the marginal benefit it receives from doing so exceeds its marginal cost. Specifically if the ratio of patient sensitivity of quality improvements (*b)* to the hospitals supply-side cost sharing *(1-r)* given the cost of labor, exceeds one-half of the level of quantity and quality chosen by its rival hospital, then a hospital will invest in quality. This can be seen from equation (3) from which we obtain the following;

$$\frac{b-m(1-r)a}{2(1-r)na^2} - \frac{x_j q_j}{2} = x_i q_i \qquad \text{where } q_i = \frac{\gamma+R-dq_j-\alpha x_j}{2} \qquad (3a)$$

In other words, *b* should be sufficiently high and o ≤ *r* <1 in order for a hospital to choose to invest in quality. If *r* = 1 there is absolutely no incentive to invest in quality.

Furthermore, from hospital *i*'s quality reaction function, an increase in the cost reimbursement given that hospital *j* plays it's anticipated strategy, will result in an increase in hospital *i's* quality. An increase in the fixed reimbursement will however result in a fall in hospital *i's* quality. Hospital *i's* conjecture leads it to react by producing more quality because its share of the cost (*1-r*) reduces with more cost reimbursement.

Thirdly, cost reimbursement has no impact on the level of quantity the hospital chooses to invest in. Also an increase in the prospective reimbursement given that the rival level plays its anticipated strategy, results in a hospital producing a fixed amount of quantity ½. This can be shown by solving the reaction function of the hospital. From (2) we can obtain

$$q_i = \frac{\gamma + R - dq_j - \alpha x_j}{2} \qquad (2a)$$

For any change in cost reimbursement (*r*) from hospital *i*'s perspective, given that hospital *j* does not respond to this policy change, then hospital *i* has no incentive to respond as well. Also notice that because an increase in cost reimbursement causes the hospital to react by choosing a higher amount of quality due to a lower cost share, at the same time its marginal cost is increasing due to quality production and so the interaction of this marginal benefit and marginal cost will determine the choice of $x_i$and q_i. If it happens that the marginal revenue is perfectly offset by the marginal cost then hospital *i's* reaction based on its conjecture will be to choose not to change its choice of quantity so that cost reimbursement appears to have no effect upon hospital *i's* quantity.

In order to solve for the Nash Equilibrium solutions of the model, we first rearrange the first order conditions (2) and (3) and impose symmetry, to obtain:

$$q_i = \frac{\gamma + \mathrm{R} + [\,A - \alpha\,]\,x_i}{(\,2 + d) + B{x_i}^2} \qquad and \qquad x_i = \frac{A}{Bq_i}$$

where A = $b - m(1 - r)a$ and B = $[3n(1 - r)]\,a^2$

Solving *qi* and *xi* simultaneously we obtain the quadratic equation

$$B(2 + d)q_i^2 - (\gamma + R)Bq_i + \alpha A = 0$$

Solving with the quadratic formula, we obtain

$$q_i = \frac{B(\gamma + R) \pm \sqrt{B^2(\gamma + R)^2 - 4[B(2 + d)(\alpha A)]}}{2B(2 + d)}$$

The Nash equilibrium solutions will depend on the parameters that constitute *A* and *B.* In order to obtain a solution we need to look at different cases depending on the exogeneous parameters.

Recall the parameter B = $[3n(1 - r)]\,a^2$

1. In the above, the parameter *"n"* comes from the labor supply function and determines the slope of the labor supply curve, thus *n* > 0, since we have an upward sloping curve.
2. The parameter *"a"* comes from the quality production function where *1/a* is the marginal product of labor. In the limit as $\lim_{a \to 0} MP_L \longrightarrow \infty$ and as $\lim_{a \to \infty} MP_L \longrightarrow 0$. Thus "*a*" should be between 0 and infinity
3. The parameter *"r"* is the cost reimbursement. (*1 – r*) is the supply side cost sharing; that is the cost burden that goes to the hospital when it undertakes quality investments. When *r* = 1 and *R*= 0 we have a fully cost based payment system. In this case *B = 0*. Here there will

be no solution to the quadratic equation. This is because the "a" coefficient in the standard quadratic formula is zero, hence it cannot be solved. This is intuitive economically because if $r = 1$, then there is no supply side cost sharing, thus the hospital can choose to invest in any level of quality under cournot competition and expect to be reimbursed by the payer. Quality competition may therefore lead to unlimited amount of quality being invested in order to outbid each other for patients. The nash equilibrium solution to *qi* and *xi* cannot be determined in this case. When $r = 0$ and $R = 1$ we have fully prospective or fixed reimbursements. In this case $B > 0$ hence there can be a solution to our equation, depending on A. When $r > 0$ and $R > 0$ we have a mixed reimbursements system. In this case $B > 0$ hence there can be a solution to our equation, depending on A. Consequently $o \leq r < 1$.

