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Do Physicians Contribute to Economic Growth? An Empirical Analysis

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ABSTRACT

Physicians may contribute to economic growth in two distinct, opposite ways. On the one hand, an efficient number of physicians may keep people healthy, which raises the productivity of laborers and allows them to return to work quickly after an illness. This type of profit-seeking behavior by physicians should raise the growth of the economy. On the other hand, too many physicians may exist in a market area, which leads to supplier-induced demand (SID). The SID may keep laborers out of work for longer periods and thereby negatively impact the growth of the economy. Moreover, the extra number of physicians may come at the expense of other types of occupations. Either way, the rent-seeking behavior of physicians should lead to slower economic growth. Which type of physician behavior dominates is an empirical question, so this thesis explores econometrically the impact that physicians have on economic growth.

This thesis tests a model of gross domestic product (GDP) growth using all fifty states in the United States and data from 14 different 3-year periods from 1973-2009. The main independent variable of interest is the number of physicians per 100,000 residents of each state, and the data are analyzed to determine if that number is positively or negatively correlated with state GDP growth while controlling for other determinants of economic growth. The analysis allows us to determine if our society is currently operating with too many or too few physicians. For most states and time periods, the empirical analysis suggests that physicians helped to quicken economic growth. For a few state-year observations, however, physicians led to slower growth at the margin, as the states were operating with too many physicians per 100,000 residents.

INTRODUCTION

With healthcare costs in the United States increasing every year, much attention has been placed on ways to cut costs and eliminate unnecessary expenditures in the healthcare system. There are many possible reasons for the large increase in spending on healthcare, such as rising income and the use of more expensive and technologically advanced medical equipment. Healthcare reform has been at the forefront of politics in the United States for the past few years, and one of the largest healthcare reform bills in history, the Patient Protection and Affordable Care Act (PPACA), was signed into law in 2010.

This act aims to eliminate inefficiency in the United States healthcare system by monitoring spending patterns and requiring all Americans to purchase health insurance or pay a penalty. By attempting to “bend the cost curve,” the act focuses on the long-term spending and practices of healthcare in America, rather than on short-term solutions. Finding ways to provide only the healthcare services that are medically necessary along with improving the population’s health overall through wellness programs and more health insurance coverage may help to bend the cost curve and reduce overall costs for the healthcare system. Some economists have found that the PPACA, while it may require higher spending by the government and the population in the short-run, will eventually bend the cost curve and slow expenditures on healthcare (Klein, 2010). However, there may be some challenges ahead before the United States healthcare industry can truly bend the cost curve. David Cutler (2010) shows that industries successful at bending the cost curve must utilize information technology, compensate workers based on value contributions and successful outcomes, and work with consumers to improve the production process. According to Cutler, the PPACA may be able to cut 1.5 percentage points off of healthcare spending growth in the United States every year starting in 2013. This means that in

20 years, spending will be 25-30 percent below current forecasts; however, for this to occur, the act must follow Cutler's three criteria to bend the healthcare cost curve and slow overall healthcare spending growth.

One theory for rising healthcare costs in the United States involves examining the efficiency of healthcare; more specifically, we can look at the efficiency of physicians themselves to see how they provide care and their outcomes at the margin. On the one hand, physicians may be efficient, as they may keep people healthy, allowing laborers to return to work more quickly after an illness and contribute to a productive society. However, physicians may be too numerous and therefore incentivized by competition to unnecessarily induce the demand for their services (a concept known as supplier-induced demand), which may keep people out of work for longer periods and negatively impact the growth of the economy. Also, the numerous physicians may come at the expense of other types of occupations, such as educators, corporate CEOs, or lawyers, which also negatively affects the growth of the economy. If physicians are "rent-seeking" and inefficient in that manner, the inefficiencies in the health economy should spill over into the economy as a whole. This efficiency effect of supplier-induced demand (SID) on the overall economy has not been fully explored in previous studies. Physicians may therefore play a role in economic growth, by both contributing to a healthy workforce and helping the economy grow, or by inducing demand and hindering the growth of the economy.

SID occurs when the supplier of a certain good or service possesses more information than the consumer, and therefore can induce the consumer to demand more of the product or service than they would if perfectly informed. SID occurs in healthcare when physicians take advantage of their medical role and training to recommend care to the patient that goes beyond what is clinically necessary, therefore resulting in financial gain for the physician. As Hay and

Leahy (1982, p. 231) explain, SID by physicians, also known as physician-induced demand, is defined as "services ordered by a physician for a patient, that the patient would refuse if he or she had the same medical knowledge and expertise as the physician, but remained the same in all other effects." SID causes a shift to the right of a consumer's demand curve, rather than a move along the curve that would normally occur as a result of a price change. Unlike in standard economic theory, the supply and demand for medical care are not completely independent.

Because a "gray" area with asymmetrical information exists regarding what medical treatments are necessary for certain conditions, physicians have the ability to increase the quantity of care while still backing up their decisions with medically relevant information. Patients rely on their physician to tell them what their demand for medical services should be. This can be shown in the context of the "principal-agent problem," where a physician acting as the agent is given the power to determine the demand for the patient, the principal. Efficiency occurs when a good or service is produced at exactly the point where the marginal social cost equals the marginal social benefit (Santerre and Neun, 2010). If a physician induces demand for services from a patient, the consumer's demand curve shifts and the production of physician services no longer occurs at the point where MSC = MSB. This can therefore lead to inefficiency in the healthcare system if physicians prescribe care beyond the medically necessary level.

Some economists have studied the effect of competition in the healthcare industry. The SID theory suggests that increasing the number of physicians in a given geographical area can cause a shift in the physician supply curve to the right, thereby decreasing the price physicians can charge for their services. This can lead to physicians offering the same services to make up for lost revenues by scheduling more visits with patients and performing more unnecessary procedures. Therefore, an increase in the number of physicians can lead to higher healthcare expenditures per capita. However, some economists (e.g. Newhouse, 1970; Fuchs and Kramer, 1972; Evans, 1974; Fuchs, 1978; Sweeney, 1980; and Sweeney, 1982) attempt to show that this is not an unlimited practice by physicians, and that physicians actually have a "target income" and will only induce demand until they reach that point. These economists also reason that physicians are restricted by moral and professional standards, the potential for malpractice suits, and a dislike of a heavy workload.

Additionally, medical technology can play a role in the contribution of healthcare to economic growth. Some may claim that medical technology is the main reason for any efficiencies and economic growth rising out of the healthcare sector. However, because physicians control medical technology, this may simply be an overspill from the efficiency of physicians into the technology field. Cutler and McClellan (2001) find that increasing spending on medical technology is worth it because the benefits exceed the costs. However, Skinner, Staiger, and Fisher (2006) explain that flat-of-the-curve medicine may be occurring with respect to medical technology. In other words, overtime, patient health improvement does come from valuable technology, but too much spending across different regions may actually be detrimental to patient health. Additionally, the same service may not be as productive in some states as it is in others (Chandra and Staiger, 2004). Therefore, medical technology is most likely not the only contributing factor to economic growth from the healthcare sector.

This study analyzes the efficiency impact of the number of physicians on the growth of state GDP. By looking at the correlation between physician density and GDP at the state level, we will see if SID, assuming that it exists when physician density increases in an area, has negatively impacted the growth of the state's economy. This idea comes from Magee's (1992) model explaining the quantity of lawyers it takes to slow the growth of an economy. The "Magee curve" is a graphical model showing that up to a certain point (in this case, 23 lawyers per one thousand white-collar workers), increasing the density of lawyers will have a positive effect on economic growth. However, after this optimal quantity is reached, increasing the density of lawyers has a negative impact on the growth of the economy. Therefore, countries with the optimal amount of lawyers per white-collar workers will grow faster than those with too many lawyers. This model will be similarly applied to the physician services market, where we analyze the effect of physician density in states of the U.S. on the growth of the state's economy as a whole, after controlling for various other growth factors.

EFFICIENCY LITERATURE

As mentioned above, physicians may be able to improve the efficiency of an economy. For example, if physicians, as a group, keep people healthy and productive, the lower absenteeism rate from work may lead to a more prosperous economy. Thus, the question of whether or not physicians add to the overall growth of an economy is important to answer. If physicians are efficient and do not induce demand for their services, increasing the number of doctors may not necessarily have a negative impact on the growth of the economy. In fact, more physicians may positively impact the growth of the economy by helping to improve the health status of the labor force.