Now recall, $A = b - m(1 - r)a$

1. As before $(1 - r)$ is the supply side cost sharing and *a* determines the productivity of labor. The parameter "*m*" comes from the labor supply equation where "*m"* > 0.
2. The parameter "*b*" comes from the hospital demand function and represents the patients sensitivity to quality investments by the hospital. We define two broad cases under which we would have a solution to the model depending on "*r"* and "*b"* and parameter values of A and B. From the second order condition, in order to ensure a maximum for profits, we placed an upper bound on "*b*".

The model yields two cases for the Nash equilibrium depending on the kind of healthcare market we make reference to. Where the kind of healthcare market depends on level of sensitivity to quality "*b*". We refer to case 1 as the "Low Quality Sensitivity market" and case 2 as the "High Quality Sensitivity Market".

Case 1: Low Quality Sensitivity Market

Where $0 \leq r < 1$ and $b < m(1-r)a$ thus we have $A < 0$

Under this case we have one unique solution to the quadratic equation, which is

$$q_{i1}^{NE} = q_{j1}^{NE} = \frac{B(\gamma + R) + \sqrt{B^2(\gamma + R)^2 + 4[B(2+d)(\alpha A)]}}{2B(2+d)}$$

$$x_{i1}^{NE} = x_{j1}^{NE} = \frac{2A(2+d)}{B(\gamma + R) + \sqrt{B^2(\gamma + R)^2 + 4[B(2+d)(\alpha A)]}}$$

The Nash Equilibrium solution in this case is unique. Here, the sensitivity of the patients' demand to quality improvements is relatively lower than the cost incurred by the hospital in investing in quality. Hospitals would choose to provide more quantity than quality of care. This can be the case of low income communities where patients cannot afford health care. Thus given the situation where there is a labor shortage, coupled with a regulated cost reimbursement less than the full cost of quality investments, such low quality sensitivity hospital markets would end up in this Nash Equilibrium under Cournot competition.

Case 2 : Multiple Nash Equilibria : High Quality Sensitivity Market

Where $0 \leq r < 1$ and $b > m(1-r)a$ thus we have $A > 0$

Under this case we have two solutions to the quadratic equation,

CASE 2a: Low Quality Equilibrium

$$q_{i2a}^{NE} = q_{j2a}^{NE} = \frac{B(\gamma + R) + \sqrt{B^2(\gamma + R)^2 - 4[B(2+d)(\alpha A)]}}{2B(2+d)}$$

$$x_{i2a}^{NE} = x_{j2a}^{NE} = \frac{2A(2+d)}{B(\gamma + R) + \sqrt{B^2(\gamma + R)^2 - 4[B(2+d)(\alpha A)]}}$$

Given that $B^2(\gamma + R)^2 > 4[B(2+d)(\alpha A)]$

CASE 2b: High Quality Equilibrium

$$q_{i2b}^{NE} = q_{j2b}^{NE} = \frac{B(\gamma + R) - \sqrt{B^2(\gamma + R)^2 - 4[B(2+d)(\alpha A)]}}{2B(2+d)}$$

$$x_{i2b}^{NE} = x_{j2b}^{NE} = \frac{2A(2+d)}{B(\gamma + R) - \sqrt{B^2(\gamma + R)^2 - 4[B(2+d)(\alpha A)]}}$$

Given that $B^2(\gamma + R)^2 > 4[B(2+d)(\alpha A)]$ and $B(\gamma + R) > \sqrt{B^2(\gamma + R)^2 - 4[B(2+d)(\alpha A)]}$

Under Case 2, the sensitivity of the patients' demand to quality improvements is relatively higher than the cost incurred by the hospital in investing in quality. Here a hospital could find itself under a HIGH QUANTITY - LOW QUALITY equilibrium or the LOW QUANTITY – HIGH QUALITY equilibrium. The solution to the equation, implies that there is some amount of

substitution going on between x_i and q_i. This means that the hospital can increase its revenues by either increasing level of quantity or quality of health care service provided. There is however a maximum amount of quantity the hospital can choose, above which it is no longer profitable to treat cases, this is because of capacity constraints.