Or, Wang, and Jamison (2005) test for physician efficiency by using a cross-country, time-series data set of twenty-one OECD countries spanning over three decades. They find evidence for the efficiency of physicians by showing that the physician workforce plays an important role in reducing mortality, though the specific health outcomes may also depend on the medical technology in various countries and the healthcare payment systems in place. Grubaugh and Santerre (1994) reach a similar conclusion about the efficiency of physicians in a study also using a panel data set of OECD countries.

Baicker and Chandra (2004) find that states with higher Medicare spending have lower-quality care than states with lower Medicare spending. They find that the mix of the provider workforce (i.e. general practitioners versus specialists) affects the Medicare spending in each state. States with more general practitioners use more effective care and spend less on healthcare, whereas states with more specialists have higher costs and have a lower quality of healthcare.

Starfield et al (2005) confirm these empirical findings. They show that an increase in the number of primary care physicians leads to lower mortality rates, though the same result does not hold for specialists. More specifically, using a cross-sectional analysis with a mixed model method, they use data from 1996-2000 for 3,075 counties in the United States. The authors find that increasing the number of specialists in the United States would not help to improve health outcomes, and a higher specialist-to-population ratio indicates a higher total mortality rate and a higher cancer mortality rate (however, this relationship does disappear after accounting for sociodemographic variables). These findings indicate the possibility that unnecessary specialist use occurs due to supplier-induced demand and therefore causes inefficiency in the form of less favorable health outcomes.

In addition, Starfield et al (2005) find that primary care physicians help to prevent illness and death. They also find that primary care physicians, when compared to specialty doctors, are associated with a more equitable distribution of health within various populations. They summarize their findings from the articles into six reasons that primary care can benefit the health of populations:

(1) Primary care can increase access to health services for deprived population groups.

(2) Primary care physicians perform better than specialty physicians for common conditions overall.

(3) Primary care preventative measures are more successful than those of specialists because they focus on overall health rather than on one specific disease or organ system.

(4) Primary care physicians can help with early management of health problems to avoid reaching the point of needing emergency services or hospitalization.

(5) Primary care focuses on the overall care and health improvement of the person rather than on improving one specific condition or disease.

(6) Primary care can help to reduce unnecessary or inappropriate specialty care.

Smetana et al (2007) review studies comparing primary versus specialist care physicians and their treatment outcomes for patients with specific medical conditions. They report that twenty-four out of forty-nine studies suggest that specialists produce better health outcomes, and only four of the studies specifically imply that primary care physicians produce better outcomes. This is contradictory to the Starfield et al (2005) study cited above that finds evidence for the efficiency of primary care physicians as compared to specialists. A variety of different models, characteristics of the physician's practice, and different case-mixes could cause the discrepancy in the findings (Smetana et al, 2007).

Not surprisingly, O'Malley and O'Malley (2007) are skeptical of the lack of data validity and various study designs in the articles studied by Smetana et al. O'Malley and O'Malley find that Smetana et al reviewed mostly observational studies and compared groups with too many different factors. Additionally, they point out that publication bias could contribute to the varied findings, as studies that find no results are most likely not published. They suggest including physician reimbursement in the models and looking at other factors such as the fragmented delivery of care and lack of access to healthcare in the United States.

Sepulveda, Bodenheimer, and Grundy (2008) look at the primary care shortage in the United States and explain that many doctors choose to practice specialty medicine rather than primary care because of higher rates of reimbursement. However, by looking into past studies, they find evidence that primary care is associated with reduced health costs and lower mortality rates. Goodman and Grumbach (2008) also argue that if a larger supply of physicians leads to greater access to care, health outcomes may improve. However, based on previous studies, Goodman and Grumbach relate that the link between health outcomes and physician supply is weak, though regions that focus mainly on primary care frequently do have better health outcomes.

Gerdtham and Lothgren (2001) used a panel set of inpatient healthcare data from sixteen OECD countries from 1975-1991 to study the effects of health systems on cost efficiency and to see if healthcare is an efficient contributor to the economy. Using an applied stochastic frontier cost model, they find that the United States has the highest level of healthcare costs within their data set. They also find that the health cost efficiency of OECD countries rose throughout the studied time period. Gerdtham and Lothgren find that the United States does not have the most efficient healthcare system set-up compared to other countries that have similar integrated systems. Again comparing the United States to other countries, Evans, Tandon, Murray, and Lauer (2001) examine a 1999 World Health Organization study of 191 OECD countries, using a panel data set from 1993-1997. They find that while the United States healthcare system is not completely efficient, it is ranked at 72 among the 191 countries with a performance index of .774, meaning that it can improve health sector efficiency by around 22% compared to the most efficient country in the study.

Retzlaff-Roberts, Chang, and Rubin (2004) use data envelopment analysis (DEA) with OECD data from twenty-seven countries in 2000. They find that the United States could learn from other countries how to be more economical in its allocation of healthcare resources, and that more healthcare does not necessarily lead to better health outcomes. Their findings show that the United States can substantially reduce health inputs (such as the number of hospital beds, physicians, MRIs, and spending on healthcare) to 90.7% of its current level while still maintaining its current level of life expectancy. They also find that the United States can potentially reduce infant mortality to 89.6% of its current level without increasing its healthcare input consumption (again, the number of hospital beds, physicians, MRIs, and spending on healthcare) and without changing its current social environment (such as the expected years of schooling that will be completed, percentage of the population that smokes tobacco, and income distribution).

SUPPLIER-INDUCED DEMAND AND MANAGED CARE LITERATURE

Since the 1970s, many empirical studies have looked at whether or not SID actually exists in the healthcare system of the United States. These studies have used data and various models to test for the existence of SID. While some studies have found evidence for its existence and others have found no evidence, few studies have been conducted to actually examine the efficiency effect of SID on the United States economy as a whole. Labelle, Stoddart, and Rice (1993) appear to be the first economists to examine what the effects of SID could mean to society as a whole, though they do not actually attempt to quantify its negative impact on the economy. Looking at SID in the United States by studying the impact of physician density on the economy as a whole may help to show whether or not SID truly exists and if it is causing inefficiency in our economy.

One thing to keep in mind is that managed care plans can have an impact on the ability of physicians to induce demand for their services. This is because managed care plans seek to reduce healthcare costs by eliminating unnecessary services and expenditures. Some studies have been done to examine the effectiveness of managed care plans in eliminating services prescribed by physicians that have been deemed unnecessary. These studies have been included in this review. However, the managed care era does not begin until around 1993, so studies of SID before then focus mainly on physicians whose patients are in traditional indemnity insurance plans.

According to Grytten, Carlsen, and Sorensen (1993), the most common approach to studying SID in the healthcare industry involves studying how changes in population-to-physician ratios affect different outcomes such as fees, physician output, and physician income. Many studies have been done to test for the existence of SID following that approach.

One of the first studies to test for SID in the healthcare market that paved the way for many more studies to come was by Joseph Newhouse. Newhouse (1970) finds that physicians are able to induce demand for their services because of the monopolistic nature of the physician market. He tests three different models of supply curves by using income data and physician prices from eighteen cities in 1961 and 1966. Newhouse first assumes that if physicians are monopolists and do use price discrimination, then patients should pay different prices for their physician visits according to their income. He then finds evidence that the market for physicians' services is monopolistic rather than competitive by showing that price discrimination does occur in practice. If the physician market is indeed monopolistic, this may show that inefficiencies do exist and that SID by physicians can negatively impact the economy.

In that same year as Newhouse's notable study, Feldstein (1970) finds a permanent excess demand for physician services in the healthcare market. He shows that physicians do have the power to vary their prices and quantity of services due to the structure of the healthcare market place. Feldstein used a model that assumed physicians determine the price and quantity of medical services, which always cause excess demand in medical care. He used time series data to compare trends in the Consumer Price Index with trends in physician fee increases from 1948-1966 and then in 1967 and 1968 when Medicare and Medicaid were introduced. Feldstein finds that the quantity of services provided by physicians decreases when fees rise. This is contradictory to standard economic theory, which predicts a supplier will provide more goods or services if the price rises. His results suggest that physician markets may not behave as standard supplier markets would, which seems to lead to the possibility of inefficiencies like SID in the healthcare industry. While Feldstein does not actually measure the efficiency impact of SID in the healthcare industry, his discovery about the structure of the physician market will be helpful in determining whether SID can actually impact the economy as a whole.

Two years later, Fuchs and Kramer (1972) conducted a study that suggests SID may be occurring in the United States. Past studies indicated that patients are the main factors in determining utilization and expenditures on physician services. However, Fuchs and Kramer find that the supply of physicians is extremely important in determining these factors. They use a cross-sectional data series from different states in 1966 to examine the quantity and pricing of physician services. Fuchs and Kramer find that an increase in the supply of physicians has a small impact on price but results in highly increased levels of utilization. However, one limit to this idea is that a higher concentration of physicians may reduce time costs for patients, which may be one factor that contributes to an increased utilization of healthcare services in physician-dense areas. Fuchs and Kramer also look at two subsets of data from 1948-1956 and 1956-1966 and find that physicians practicing in states where the physician-to-population ratio is high do provide more services. This is one of the first studies to really show the correlation between physician supply and the utilization of healthcare services. This concept is very relevant in determining whether SID impacts the efficiency of the economy by allocating too much money to healthcare due to rent-seeking by physicians when competition increases.

Evans (1974) explores the impact of the principal-agent problem on the physician-patient relationship. As noted above, the principal-agent problem in healthcare can cause inefficiencies and therefore may result in a negative impact on the economy. He looks at income data from over two thousand physicians in 1969 and 1971 to determine physician workload and physician density in different regions of the United States. He finds that prices for physician services are higher in areas with a higher physician density. This has potential to explain why the GDP in some states may grow slower if the physician density is higher. Evans also claims that physicians have some sort of target income or target level of hours worked, and will therefore not induce demand for their services indefinitely. However, this study does not fully explain why physicians do not just continually raise their fees to achieve their target income rather than increase the number of services they provide.

Rather than examining physician office visits to study SID, Fuchs (1978) uses total in-hospital operations as a measurement for the quantity of services offered. Fuchs believes that a count of office visits to physicians may be skewed because there is a large variation in the type of visit, length of the visit, and the number of tests that may result from each visit. He therefore uses surgical utilization rates from 22 different areas in the United States from 1963 and 1970 to test his theory. Fuchs finds empirically that the supply of physicians in hospitals has a positive effect on the demand for their services. However, because this study focuses on surgeons in hospitals rather than physicians in other practices, the SID theory could have a different application here than when tested with physician office visits. Surgeons are subject to different constraints and practices than regular physicians.

Contrary to previous studies, Hay and Leahy (1982) do not find support for SID in the United States. They begin by assuming that a profit-maximizing physician will provide more services, all things held constant, to a medically uninformed patient base. Hay and Leahy use a profit maximization model of physician pricing behavior to find empirically that medical professionals and their families are just as likely to visit physicians as non-medical professionals. This occurs despite their higher level of medical knowledge, even after controlling for sociodemographic factors (such as age, income, education, race, and family size), access to care, price, and perceived health status factors. They use data from a household survey of over 5,000 individuals conducted between 1975 and 1976 to look at the healthcare utilization of the individual. If their findings are indeed accurate, this may result in the finding for our study that GDP is not affected by the density of physicians in the states.

Reinhardt (1985) wrote an editorial explaining that physician-induced demand research can be narrowed into three specific questions. The questions are as follows: (1) “Can physicians manipulate their patients’ demand for physician services?”, (2) “If so, do physicians ever do this for the sake of pecuniary gain?”, and (3) “If so, will physicians at any time have fully explored the potential to maximize their hourly income in this way, or is there unexploited slack whose extent varies with the economic pressure on the physician?" He explains that the work of health economists has mainly focused on the third question to see if there are constraints on the price-output decisions of physicians. Reinhardt also explains that there are few physicians that would completely deny the power to induce demand, yet few physicians would be willing to admit that they would do this for personal gain. He did not test this model of questions using specific data but rather looked at past studies by health economists to determine the behavior of physicians.

The managed care era was at its prime height from 1993 to 1999. Prior to this, studies were done to examine whether or not evidence existed for SID in healthcare assuming traditional indemnity insurance systems. The studies after 1993 examine SID with an included managed care aspect, with many of the patients in HMO insurance plans. As one of the main goals of managed care plans is to reduce costs and eliminate unnecessary services, SID is something that should theoretically be eliminated in managed care plans. This implies that managed care may help to increase efficiency in healthcare and, according to our study, may possibly help to limit the impact that SID can have in slowing GDP growth. If managed care plans are able to prevent SID and rent-seeking by physicians, these plans may be better for the health economy and the economy as a whole than traditional indemnity insurance plans. Many of the following studies look at SID in a managed care framework.

As mentioned, not much has been done to examine the effects of SID in healthcare and its efficiency impact on the economy. However, Labelle, Stoddart, and Rice (1993) urge economists to pay more attention to the consequences of SID. Their study looks at the clinical effectiveness of the health services utilized by patients as well as the effectiveness of the agency relationship between the physician and the patient. As they mention, some studies cast doctors as imperfect agents for the patient because of the potential financial gain doctors can get from providing more services to patients (therefore implying the physician-agent problem as mentioned above).

Labelle, Stoddart, and Rice (1993) also look at past frameworks for studying SID and where information may be lacking in SID literature, without actually using data to prove their point. Two questions they pose to study the effects of SID are (1) Would the patient still have desired the service if he/she had the same medical knowledge as the physician? and (2) Did the service contribute positively to the patient's health status? If a patient would have rejected a certain service and the service did not contribute positively to his or her health, it is considered a welfare loss to society. These two questions were relatively new to the study of SID in physician services at the time. As these economists try to prove, looking at the value of the service both at the margin and socially can help to determine the true effectiveness of the service. Essentially, Labelle, Stoddart, and Rice find a need to ensure that the prices patients face privately reflect the marginal social cost of care. This would help to avoid unnecessary healthcare procedures where the marginal social cost exceeds its marginal social benefit. Therefore, they note that studying the efficiency of the services by the physician can help to determine whether or not SID exists and whether it may impact society. However, this study does not attempt to estimate or quantify the actual effects of SID by physicians on society as a whole. This paper was met with much uproar from the healthcare community, including an editorial response by Mark Pauly (1994) who does not see the need for examining the impact of SID on health status. Pauly argues that it first needs to be established whether or not SID actually happens in practice.

Several years later, managed care had been around for a while and was beginning to become even more frequent in the United States health insurance system. Stano (1997) finds evidence of strong financial incentives to economize and make managed care plans well suited to reduce moral hazard, SID, and other forms of excess utilization in healthcare. He looked at the present value of HMO expenditures on continuing care options as compared to upfront alternatives by comparing five different percentages of disenrollment rates for HMO plans over treatment periods of 3, 5, 10, and 15 years. Stano analyzed the HMO decisions that have multiple treatment options, and found that physicians in managed care are more likely to substitute outpatient for inpatient care. He shows that physicians in managed care have a bias towards continuing care options rather than treatment options with high upfront costs. This shows that managed care plans may be more cost-effective by reducing SID and may therefore prevent wasted resources. He concludes that an ideal health system would provide treatment decisions based on all present and future predicted treatment costs, rather than just present ones. This finding implies that controlling SID through managed care plans eliminate inefficiencies resulting from physicians providing unnecessary services. This study may have an implication for the economy as a whole as managed care plans are becoming more frequent in the United States healthcare system.

Jaegher and Jegers (1999) also consider how SID affects patient welfare and develop an equation to estimate the welfare loss to patients due to physician market power. If SID by physicians negatively impacts patients, the economy as a whole may be affected. They look at both the neoclassical model by Farley (1986) and the inducement model of SID. They find that as long as the price physicians receive is greater than marginal cost, the physicians will prescribe a level of care to right of the demand curve for perfectly informed patients. Because market power involves a deadweight loss, they claim that the loss in consumer surplus to the patient (because of the absence of perfect competition in healthcare) will be larger than the gain in profits to the physician. They do not test this with data but rather derive various models based on the past models of health economists to determine physician behavior.

As mentioned previously, SID is possible because of the information gap between physicians and patients. Calcott (1999) looks at the information level of patients by using a game model of "cheap talk" with the doctor's advice acting as "signals" the patient receives. He shows that patients with little information may be more vulnerable to SID than well-informed patients. Additionally, improvement in information may lead the patient to be confident enough to disregard advice from the doctor and decline treatment more often, which results in less SID than would normally occur for a patient with no information.

Again, as managed care was growing in the 1990s, more and more patients were switching to these HMO plans. Hirth and Chernew (1999) argue that even if the physician labor market is dysfunctional under fee-for-service incentives, it can become better as managed care becomes more dominant. This could mean a reduction in the amount of SID that exists in the physician market and therefore an improvement in efficiency of the overall economy. They show that a change from traditional insurance to salaried or capitated payment for physicians reduces their incentives to over-treat patients. Managed care plans can control the ability of physicians to induce demand for their services by monitoring practice patterns and removing doctors who over-treat from their networks. By using a model of physician behavior and many variables and possible scenarios, Hirth and Chernew show that in fee-for-service practices, physicians partially or fully offset small changes to practice sizes by inducing demand. However, in a managed care dominated environment, the earnings of physicians in oversupplied specialties fell as opportunities to induce demand were exhausted.