Case 2 could apply to affluent communities where patients can afford health care. Thus given the situation where there is a labor shortage, coupled with a regulated cost reimbursement less than the full cost of quality investments, such high quality sensitivity hospital markets would end up in this multiple Nash Equilibrium under Cournot competition.

Proposition 1: A hospital Nash Equilibrium can only be obtained if and only if the reimbursement system is either fully prospective or a mixed scheme, labor resource is sufficiently productive and patients are sufficiently sensitive to quality improvements.

1. The intuition is that quality improvements at the Nash Equilibrium level based on this model, will only be obtained if the hospital is not being reimbursed the full cost; hence reimbursement is either fully prospective or a mixed scheme; where there is a fixed proportion and some amount of cost being reimbursed. Hence x_i^{NE} has a solution iff o ≤ *r* <1. Also "*a*" should be between 0 and infinity because from the model, $MP_L = 1/a$ and in the limit as $\lim_{a\to 0} MP_L \longrightarrow \infty$ and as $\lim_{a\to 1} MP_L \longrightarrow 0$. Finally patient conditions need to be sensitive enough to quality improvements ($b > 0$).

Quality Of Care Improvements

As per the detailed review of previous literature on reimbursement incentives/systems and their impact on choice of quality, some findings point towards the direction that when cost reimbursement systems are used, this gives providers the incentive to over-provide services, while

the fixed payment scheme results in under provision. In this section we mathematically compute the effect of a change in the exogenous parameters of the model on the endogenous parameters. We are interested in the direction of this effect. Specifically we are interested in how changes in the labor market as well as reimbursement policies will interact with and affect the amount of quantity and quality of healthcare the hospital will choose to provide[2].

Comparative Statics Results

Exogenous Parameters	**Endogenous Parameters**						
	q_1^{NE}	x_1^{NE}	q_{2a}^{NE}	x_{2a}^{NE}	q_{2b}^{NE}	x_{2b}^{NE}	
Labor market (*m*)	↓	↓	↑	↓	↓	↑	
Labor market (*n*)	↓	↓	↑	↓	↓	↑	
Fixed Reimbursement (*R*)	↑	↑	↑	↓	↓	↑	
Cost Reimbursement (*r*)	↑	↑	↓	↑	↑	↓	
(Interaction Effect) *∂R ∂m*	↑	↑	↓	↑	↑	↓	
(Interaction Effect) *∂R ∂n*	↑	↑	↓	↑	↑	↓	
(Interaction Effect) *∂r ∂m*	↓	↓	↑	↓	↓	↑	
(Interaction Effect) *∂r ∂n*	↑	↑	↑	↓	↓	↑	

Prospective Reimbursement

Fixed payments or prospective capitation reimbursements has received a lot of attention in the literature especially since the introduction of the Diagnosis Related Group (DRG) system in the U.S. Findings in the literature paint a very pessimistic picture of the impact of prospective reimbursement on the health care system. Some studies have shown that patients are discharged quicker, and sicker. Others find that prospectively paid providers cream low severity patients and skimp or dump high severity one patients in order to maximize profits. Results based on the extensions we incorporated into the standard model yields the following propositions based on comparative statics.

Proposition 2: Fixed reimbursements could lead to an increase in both the amount and quality of health services provided in low quality sensitivity markets.

This proposition comes directly from the comparative statics of case 1 where $\frac{\partial q_1^{NE}}{\partial R} > 0$ and $\frac{\partial x_1^{NE}}{\partial R} > 0$. The results from comparative statics shows that an increase in the fixed reimbursement will under the first case where $b < m(1-r)a$, in contrast with the literature, lead hospitals to increase both the quantity and quality of health care services being provided.

Proposition 3: In high quality sensitivity markets, an increase in the fixed reimbursement could result in an increase in quality of health care provided for hospitals under the high quality equilibrium.