Cutler, McClellan, and Newhouse (2000) conducted a study to test the effectiveness of managed care plans in preventing SID. They use data from the different health plan designs (i.e. HMOs, PPOs, indemnity plans, etc.) of a health insurance company with 250,000 covered lives for 30 months from July 1993 to December 1995. They focus on the management of heart disease to show that managed care may yield substantial increases in measured productivity relative to traditional insurance, which may imply that SID is limited by managed care plans.

Many physician practices have some patients in traditional indemnity insurance plans and some in managed care plans. Glied and Zivin (2001) look at how physicians behave when some, but not all, of their patients are in managed care. They use data from a survey of physicians for a total of 35,000 physician office visits (including method of payment, diagnosis, geographic location, etc.). They find that practice composition has a strong effect on treatment, and that fee-for-service patients receive more treatment when managed care enrollment is high in a particular physician practice. Physicians may profit from inducing demand from indemnity patients but may not profit from doing the same to managed care patients. Therefore, as managed care concentration increases for an individual practice, the physician may increase the intensity or frequency of indemnity-reimbursed medical services to make up for a loss in revenues from HMO patients. They show that financial incentives do matter, since physicians induce demand of fee-for-service patients to compensate for low payments from managed care patients. This may imply that inefficiencies occur when physicians are faced with both managed care and indemnity insurance patients.

Instead of simply testing whether or not managed care plans are able to reduce or eliminate SID, Lindrooth, Norton, and Dickey (2002) focus on how managed care affects social welfare. This is in line with our examination of the impact of physician density on the economy as a whole. They explain that managed care controls costs through a combination of provider selection, bargaining, and utilization management. Provider selection will reduce expenditures if patients are sent to efficient providers. Utilization management will reduce expenditures if providers reduce treatment intensity due to monitoring by insurance companies. By using data from a Medicaid behavioral health carve-out plan in Massachusetts to look at cost-sharing percentages and the financial structure of health plans, Lindrooth, Norton, and Dickey show that utilization management will therefore be welfare-improving if it prevents SID from occurring. This may imply that managed care may be more efficient than indemnity insurance plans if utilization management is correctly implemented.

Friesner and Stevens (2006) studied the impact that different levels of ownership (from full ownership to no ownership, based on percentages) have on rent-seeking behavior and efficiency within specialty healthcare practices. They use a model to show different levels of ownership and the firm's profit function, and they find that if practitioners are not required to be technically efficient, they will typically respond to lower ownership with rent-seeking behavior. The physicians will substitute their services for those of their assistants. Since rent-seeking reduces profitability, physicians with a higher ownership in a practice will be less likely to do this. SID can be considered rent-seeking because it is not efficient and will not improve profitability in the long run. If physicians do indeed respond to lower levels of ownership with rent-seeking, inefficiencies from the health economy may spill out into the general economy as a result of the rent-seeking.

Deb et al (2006) estimate the treatment effects of managed care plans on the utilization of healthcare services. They find significant evidence of self-selection into managed care plans. However, after accounting for self-selection, an individual enrolled in an HMO plan has 2 more visits to a doctor and 0.1 more visits to the emergency room per year than would the same individual enrolled in a non-managed care plan. They use data from two different household surveys in 1996. The Medical Expenditure Panel Survey was a panel design study with interviews occurring over a two and a half year period to survey individuals about their medical expenditures, utilization, and demographics. The Community Tracking Study sampled 51 metropolitan areas and 9 non-metropolitan areas to ask households about their enrollment in managed care plans. Their findings are contradictory to the theory of SID, which would assume that patients in indemnity plans have more visits to the doctor because their physician induces demand for his or her services. This may imply that managed care plans do not actually improve efficiency in our economy after all.

Studies looking at the existence of SID are still being performed today, as no one study has found completely conclusive evidence to absolutely prove its existence. By looking at data and models from fifty-one previous studies of supplier-induced demand, Leonard, Stordeur, and Roberfroid (2009) assess the correlation between physician density and healthcare consumption. They show that the increase of healthcare consumption can be considered a normal effect of increased care availability in regions with a previously low physician density and unmet health needs, also known as the availability effect. However, they also conclude that an increase in physician density tends to lead to physician-induced demand. This follows our idea that increasing the physician density of a state may lead to inefficiencies and therefore inhibit the GDP growth in that state.

Melichar (2009) shows that physicians respond to financial incentives at the margin. He uses data from a survey of 1,226 office-based physicians about reasons for office visits they conduct, tests ordered, diagnosis, and medications prescribed for about 30 patients of each physician. He finds that physicians with capitated managed care contracts make treatment decisions that are consistent with profit maximization. If a lack of incentive to consider marginal costs leads non-capitated physicians to over-provide medical care, capitation may lead doctors to eliminate unnecessary services without affecting health outcomes. This implies that there are ways (such as changing the structure of payment to the physician) to prevent inefficiencies from occurring in healthcare without compromising the health of the patients.

As mentioned above, one aspect of supplier-induced demand that has not received much attention is the efficiency impact of SID on the economy as a whole. In other words, there is a shortage of findings about the consequences and outcomes of physicians inducing demand for their services from patients who may not have the medical knowledge to say no to an unnecessary treatment. Much of the literature regarding SID focuses on the amount of inducement or if supplier-induced demand actually exists at all, rather than looking at the end result. The net social benefit of SID has not yet been explored in full detail. Studying the correlation between physician density and the growth of GDP may help to determine if there are any negative financial consequences of supplier-induced demand on society. This will help to show whether or not physicians are efficient, and, if not, whether or not their inefficiencies have a significant impact on the economy overall. This study shows that SID does have a negative impact on the growth of the economy in the states of the United States at some level of physicians per capita.

NOTE: A number of studies have been done internationally on SID, particular in the United Kingdom, Norway, and Australia. The results of these studies are not completely applicable to SID in the United States due to the different designs of healthcare systems in these countries.

However, these studies are notable because they have used a variety of methods to study and evaluate the concept of SID. Following is a brief summary of the findings of these studies.

Birch (1988) finds considerable support for evidence of SID in the United Kingdom, as patients in areas with a plentiful supply of dentists received considerably more services.

Grytten, Carlsen, and Sorensen (1993) look at primary care physicians in Norway and find no evidence of inducement with respect to physician-initiated visits. However, they do find evidence of inducement for laboratory tests in Norway.

Carlsen and Grytten (1998) find no evidence for inducement of doctor visits or laboratory tests in Norway. They find that the number of visits and revenue from lab tests per physician are lower in physician dense areas than in physician scarce areas, which could indicate that physicians don’t generate more demand for their services as competition increases. They did, however, find that the population health status was slightly better in municipalities with a lower number of doctor visits and smaller revenue generated from laboratory tests.

Sorensen and Grytten (1999) look at physicians in Norway and show a greater incentive for a physician to induce demand if the physician is paid on a fee-based system. They also find that greater competition will provide more of an incentive to exploit this system for physicians.

Grytten and Sorensen (2000) study SID for primary care physicians in Norway and look at fee-for-service versus salaried physicians. They find that neither of the two groups increased their visit output as a response to increase in physician density. This shows no evidence for SID in Norway.

Richardson (2001) showed that fee-for-service doctors in Australia scheduled almost 30% more return visits than physicians paid on a salary basis.

Frank, Glazer, and McGuire (2000) explain that health plans paid by capitation have an incentive to distort the quality of services they offer to attract profitable and deter unprofitable enrollees.

Peacock and Richardson (2007) show that the impact of SID may become stronger as the supply of physicians rises.

EMPIRICAL MODEL

This study uses an economic growth equation to model the relationship between physicians per capita and gross domestic product (GDP) in all fifty states. The model is tested for 14 different 3-year periods from 1973-2009. This analysis is largely based on Harold Brumm's (1999) empirical model. Brumm's model is designed to explain economic growth among U.S. states.

To test for the robustness of the results, several specifications of the model are examined. The various economic growth models include time-fixed and state-fixed effects for all equations. Each equation uses economic growth as the dependent variable, and a panel data set of all fifty states is used. Both ordinary-least squares (OLS) and two-stage least squares (2SLS) methods are employed when estimating the models.

More specifically, we test for a direct or inverse relationship between the current number of physicians per 100,000 residents of a state, CPHYS, and the rate of economic growth in a particular state over the next three years, YGR. However, other variables are included in the model to account for various factors that may influence economic growth within the state during that same time period. The estimation equation takes the following general form:

YGR = f(LOG(PCCGDP), POPGR, ED, INVEST, ESCTAX, CPHYS) (1)

where LOG(PCCGDP) = logarithm of state GDP per capita in the base year, POPGR = population growth over the next three years, ED = level of education in the base year, INVEST = level of public investment spending in the base year, and ESCTAX = effective state corporate tax rate in the base year.