This proposition follows directly from the result of the comparative statics results of the effect of a change in the prospective reimbursement schedule on choice of quality of care:

$\frac{\partial x_{2a}^{NE}}{\partial R} < 0$ and $\frac{\partial x_{2b}^{NE}}{\partial R} > 0$

The results from comparative statics shows that even when patient demand is highly sensitive to quality improvements, an increase in the fixed reimbursement will under the first equilibrium in case 2 (low quality equilibrium), in consistency with the literature, lead hospitals to reduce the quality of health care services being offered. In contrast with existing literature however, under the second equilibrium of case 2 (high quality equilibrium), an increase in fixed reimbursements will push hospitals to increase quality of health care services offered. From these results we find that hospitals who find themselves under the second equilibrium of case 2 will find that their response to the increases in fixed reimbursement based on their conjecture from their response function was indeed wrong and would revise their actions.

Cost Reimbursement

Proposition 4: An increase in cost reimbursement could lead to a decrease in quality of healthcare services under high patient quality sensitive markets when the hospital is in a high quality equilibrium.

This proposition also follows directly from the comparative statics results that measures the impact of a change in cost reimbursement on the choice of quality by hospitals.

$$\frac{\partial x_{2a}^{NE}}{\partial r} > 0 \quad \text{and} \quad \frac{\partial x_{2b}^{NE}}{\partial r} < 0$$

When the hospital is in a low quality equilibrium under a high patient quality sensitivity market $[b > m(1-r)a]$, the results from comparative statics shows that an increase in the cost reimbursement will in consistency with the literature, motivate hospitals to improve the quality of health care services being provided to patients. However, an increase in cost reimbursement when the hospital is in a high quality equilibrium of case 2, push hospitals to reduce quality investments

in health care. This proves that there will not always be creaming of patients under cost reimbursements.

Proposition 5: The labor market shortage leads to high labor costs spillovers that might either encourage or discourage quality improvements by hospitals depending on the equilibrium situation the hospital finds itself and places an opposing force on the direction of effect of cost or fixed reimbursements.

For case 2a $\frac{\partial x_{2a}}{\partial m} < 0, \frac{\partial x_{2a}}{\partial n} < 0, \frac{\partial x_{2a}}{\partial r \partial n} < 0, \frac{\partial x_{2a}}{\partial r \partial m} < 0, \frac{\partial x_{2a}}{\partial R \partial n} > 0, \frac{\partial x_{2a}}{\partial R \partial m} > 0,$

For case 2b $\frac{\partial x_{2b}}{\partial m} > 0, \frac{\partial x_{2b}}{\partial n} > 0, \frac{\partial x_{2b}}{\partial r \partial n} > 0, \frac{\partial x_{2b}}{\partial r \partial m} > 0, \frac{\partial x_{2b}}{\partial R \partial n} < 0, \frac{\partial x_{2b}}{\partial R \partial m} < 0$

This comes directly from the comparative statics results. Generally an increase in the labor market shortage signifying higher labor costs reduces the choice of quality by low quality equilibrium hospitals whiles leading to an increase in the choice of quality for high quality equilibrium hospitals.

Furthermore we find that the effect of the fixed reimbursement on the choice of provider quality is opposed by the labor market shortage. If the labor market shortage is very high and therefore there are high costs of labor, then an increase in the prospective reimbursement will put upward pressure on the reduction in quality investments that is chosen by low quality equilibrium hospitals and downward pressure on the increase in quality improvements that would have been chosen by hospitals under the high quality equilibrium hospitals without such high labor costs.

Similar to the above results, we find that the effect of the cost reimbursement on the choice of provider quality is also opposed by the labor market shortage. If the labor market shortage is very high and therefore there are high costs of labor, then an increase in the cost reimbursement will

place downward pressure on the increase in quality investments that is chosen by low quality equilibrium hospitals, on the other hand there will be upward pressure on the decrease in quality improvements that would have been chosen by hospitals under the high quality equilibrium hospitals in the absence of such high labor costs

We also infer from the comparative statics results that the labor market impact under case two seems to serve as an equalizing mechanism in choice of quality by hospitals under the two equilibriums for both cost and prospective reimbursements. For instance it can be inferred that as parameters in the labor market increase, the cost spillover effects from the labor market constraints acts indirectly to restrict an excessive increase in quality investments due cost reimbursement from low quality hospitals and to restrict an excessive decrease in quality improvements from the high quality hospitals in order to bring their healthcare quality levels closer.

However, generally we find that the labor market constraint places an opposing force on the direction of the effect of reimbursement incentive on inducing quality of health care hence preventing the reimbursement policy from attaining its full effect.

1.5 CONCLUSION

The Nash Equilibrium solution to the model yields two cases with one of the cases having a multiple equilibrium; the two cases depend on the whether or not the patients' sensitivity to quality investments is greater relative to the hospitals cost of quality investments. The implications of our model are the following; 1. The labor market shortage; signifying higher labor costs, has different impacts for different hospitals but generally places an opposing force on the direction of what the choice of a hospitals quality improvements would have been with a change in reimbursement policy, in the absence of high labor costs. 2. Cost reimbursement does not always lead to quality

improvements as we find in the literature, indeed we find that an increase in cost reimbursement could lead to a decrease in quality of healthcare services under high patient quality sensitive markets when the hospital is in a high quality equilibrium. 3. Prospective reimbursement is found not to always lead to decreases in quality, when a hospital is in a high quality equilibrium, in a high patient quality sensitive market we find that increases in prospective payment will increase quality of care provision.

The policy implication here is that to the extent that high labor costs due to medical labor supply constraints lead to an interference in the impact of reimbursement incentives for quality improvements, then reimbursement policy would have to incorporate the relative labor costs faced by hospitals in their payment schemes. Alternatively, medical labor market shortages would have to be addressed through policy that aims at increasing such labor supply and decreasing labor costs.

END NOTES

[1]Pautler and Frankena (1984), Vander Weide and Zalkind (1981) Douglas and Miller (1974), Schmalensee (1977), and White (1972).

[2]In order to obtain the comparative statics for *qi* and *xi*, it can easily be shown from $x_i = \frac{A}{Bq_i}$, that the comparative statics of *xi* with respect to the exogenous parameters, is negatively related to the comparative statics of *qi* with respect to the exogenous parameters, with consideration of the sign of A.

$$\frac{\partial x}{\partial a} = \frac{A}{B}\frac{\partial(1/q_i)}{\partial a} = \frac{A}{B}(-1)(q_i^{-2})\left(\frac{\partial q_i}{\partial a}\right) = -\frac{A}{B}(q_i^{-2})\left(\frac{\partial q_i}{\partial a}\right)$$

1. CASE 1: Where $b < m(1-r)a$ we have A < 0, thus $\frac{\partial x}{\partial a} = \frac{A}{B}(q_i^{-2})\left(\frac{\partial q_i}{\partial a}\right)$,in this case, the amount of quality and quantity of health care produced are complements. Thus the sign of comparative statics will be the same for *xi* and *qi* with respect to the exogenous parameters.
2. CASE 2: Where $b > m(1-r)a$ we have A > 0 thus $\frac{\partial x}{\partial a} = -\frac{A}{B}(q_i^{-2})\left(\frac{\partial q_i}{\partial a}\right)$,in this case, the amount of quality and quantity of health care produced are substitutes. Thus the sign of comparative statics will be opposite for *xi* and *qi* with respect to the exogenous parameter.

REFERENCES

1. About AHRQ. March 2016. Agency for Healthcare Research and Quality, Rockville, MD. Retrieved from: http://www.ahrq.gov/cpi/about/index.html (date accessed : 9/5/2016)