The state's initial per-capita GDP is included in the estimation equation (Brumm, 1999). This is because the neoclassical growth model predicts the conditional convergence hypothesis, which means that a state with initially low GDP will grow at a faster rate than states with an initially higher GDP, all other variables held constant (Brumm, 1999). As such, a negative coefficient should be found on this variable. However, the convergence may be shaped by other factors that influence both the patterns of convergences and state growth rates (Tomljanovich, 2004). Additionally, GDP is measured on a per-capita basis to take into account population movements (Tomljanovich, 2004).

The state's population growth rate is also included in the estimation equation (Brumm, 1999). Here, however, we specify population growth over the next three years rather than past growth to control for the possibility that physician density may be high in areas where population is expected to grow rapidly. The neoclassical model normally predicts that an increase in the rate of population growth will reduce the rate of economic growth because society shifts its savings from capital to children (Brumm, 1999). However, if population growth captures the movement of labor from one state to another, the empirical analysis may uncover a direct relationship between these two variables.

Human capital differences across states are also included in the model as education. For example, Barro (1992) finds that countries starting with a higher level of educational attainment grow faster for a given level of initial per capita GDP. Brumm (1999) includes the percentage of the population with at least twelve years of schooling as a measure of human capital. Mankiw, Romer, and Weil (1992) measure human capital by the percentage of the working-age population that is in secondary school. They find that including human capital in a growth equation may help to more accurately measure the impact of physical-capital accumulation and population growth on economic growth and may result in a more precise estimate. While years of schooling may have provided an accurate account for human capital, these data are not available at the state level for the years included in this study. Thus, we follow Hickman and Olney (2010) who use enrollment in higher education as a measure of human capital.

Following Brumm (1999), state investment on infrastructure is included in the model. State investment spending includes expenditures directed towards maintaining existing infrastructure and building new infrastructure. These types of expenditures can have an impact on growing the economy. There are multiple measures of state spending on infrastructure available, such as health, employment, corrections, etc. While spending on education is usually included in this, this measure was already included when measuring human capital. We focus here on four main types of state spending on infrastructure – highways, police, public welfare, and natural resources. Munnell (1992) suggests included spending on highways as they help to efficiently transport goods and transport people to their jobs in the labor market. Well-kept highways are important as well. Police is included as a measure of safety. This spending will most likely have a positive effect on economic growth.

The “burden of the state’s tax structure” is also included (Brumm, 1999). This is because as states impose higher tax rates to fund government consumption, there is less money available in the private sector and therefore economic growth is slowed (Brumm, 1999). However, the magnitude of these effects is still up for debate, and the effects may be only temporary

(Tomljanovich, 2004). The burden of the state's tax structure is measured by using the highest non-financial corporate tax rate in the state, adjusted for federal deductibility.

The main independent variable under consideration is the current ratio of physicians per 100,000 residents. The sign of the estimated coefficient on this variable identifies if physicians help increase (positive sign) or slow (negative sign) the growth of the economy. A positive coefficient estimate on physician density would reflect the finding that physicians contribute to economic growth by keeping people healthy and productive. In contrast, a negative coefficient estimate indicates too many physicians and demand inducement.

SAMPLE AND DATA SOURCES

This study examines how the number of physicians influences the 3-year economic growth rate of all 50 states for 14 different time periods over the years from 1973 to 2009. Three-year growth rates are used to even out swings in the business cycle. The 14 different time periods allow for four different base years of analysis during each full decade (e.g., 1980-1983, 1983-1986, 1986-1989, and 1989-1992). The time period under investigation begins in 1973 and ends in 2009 because data for some of the variables are unavailable either before or after those dates. These years allow us to test how economic growth relates to the number of physicians separately for the decades of the 1970s, 1980s, 1990s, and 2000s, with a particular focus on the 1990s as the main period of managed care in the United States health insurance market. If for a particular year data are not available for a specific variable, a figure is interpolated. For example, if the data for the corporate tax rate are not available for 1976, the data from the years 1975 and 1977 are averaged.

Gross domestic product information came from the Bureau of Economic Analysis and is measured in current dollars. Population data are obtained from the Bureau of the Census and is estimated for intercensal years by using the population estimate as of July 1. The data for the rate of physicians per 100,000 residents are found in the *Statistical Abstract of the United States*, which is published every year. Each population estimate was based on census data for July of that year. Enrollment in higher education (both public and private) was also obtained from the *Statistical Abstract of the United States*. Data for state spending on infrastructure are obtained from the *Book of the States*, which is published every year or two. These measures include spending on highways, public welfare, natural resources, and police. Corporate tax data was also found in the *Book of the States*. The highest non-financial rate for each state was taken and then adjusted for federal deductibility. Descriptive statistics and data sources are provided in Table 1 for all of the variables used in the estimation equation.

EMPIRICAL RESULTS

The objective of this thesis is to determine if the number of physicians increases or slows the growth of a state economy. As such, it is crucial that other factors are held constant so we can isolate a cause and effect relationship between these two variables. With that goal in mind, note that equation (1) holds constant state GDP per capita, future population growth, education, public investment spending, and the effective state corporate tax rate. However, some omitted immeasurable factors may influence both the number of physicians per capita and the growth of the state economy. If so, this unobservable heterogeneity may result in endogeneity bias and thus, at best, we can only draw inferences about association among and not causation between these two variables.

Given this potential endogeneity problem, all specifications involving equation (1) include state- and time-fixed effects. Specification of these fixed effects helps to control for any time-invariant omitted variables. In another specification, we also include individual state time trends. The individual state time trends should capture any omitted variables trending over time that simultaneously influence both the number of physicians and state economic growth. In yet another specification, equation (1) is estimated using the two-stage least square (2SLS) technique along with both fixed effects and the individual state time trends.

As an instrumental variable in the 2SLS analysis, we include the physician-to-population ratio three years prior. Several studies including Evans, Froeb and Werden (1993), Davis (2005), and Bates, Hilliard, and Santerre (2012) have used a lagged measure of market concentration as an instrument. Murray (2006) notes that analysts sometimes use long lags of potential instruments on the basis that longer lags reduce any correlation between the instrument and the disturbances in the error term of the original ordinary least squares regression. However, he points out that more distant lags are also more likely to be weakly correlated with the troublesome suspected endogenous variable. Given this trade-off, the three-year lagged value of the physician-to-population ratio seems to be appropriate.

Table 2 shows the multiple regression results of the linear relationship between the number of physicians and economic growth from 1973-2009. Here, the dependent variable used was state GDP growth over the next three years for each of the 14 base years. The first column shows the independent variables and the specifications for each equation (such as the inclusion of time-fixed effects). Standard errors are clustered at the state level for all equations. Clustering makes all standard errors fully robust against arbitrary heteroskedasticity and serial correlation (Wooldridge, 2002).

The second column in Table 2 shows the results of the first ordinary-least squares model. The coefficient of determination (the adjusted R^2 value) is 0.69, so approximately 69% of the variation in economic growth can be attributed to the factors included in the model. According to the regression results, the number of physicians per capita has a direct effect on the growth of GDP. Its estimated coefficient is found to be statistically significant at the one percent level. This finding implies that physicians contribute positively to economic growth at the margin. Specifically, if the number of physicians increases by one more per 100,000 people, the rate of economic growth increases by 0.024 percentage points.

In terms of the control variables, state GDP per capita has an inverse effect on economic growth due to the convergence hypothesis explained above, and the estimated coefficient on this variable is statistically significant. The estimated coefficient on population growth is also statistically significant, meaning that population growth has a positive effect on economic growth. This means that the more population grows, the higher the GDP in that state will grow (this is contradictory to Brumm's findings that positive population growth will actually have a negative effect on the growth of GDP). Education is not found to have a statistically significant effect on economic growth, likely because of the way it is measured. The effect of public investment spending is found to have a negative effect on economic growth and its coefficient estimate is statistically significant. On average, states may not be effectively investing public money. The effective state corporate tax rate is found to have a negative but not statistically significant effect on economic growth in this first specification.

The third column in Table 2 shows the results of the second OLS model. Unlike the first model, this equation also includes individual state time-trends. The coefficient of determination (the adjusted R^2 value) is 0.733, so approximately 73% of the variation in economic growth can be attributed to the factors included in the model. The number of physicians is again found to have a positive effect on the growth of GDP and its estimated coefficient is found to be statistically significant at the one percent level. The estimated coefficient of 0.038 suggests an even larger effect than the one shown in column 2, although it is less precisely estimated.