2. Acemoglu, D. & Finkelstein, A. (2008). Input and technology choices in regulated industries: Evidence from the health care sector. Journal of Political Economy, 116(5), 837-880.
3. Acemoglu, D., Finkelstein, A., & Notowidigdo, M. J. (2009). Income and health spending: Evidence from oil price shocks. National Bureau of Economic Research Working Paper 14744.
4. Akerlof, G. A. (1970). The market for 'lemons': Quality uncertainty and the market mechanism. Quarterly Journal of Economics, 84, 488-500
5. Allen, Robin, and Paul J. Gertler. 1991. "Regulation and the Provision of Quality to Heterogeneous Consumers: The Case of Prospective Pricing of Medical Services." Journal of Regulatory Economics, 3(4): 361-375.
6. American Hospital Association, Dafny, L. September 22, 2015, "Testimony: Health Insurance Industry Consolidation: What Do We Know From the Past, Is It Relevant in Light of the ACA, and What Should We Ask?" Retrieved from: http://www.aha.org/advocacy-issues/testimony/2015/150929-tes-nickelscompetition.pdf (date acessed : 9/5/2016)
7. Arrow, K. J. (1963). Uncertainty and the welfare economics of medical care. American Economic Review, 53(5), 941-973
8. Bazzoli, G. J. (1985). Does educational indebtedness affect physician specialty choice? Journal of Health Economics, 4,1-19
9. Bhaskar, V., Manning, A., & To, T. (2002). Oligopsony and monopsonistic competition in labor markets. *The Journal of Economic Perspectives*, *16*(2), 155-174.
10. Bhattacharya, J. (2005). Specialty selection and lifetime returns to specialization within medicine. Journal of Human Resources, 40(1), 115-143
11. Bloom, N., Propper, C., Seiler, S., & Van Reenen, J. (2015). The impact of competition on management quality: evidence from public hospitals. *The Review of Economic Studies*, rdu045.
12. BLS Economic New Release, Employment projections for : 2014 – 2024 summary, http://www.bls.gov/news.release/ecopro.nr0.htm (date accessed : 9/5/2016)
13. Boal, W. M., & Ransom, M. R. (1997). Monopsony in the labor market. *Journal of Economic Literature*, *35*(1), 86-112.
14. Borjas, G. J. (2000). *Labor economics* (Vol. 2). New York: McGraw-Hill.
15. Brekke, K. R., Nuscheler, R., & Rune Straume, O. (2006). Quality and location choices under price regulation. *Journal of Economics & Management Strategy*, *15*(1), 207-227.
16. Brekke, K. R., Nuscheler, R., and Straume, O. R. (2007), Gatekeeping in Health Care, Journal of Health Economics 26, 149–170.
17. Buerhaus, P. I., Auerbach, D. I., & Staiger, D. O. (2009). The recent surge in nurse employment: Causes and implications. Health Affairs-Web Exclusive 657-668.
18. Bureau of Economic Affairs http://www.bea.gov/newsreleases/industry/gdpindustry/2016/pdf/gdpind116.pdf retrieved 9/30/2016
19. Calem, P. S. and Rizzo, J. A. (1995), Competition and Specialization in the Hospital Industry: An Application of Hotelling's Location Model, Southern Economic Journal 61, 1182–1198.
20. Chalkley, M., Malcomson, J.M., 1998. Contracting for health services when patient demand does not reflect quality. Journal of Health Economics 17, 1-19.
21. Cooper, Z., Gibbons, S., Jones, S., & McGuire, A. (2011). Does hospital competition save lives? Evidence from the English NHS patient choice reforms. *The Economic Journal*, *121*(554), F228-F260.
22. Cooper, Z.N., Gibbons, S., Jones, S. and McGuire, A. (2010a). Does Hospital Competition Improve Efficiency? An Analysis of the Recent Market-based Reforms to the English NHS, London: Centre for Economic Performance.

23. Cutler, D. M., Huckman, R. S., and Kolstad, J. T. (2010). Input constraints and the efficiency of entry: Lessons from cardiac surgery. American Economic Journal: Economic Policy, 2(1):51–76.
24. Danzon, P., 1982. Hospital 'profits': the effect of reimbursement policies.Journal of Health Economics 1, 29-52.
25. Douglas, George W., and James C. Miller. 1974. "Quality Competition, Industry Equilibrium, and Efficiency in the Price-Constrained Airline Market." American Economic Review, 64(4): 657-669.
26. Dranove, David. 1987. Rate-setting by diagnosis related groups and hospital specialization. RAND Journal of Economics 18:417-27.
27. Ellis, R. P., & McGuire, T. G. (1986). Provider behavior under prospective reimbursement: Cost sharing and supply. *Journal of health economics*, *5*(2), 129-151.
28. Ellis, R. P., & McGuire, T. G. (1987). Setting capitation payments in markets for health services. *Health care financing review*, *8*(4), 55-64
29. Ellis, R. P., & McGuire, T. G. (1990). Optimal payment systems for health services. *Journal of health economics*, *9*(4), 375-396.
30. Ellis, Randall P. 1998. Creaming, skimping, and dumping: Provider competition on the intensive and extensive margins. Journal of Health Economics 17:537-55.
31. Ellis, Randall P., and Thomas G. McGuire. 1996. Hospital response to prospective payment: Moral hazard, selection, and practice-style effects. Journal of Health Economics 15:257-77.
32. Frank, Richard G., and Judith R. Lave. 1989. A comparison of hospital responses to reimbursement policies for Medicaid psychiatric patients. RAND Journal of Economics 20:588-600.
33. Gagne, R. & Leger, P. T. 2005. Determinants of physicians' decisions to specialize. Health Economics, 14, 721-735.
34. Gaynor, M. (2004). Competition and quality in hospital markets. What do we know? What dont we know? Economie Publique, vol. 15(2), pp. 3–40.
35. Gaynor, M. (2006). *What do we know about competition and quality in health care markets?* (No. w12301). National Bureau of Economic Research.
36. Gaynor, M., & Town, R. J. (2011). *Competition in health care markets* (No. w17208). National Bureau of Economic Research.
37. Gaynor, M., Propper, C., & Seiler, S. (2012). *Free to choose? Reform and demand response in the English National Health Service* (No. w18574). National Bureau of Economic Research.
38. Gowrisankaran, G., Town, R., 2003. Competition, payers, and hospital quality. Health Services Research, 38, 1403—1422.
39. Gravelle, H. (1999), Capitation Contracts: Access and Quality, Journal of Health Economics 18, 315–340.
40. Gravelle, H. and Masiero, G. (2000), Quality Incentives in a Regulated Market with Imperfect Competition and Switching Costs: Capitation in General Practice, Journal of Health Economics 19, 1067–1088.
41. Hamermesh, D. S. (1993). Labor demand. Princeton, NJ: Princeton University Press
42. Harris, J. E. (1979). Pricing rules for hospitals. *The Bell Journal of Economics*, 224-243.
43. Held, Philip J., and Mark V. Pauly. 1983. "Competition and Efficiency in the End Stage Renal Disease Program." Journal of Health Economics, 2(2): 95-118.
44. Hodgkin, Dominic, and Thomas G. McGuire. 1994. Payment levels and hospital response to prospective payment. Journal of Health Economics 13:1-29.
45. Iglehart, J. K. (2008). Grassroots activism and the pursuit of an expanded physician supply. New England Journal of Medicine, 358(16), 1741-1749

46. Janeba Nicole, 2008. Healthcare Payment Reform & Provider Reimbursement: A Summary of Strategies for Consideration by the Oregon Health Fund Program, Oregon Health Policy and Research
47. Karlsson, M. (2007), Quality Incentives for GPs in a Regulated Market, Journal of Health Economics 26, 699–720
48. Kessler, D. and McClellan, M. (2000), Is Hospital Competition Socially Wasteful?, Quarterly Journal of Economics 115, 577–615.
49. Kessler, D.P. and Geppert, J.J. (2005). The effects of competition on variation in the quality and cost of medical care, Journal of Economics and Management Strategy, vol. 14(3), pp. 575–89.
50. Kleiner, M. M. & Kudrle, R. T. (2000). Does regulation affect economic outcomes? The case of dentistry. Journal of Law and Economics, 43, 547-582
51. Kleiner, M. M. (2006). Licensing occupations: Ensuring quality or restricting competition? Kalamazoo, MI: W. E. Upjohn Institute for Employment Research
52. Leland, H. E. (1979). Quacks, lemons, and licensing: A theory of minimum quality standards. Journal of Political Economy, 87(6), 1328-1346
53. Ma, C. A. and Burgess, J. F. (1993), Quality Competition, Welfare, and Regulation, Journal of Economics 58, 153–173.
54. Ma, C.A., 1994. Health care payment systems: cost and quality incentives. Journal of Economics & Management Strategy 3, 93-112.
55. Matsumura, T. and Matsushima, N. (2007), Congestion-Reducing Investments and Economic Welfare in a Hotelling Model, Economics Letters 96, 161–167.
56. McClellan, Mark. 1997. Hospital reimbursement incentives: An empirical analysis. Journal of Economics and Management Strategy 6:91-128.
57. Miller H. D. Creating payment systems to accelerate value- driven Health care: Issues and options for policy reform. The commonwealth fund, September 2007.
58. Mukamel, D., Zwanziger, J., Tomaszewski, K.J., 2001. HMO penetration, competition and risk-adjusted hospital mortality. Health Services Research, 36, 1019—1035
59. Newhouse, J. P. (1970). Toward a theory of nonprofit institutions: An economic model of a hospital. *The American Economic Review*, *60*(1), 64-74.
60. Newhouse, J. P. (1996). Reimbursing health plans and health providers: efficiency in production versus selection. *Journal of economic literature*, *34*(3), 1236-1263.
61. Nicholson, S and Propper, C (2012). Medical Workforce. Handbook of Health Economics, Volume 2. 874-919
62. Nursing workforce; http://www.nursingworld.org/MainMenuCategories/ThePracticeofProfessionalNursing/workforce/Fast-Facts-2014-Nursing-Workforce.pdf (date accessed : 9/5/2016)
63. Pautler, P. A., & Frankena, M. W. (1984). An Economic Analysis of Taxicab Regulation. *Bureau of Economics Staff Report*.
64. Phillips, L. (January 23, 2015) "Health Care M&A Broke Records in Q4 2014, and for Full Year, According to Health Care M&A News." Irving Levin Associates. Retrieved from: http://www.levinassociates.com/pr2014/pr1501mamq4 (date acessed : 9/5/2016)
65. Pope Gregory C., 1989, Hospital nonprice competition and medicare reimbursement policy. Journal of health Economics. 8 : 147 -172
66. Propper, C., Burgess, S. and Green, K. 2004. Does competition between hospitals improve the quality of care? Hospital death rates and the NHS internal market, Journal of Public Economics, vol. 88(7–8), 1247–72.