The fourth column in Table 2 shows the results from the 2SLS model that also includes state- and time-fixed effects and individual state time trends.[1] The number of physicians is found to have a positive effect on the growth of GDP with an estimated coefficient of 0.059. However, its coefficient is even less precisely estimated than for the first two regression models.

The less precisely estimated coefficient on the physician to population ratio in the fourth column of Table 2 led us to experiment with a nonlinear relation. Table 3 shows the multiple regression results of the nonlinear relationship between the number of physicians and economic growth using data from 1973 to 2009. The second column shows the OLS model with both fixed effects and individual state time trends. Note that the coefficient estimate on the linear term is positive and the coefficient estimate on the squared term is negative. This means that physicians per capita has an inverted-U effect on the rate of economic growth. This inverted U-effect shows up even under 2SLS estimation as reported in column 3. In both cases, the results for the control variables remain qualitatively the same.

Lastly, Table 4 shows the multiple regression results of the nonlinear relationship between the number of physicians and economic growth using data from 1973 to 2000. This excludes 2001-2009 because after the year 2000, the *Physician Characteristics and Distribution in the United States* publication by the American Medical Association, where the *Statistical*

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[1] First-stage results are shown in the second column of Appendix 1. Note that the instrument (3-year lagged physician to population ratio) possesses a positive coefficient estimate which is statistically significant.

Abstract of the United States obtains its physician per capita data, began measuring physician totals by state in a different way. Prior to 2001, physicians in each state were measured as total active, non-federally employed physicians. However, beginning in 2001, the physician totals began to include federally employed physicians. This meant that the number of physicians per capita in each state might be artificially higher than previous years due to this change in measurement. However, even after excluding the data from 2001 onward, we still find the effect of physicians per capita to be positive and statistically significant.

Figure 1 shows the simulated relationship between the number of physicians per 100,000 and economic growth using the estimated equation from column 3 in Table 3. According to the figure, the maximum economic growth rate occurs when the typical state possesses about 341 physicians per 100,000 residents. According to our data, only 25 state-year observations had a physician to population ratio in excess of 341. These state-year observations likely reflect a large number of specialists relative to primary care physicians. Unfortunately, data on the number of specialists by year and state are unavailable to test if that is the case.

SUMMARY AND CONCLUSION

The analysis shows a clear and statistically significant relationship between the number of physicians per capita in the U.S. states and the growth of state GDP for the years tested. These findings thus reveal the overall efficiency of healthcare (more specifically, the efficiency of physicians themselves) and their impact on the United States economy. If physicians are efficient and keep the population healthy, the economy will grow – which may be true, as shown by our results. In this case, if most states are operating at an ideal level of physicians per capita, supplier-induced demand may not be a factor for healthcare in the United States, and we may be operating with a very efficient healthcare system in terms of how well it fosters the growth of the economy.

However, as shown by Figure 1, there is a limit to the efficient number of physicians. As shown above, too many physicians per capita may lead to increased competition in the healthcare industry and may therefore result in supplier-induced demand. If supplier-induced demand is inefficient because it leads to wasted resources, this will have a negative impact on the economy and may slow economic growth. The peak of the curve on Figure 1 lies at 341 physicians per 100,000 residents of a state. If the physician per capita level is lower than this number, the economy grows with the addition of more physicians to the healthcare system in the typical state. However, after the number of physicians per 100,000 residents reaches 341, the economic growth of the state slows.

One downside to this study is that we did not address the differences between primary care physicians and specialists in each state. Studies such as Starfield et al (2005) have found that primary care physicians are more effective at lowering overall mortality rates for common conditions than specialists, which may mean that primary care physicians are more efficient than specialists. Looking further at the effect of specialists per capita on GDP growth as compared to the effect of primary care physicians per capita on GDP growth may find a different outcome for specialists than for primary care physicians. Examining the different effects of specialist and primary care doctors on the growth of the economy would be a fruitful extension of this analysis.

This study may have larger implications for the number of physicians allowed to practice in each state based on the state's population. If a state allows too many physicians to practice medicine, the economy of the state may be harmed due to inefficiencies from healthcare such as supplier-induced demand. Some states in particular years in this study were operating with more than 341 physicians per 100,000 residents. This may raise the case for reducing the number of physicians practicing in those states if they are still operating with more than the optimal number of physicians. Similarly, some states may be able to increase the number of physicians by a significant amount, and as a result this may improve economic growth in those states. The United States government may need to look into the issue of physician density and possibly utilize healthcare reform to change the distribution of physicians. This may stimulate economic growth by reducing inefficiencies like supplier-induced demand in the healthcare system and by promoting the most efficient healthcare practices to cut down costs and eliminate unnecessary expenditures.

REFERENCES

Baicker, Katherine and Amitabh Chandra. “Medicare Spending, The Physician Workforce, and Beneficiaries’ Quality of Care.” *Health Affairs* W4 (2004): 184-197.

Barro, Robert. “Human Capital and Economic Growth.” *Federal Reserve Bank of Kansas City* (1992): 199-230.

Bates, Laurie, James Hilliard, and Rexford Santerre. “Do Health Insurers Possess Market Power?” *Southern Economic Journal* (forthcoming 2012).

Birch, Stephen. “The Identification of Supplier-Inducement in a Fixed Price System of Health Care Provision.” *Journal of Health Economics* 7 (1988): 129-150.

Brumm, Harold. “Rent Seeking and Economic Growth: Evidence from the States.” *The Cato Journal* 19 (1999): 7-16.

Calcott, Paul. "Demand Inducement as Cheap Talk." *Health Economics* 8 (1999): 721-733.

Carlsen, Fredrik and Jostein Grytten. “More Physicians: Improved Availability or Induced Demand?” *Health Economics* 7 (1998): 495-508.

Chandra, Amitabh and Douglas Staiger. “Testing a Roy Model with Spillovers: Evidence from the Treatment of Heart Attacks.” *National Bureau of Economic Research*, Working Paper no. 10811 (October 2004).

Cutler, David. "How Health Care Reform Must Bend the Cost Curve." *Health Affairs* 29 (2010): 1131-1135.

Cutler, David and Mark McClellan. “Is Technological Change in Medicine Worth It?” *Health Affairs* 20 (2001): 11-29.

Cutler, David, Mark McClellan, and Joseph Newhouse. “How Does Managed Care Do It?” *RAND Journal of Economics* 31 (2000): 526-548.

Davis, Peter. “The Effect of Local Competition on Admission Prices in the U.S. Motion Picture Exhibition Market.” *Journal of Law and Economics* 48 (2005): 677-708.

Deb, Partha, Chenghui Li, Pravin Trivedi, and David Zimmer. “The Effect of Managed Care on Use of Health Care Services: Results From Two Contemporaneous Household Surveys.” *Health Economics* 15 (2006): 743-760.

Evans, David B., Ajay Tandon, Christopher Murray, and Jeremy A. Lauer. "The Comparative Efficiency of National Health Systems in Producing Health: An Analysis of 191 Countries." *World Health Organization GPE Discussion Paper Series* No. 29 (2001).

Evans, Robert G. "Supplier-Induced Demand: Some Empirical Evidence and Implications." *The Economics of Health and Medical Care*. Ed. Mark Perlman. New York: Halsted, 1974: 162-173.

Evans, William N., Luke M. Froeb, and Gregory J. Werden. “Endogeneity in the Concentration-Price Relationship: Causes, Consequences and Cures.” *The Journal of Industrial Economics* 41 (1993): 431–438.

Farley, Pamela. “Theories of the Price and Quantity of Physician Services.” *Journal of Health Economics* 5 (1986): 315–333.

Feldstein, Martin S. “The Rising Price of Physician’s Services.” *The Review of Economics and Statistics* 52 (1970): 121-133.

Frank, Richard, Jacob Glazer, and Thomas McGuire. “Measuring Adverse Selection in Managed Health Care.” *Journal of Health Economics* 19 (2000): 829-854.

Friesner, Dan and Chris Stevens. “Ownership and Rent-Seeking Behavior in Specialty Health Care Practices.” *Economics Bulletin* 9 (2007): 1-14.

Fuchs, Victor R. “The Supply of Surgeons and the Demand for Operations.” *The Health Economy*. Ed. Victor Fuchs. Cambridge, Massachusetts: Harvard University Press, 1986: 126-147.

Fuchs, Victor R. and Marcia J. Kramer. “Determinants of Expenditures for Physicians’ Services.” *The Health Economy*. Ed. Victor Fuchs. Cambridge, Massachusetts: Harvard University Press, 1972: 67-107.