67. Propper, C., Wilson, D. and Burgess, S. (2006). Extending choice in English health care: the implications of the economic evidence, Journal of Social Policy, vol. 35(4), 537–57.
68. Rogerson, W.P., 1994, Choice of treatment intensities by a nonprofit hospital under prospective priceing, J. Econ. Manage. Strategy 3, 7-52
69. Romano, P. and Mutter, R. (2004). The evolving science of quality measurement for hospitals: Implications for studies of competition and consolidation, International Journal of Health Care Finance and Economics, vol. 4(2), 131–57.
70. Schmalensee, Richard. 1977. "Comparative Static Properties of Regulated Airline Oligopolies." Bell Journal of Economics, 8(2): 565-576.
71. Shen, Y.C. (2003). The effect of financial pressure on the quality of care in hospitals, Journal of Health Economics, vol. 22(2), 243–69.
72. Shields, M. A. (2004). Addressing nurse shortages: What can policy makers learn from the econometric evidence on nurse labour supply? Economic Journal, 114, F464-F498.
73. Shortell, S. M., Hughes, E. F., 1988. The effects of regulation, competition, and ownership on mortality rates among hospital inpatients. New England Journal of Medicine, 318, 1100—1107.
74. Sloan, F. A. (1970). Lifetime earnings and physicians' choice of specialty. Industrial and Labor Relations Review, 24, 47-56
75. Squires D. and Anderson C, (2015). *U.S. Health Care from a Global Perspective: Spending, Use of Services, Prices, and Health in 13 Countries*, The Commonwealth Fund
76. Staiger, D. O., Spetz, J., & Phibbs, C. S. (2010). Is there monopsony in the labor market? Evidence from a natural experiment. *Journal of Labor Economics*, *28*(2), 211-236.
77. Tay, A. (2003), Assessing Competition in Hospital Care Markets: The Importance of Accounting for Quality Differentiation, RAND Journal of Economics 34, 786–814.
78. U.S. Department of Health and Human Services, Health Resources and Services Administration, National Center for Health Workforce Analysis. Projecting the Supply and Demand for Primary Care Practitioners Through 2020. Rockville, Maryland: U.S. Department of Health and Human Services, 2013 (date accessed : 9/5/2016)
79. US health services deals insights: Analysis and trends in US health services activity 2014 and 2015 Outlook. (February 2015) , PricewaterhouseCoopers Deals practice. Retrieved from: http://www.pwc.com/us/en/healthcare/publications/assets/pwc-health-services-deals-insights-2014.pdf (date accessed : 9/5/2016)
80. Vander Weide, James H., and Julie H. Zalkind. 1981. "Deregulation and Oligopolistic Price-Quality Rivalry." American Economic Review, 71(1): 144-154.
81. Vitalari, N. P. (2016). Prospects for the future of the U.S. healthcare industry: a speculative analysis. *Am J Med Res*, *3*(2), 7-52.
82. Vogt, W.B. and Town, R.J. (2006). How Has Hospital Consolidation Affected the Price and Quality of Hospital Care, Princeton, NJ: Robert Wood Johnson Foundation
83. White, Lawrence J. 1972. "Quality Variation When Prices Are Regulated." Bell Journal of Economics and Management Science, 3(2): 425-436.
84. Wolinsky, A. (1997), Regulation of Duopoly: Managed Competition vs Regulated Monopolies, Journal of Economics and Management Strategy 6, 821–847.