Gerdtham, Ulf-G., and Michael Lothgren. "Health System Effects on Cost-Efficiency in the OECD Countries." *Applied Economics* 33 (2001): 643-647.

Glied, Sherry and Joshua Zivin. “How Do Doctors Behave When Some (But Not All) of Their Patients Are In Managed Care?” *Journal of Health Economics* 21 (2002): 337-353.

Goodman, David C., and Kevin Grumbach. "Does Having More Physicians Lead to Better Health System Performance?" *The Journal of the American Medical Association* 299 (2008): 335-337.

Grubaugh, Stephen G., and Rexford E. Santerre. "Comparing the Performance of Health Care Systems: An Alternative Approach." *Southern Economic Journal* 60 (1994): 1030-1042.

Grytten, Jostein and Rune Sorensen. “Type of Contract and Supplier-Induced Demand for Primary Physicians in Norway.” *Journal of Health Economics* 20 (2001): 379-393.

Grytten, Jostein, Fredrik Carlsen, and Rune Sorensen. “Supplier Inducement In a Public Health Care System.” *Journal of Health Economics* 14 (1995): 207-229.

Hay, Joel and Michael J. Leahy. "Physician-Induced Demand – An Empirical Analysis of the Consumer Information Gap." *Journal of Health Economics* 1 (1982): 231-244.

Hickman, Daniel and William Olney. "Globalization and Investment in Human Capital." *Industrial and Labor Relations Review* 64 (2011).

Hirth, Richard and Michael Chernew. "The Physician Labor Market in a Managed Care Dominated Environment." *Economic Inquiry* 37 (1999): 282-294.

Jaegher, Kris and Marc Jegers. "A Model of Physician Behavior With Demand Inducement." *Journal of Health Economics* 19 (2009): 231-258.

Klein, Ezra. "Does Health-Care Reform Bend the Cost Curve Up?" *The Washington Post*: 10 September 2010. Web. <http://voices.washingtonpost.com/ezra-klein/2010/09/does_health-care_reform_bend_t.html>.

Labelle, Roberta, Greg Stoddart, and Thomas Rice. "A Re-examination of the Meaning and Importance of Supplier-Induced Demand." *Journal of Health Economics* 13 (1994): 347-368.

Leonard, Christian, Sabine Stordeur, and Dominique Roberfroid. "Association Between Physician Density and Health Care Consumption: A Systematic Review of the Evidence." *Health Policy* 91 (2009): 121-134.

Lindrooth, Richard, Edward Norton, and Barbara Dickey. "Provider Selection, Bargaining, and Utilization Management in Managed Care." *Economic Inquiry* 40 (2002): 348-366.

Magee, Stephen P. "How Many Lawyers Ruin an Economy?" *Wall Street Journal*, New York: 24 September 1992.

Mankiw, M. Gregory, David Romer, and David Weil. "A Contribution to the Empirics of Economic Growth." *The Quarterly Journal of Economics* 107 (1992): 407-437.

Melichar, Lori. "The Effect of Reimbursement on Medical Decision Making: Do Physicians Alter Treatment in Response to a Managed Care Incentive?" *Journal of Health Economics* 28 (2009): 902-907.

Munnell, Alicia H. " Policy Watch: Infrastructure Investment and Economic Growth." *The Journal of Economic Perspectives* 6 (1992): 189-198.

Murray, Michael P. "Avoiding Invalid Instruments and Coping with Weak Instruments." *Journal of Economic Perspectives* 20 (2006): 111-132.

Newhouse, Joseph P. "A Model of Physician Pricing." *Southern Economic Journal* 37 (1970): 174-183.

O'Malley, Patrick G. and Ann S. O'Malley. "Studies Comparing Quality of Care by Specialty." *Arch Intern Med* 167 (2007): 8-9.

Or, Zeynep, Jia Wang, and Dean Jamison. "International Differences in the Impact of Doctors on Health: A Multilevel Analysis of OECD Countries." *Journal of Health Economics* 24 (2005): 531-560.

Pauly, Mark. "Editorial: A Re-examination of the Meaning and Importance of Supplier-Induced Demand." *Journal of Health Economics* 13 (1994): 369-372.

Peacock, Stuart and Jeff Richardson. "Supplier-Induced Demand: Re-examining Identification and Misspecification in Cross-Sectional Analysis." *The European Journal of Health Economics* 8 (2007): 267-277.

Reinhardt, Uwe. "The Theory of Physician-Induced Demand: Reflections After a Decade." *Journal of Health Economics* 4 (1985): 187-193.

Retzlaff-Roberts, Donna, Cyril F. Chang, and Rose M. Rubin. "Technical Efficiency in the Use of Health Care Resources: A Comparison of OECD Countries." *Health Policy* 69 (2004): 55-72.

Richardson, Jeffrey. "Supply and Demand for Medical Care: Or, Is the Health Care Market Perverse." *Centre for Health Program Evaluation* (2001): Working Paper 123.

Santerre, Rexford E., and Stephen P. Neun. *Health Economics - Theory, Insights, and Industry Studies*. United States: South-Western, Cengage Learning, 2010.

Sepulveda, Martin J., Thomas Bodenheimer, and Paul Grundy. "Primary Care: Can It Solve Employers' Health Care Dilemma?" *Health Affairs* 27 (2008): 151-158.

Skinner, Jonathan, Douglas Staiger, and Elliot Fisher. "Is Technological Change in Medicine Always Worth It? The Case of Acute Myocardial Infarction." *Health Affairs* 25 (2006): 34-47.

Smetana, Gerald W., Bruce E. Landon, Andrew B. Bindman, Helen Burstin, Roger B. Davis, Jennifer Tija, and Eugene C. Rich. "A Comparison of Outcomes Resulting From Generalist vs Specialist Care for a Single Discrete Medical Condition." *Arch Intern Med* 167 (2007): 10-20.

Sorensen, Rune and Jostein Grytten. "Competition and Supplier-Induced Demand in a Health Care System with Fixed Fees." *Health Economics* 8 (1999): 497-508.

Stano, Miron. "Do HMOs Promote Efficient Treatment Alternatives?" *Business Forum* (1997): 45-51.

Starfield, Barbara, Leiyu Shi, and James Macinko. "Contribution of Primary Care to Health Systems and Health." *The Milbank Quarterly* 83 (2005): 457-502.

Starfield, Barbara, Leiyu Shi, Atul Grover, and James Macinko. "The Effects of Specialist Supply on Populations' Health: Assessing the Evidence." *Health Affairs* W5 (2005): 97-107.

Sweeney, George H. "Determinants of Physicians' Earnings: An Empirical Test of the Target Income Model." Vanderbilt University, 1980.

Sweeney, George H. “The Market for Physicians' Services: Theoretical Implications and an Empirical Test of the Target Income Hypothesis.” *Southern Economic Journal* 48 (1982): 594-613.

Tomljanovich, Mark. “The Role of State Fiscal Policy in State Economic Growth.” *Contemporary Economic Policy* 22 (2004): 318-330.

Wooldridge, J.M. “Econometric Analysis of Cross Section and Panel Data.” Cambridge, Massachusetts: The MIT Press, 2002.

Table 1: Descriptive Statistics and Data Sources

	Mean	**Maximum**	**Minimum**	**Std. Dev.**	**Data Source**
Growth of State GDP per capita	5.33	23.52	-9.06	3.05	1
State GDP Per Capita	22260.14	66422.67	4493.21	12032.34	1
Population Growth	0.03	0.20	-0.08	0.03	2
Education (College Enrollment as a percent of State Population)	5.31	9.16	2.67	1.00	3
Public Investment Spending per capita	800.94	4324.39	127.11	564.41	4
Effective State Corporate Tax Rate	0.06	0.14	0.00	0.03	4
Physicians Per 100,000 population	199.46	462.00	90.00	61.43	3

1. Bureau of Economic Analysis
2. Bureau of the Census
3. Statistical Abstract of the United States
4. Book of the States

Table 2: Multiple Regression Results of the Linear Relationship Between Number of Physicians and Economic Growth, 1973-2009

	Dependent Variable: State GDP Growth over the Next 3 Years		
Independent Variables	Estimated Coefficient (t-statistic)		
Constant	138.080*** (12.97)	147.102*** (5.41)	133.751*** (4.55)
State GDP Per Capita	-13.878*** (-12.97)	-20.137*** (-16.58)	-20.063*** (-16.49)
Population Growth	41.091*** (9.49)	42.254*** (9.90)	41.157*** (9.37)
Education	0.070 (0.29)	-0.148 (-0.42)	-0.112 (-0.33)
Public Investment Spending	-0.002*** (-4.25)	-0.001 (-1.54)	-0.002* (-1.76)
Effective State Corporate Tax Rate	-12.850 (-1.15)	-27.934** (-1.99)	-29.742** (-2.11)
Physicians Per 100,000 Population	**0.024*** (3.30)**	**0.038** (2.27)**	**0.059* (1.86)**
Time Fixed Effects	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes
Individual State Time Trends	No	Yes	Yes
Two-Stage Least Squares	No	No	Yes
Adjusted R^2	0.690	0.733	0.732
Number of Observations	700	700	700

1. One, two, and three asterisks indicate statistical significance at the 10, 5, and 1, percent levels, respectively.
2. Standard errors clustered at the state level.

Table 3: Multiple Regression Results of the Non-Linear Relationship Between Number of Physicians and Economic Growth, 1973-2009

	Dependent Variable: State GDP Growth over the Next 3 Years	
Independent Variables	Estimated Coefficient (t-statistic)	
Constant	1.454 (0.02)	-180.034** (-2.00)
State GDP Per Capita	-20.276*** (-17.60)	-20.275*** (-17.42)
Population Growth	40.773*** (9.81)	36.920*** (8.36)
Education	-0.287 (-0.84)	-0.362 (-1.04)
Public Investment Spending	-0.001 (-1.89)	-0.001 (-1.48)
Effective State Corporate Tax Rate	-28.642** (-2.12)	-33.164** (-2.37)
Physicians Per 100,000 Population	**0.130*** (3.37)**	**0.273*** (4.01)**
(Physicians Per 100,000 Population)^2	**-0.0002*** (-2.70)**	**-0.0004*** (-3.76)**
Time Fixed Effects	Yes	Yes
State Fixed Effects	Yes	Yes
Individual State Time Trends	Yes	Yes
Two-Stage Least Squares	No	Yes
Adjusted R^2	0.739	0.726
Number of Observations	700	700

1. One, two, and three asterisks indicate statistical significance at the 10, 5, and 1, percent levels, respectively.
2. Standard errors clustered at the state level.

Table 4: Multiple Regression Results of the Non-Linear Relationship Between Number of Physicians and Economic Growth, 1973-2000

	Dependent Variable: State GDP Growth over the Next 3 Years
Independent Variable	Estimated Coefficient (t-statistic)
Constant	-618.062** (-2.08)
State GDP Per Capita	-21.213*** (-14.03)
Population Growth	27.175*** (3.36)
Education	-0.343 (-0.76)
Public Investment Spending	-0.005** (-2.42)
Effective State Corporate Tax Rate	-40.107** (-2.176)
Physicians Per 100,000 Population	**0.536**** **(2.53)**
(Physicians Per 100,000 Population)^2	**-0.0007***** **(-3.24)**
Time Fixed Effects	Yes
State Fixed Effects	Yes
Individual State Time Trends	Yes
Two-Stage Least Squares	Yes
Adjusted R^2	0.631
Number of Observations	550

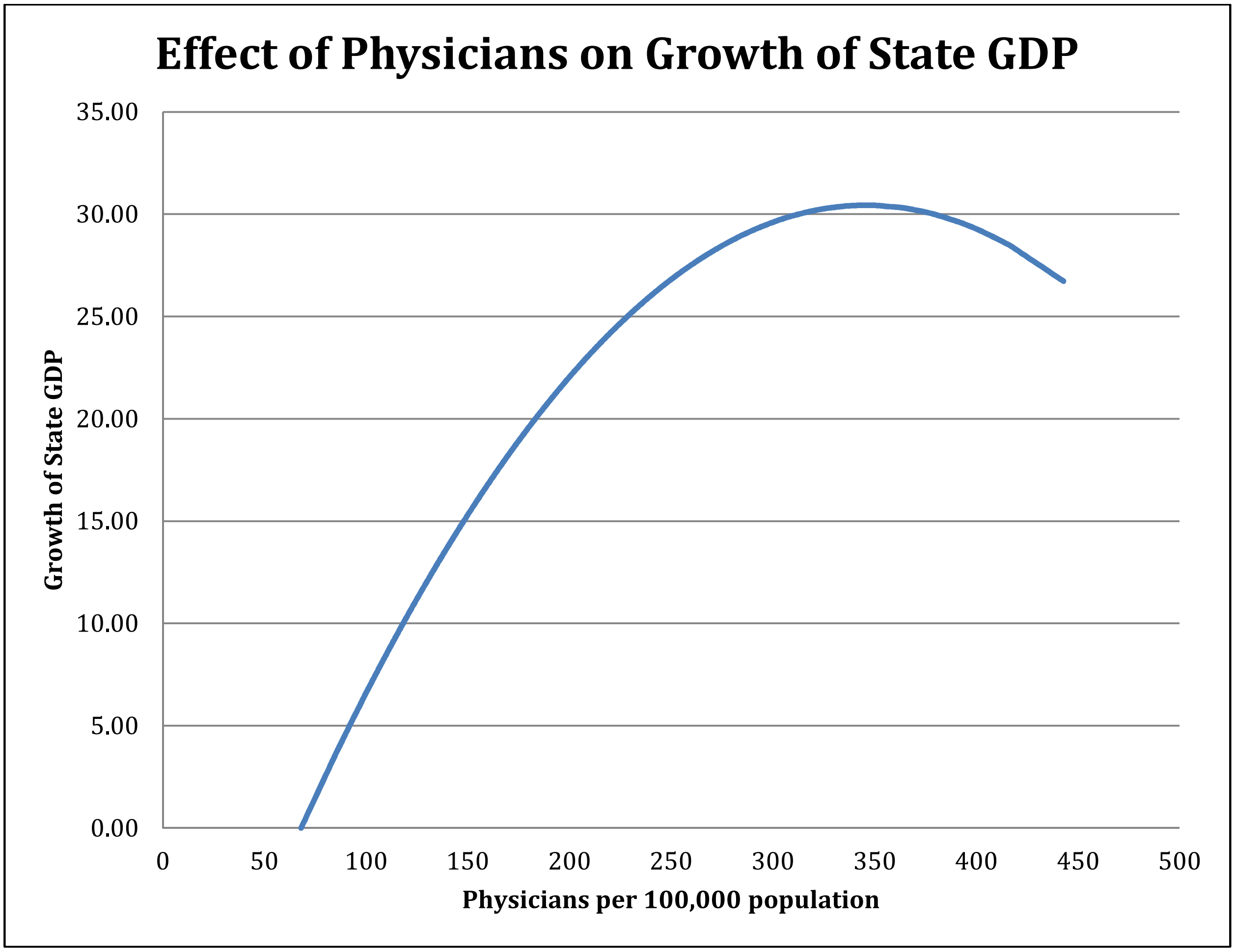
1. One, two, and three asterisks indicate statistical significance at the 10, 5, and 1, percent levels, respectively.
2. Standard errors clustered at the state level.

Appendix – Table 1 –First-stage Results for the Relationship between the Number of Current Physicians per Capita and 3-Year Lagged Measure of Physician Density

	Estimated Coefficient (t-statistic)			
Dependent Variable	Current Physicians	Current Physicians^2	Current Physicians	Current Physicians^2
Constant	112.927*** (2.70)	27306.990 (1.53)	364.543*** (4.42)	-245966.100*** (-5.53)
State GDP Per Capita	-8.718** (-2.02)	-2630.605 (-1.46)	-11.624*** (-2.79)	-4472.784** (-2.30)
Population Growth	53.048*** (3.52)	15951.32*** (2.59)	50.335*** (3.78)	16975.780*** (2.86)
Education	-0.349 (-0.45)	-257.923 (-0.80)	-0.913 (-0.88)	-611.456 (-1.26)
Public Investment Spending	0.006*** (3.18)	2.362*** (2.75)	0.008*** (2.59)	3.551** (2.25)
Effective State Corporate Tax Rate	45.546 (1.07)	22733.130 (1.37)	73.907* (1.67)	33496.030 (1.62)
Previous Physicians Per 100,000 Population	**0.869*** (30.67)**	n/a	**0.383*** (8.34)**	n/a
(Previous Physicians Per 100,000 Population)^2	n/a	**1.007*** (59.04)**	n/a	**0.532*** (10.90)**
Time Fixed Effects	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes
Individual State Time Trends	No	No	Yes	Yes
Adjusted R^2	0.990	0.990	0.993	0.993
Number of Observations	700	700	700	700

1. One, two, and three asterisks indicate statistical significance at the 10, 5, and 1, percent levels, respectively.
2. Standard errors clustered at the state level.

Figure 1


Effect of Physicians on Growth of State GDP
Growth of State GDP
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0
50
100
150
200
250
300
350
400
450
500
Physicians per 100,000 population