Impact of the Dialysis Industry on Kidney Transplants

by

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Abstract

The aim of this paper is to examine the impact of the kidney dialysis industry on the kidney transplants, both cadaveric and living. This particular topic has not been addressed in formal research dealing with the organ shortage. The intent is to examine the various aspects of the dialysis industry and the relation to transplantation. A cross sectional analysis is used to examine this relationship

Acknowledgments

To my friends and family; your impact may not be known or visible, but I assure you that it has been substantial. I thank everyone that guided me through my education. Dr. Finck and Dr. Ault for sparking an interest in economics. Those helping with this thesis directly: Dr. Beard for the inspiration of this topic, Dr. Jackson for guidance with the empirical aspects, and Dr. Beil for advice and guidance through graduate school.

Table of Contents

List of Tables

List of Illustrations

List of Abbreviations

CON	Certificate of Need
ESRD	End Stage Renal Disease Program
HCFA	Health Care Financing Administration
NOTA	National Organ Transplant Act
UNOS	United Network for Organ Sharing

Introduction

The topic of this thesis is whether the structure of the dialysis industry decreases the incentive of transplant hospital to perform kidney transplants, both cadaveric and living. The National Organ Transplant Act of 1984 (NOTA), place restrictions on compensation for organ donation. The structure of third party payment and reimbursement in the dialysis industry raises the question as to the disincentive exists in regard to performing kidney transplants. Third party payments occur when a person receiving the good or service does not directly pay for said good or service. In this instance, dialysis is paid for up to eighty percent by the End Stage Renal Disease Program (ESRD), under the Health Care Financing Administration (HCFA) a part of Medicare (Barnett, Beard and Kaserman). The remainder of the fees are paid for by the individual or private insurance.

The focus of this thesis is primarily on the incentives of transplant hospitals to perform kidney transplants, both from cadaveric and living donors. The reason this is of interest is the apparent inefficiency of the current market, evidenced by the 95,000 individuals listed on the waiting list for kidney transplants according to the National Kidney Foundation's website. Kaserman and Barnett speculated that the regulated price of organs at zero is one of the largest factors contributing to the shortage. Others, primarily those opposed to donor compensation have argued the lack of education spending on organ donation is one of the largest problems causing the shortage (Beard et al. 2004). Testing and disproving this hypothesis was the point of analysis of Beard et al. and Lawson.

One factor that has been ignored is the impact of the dialysis industry on donation and transplantation. Speculation centers on the third party payment system in place with end stage renal treatment and vested interest of the hospitals and dialysis clinics. The hypothesis being

dialysis machines can theoretically keep a patient alive nearly indefinitely. In some sense, this could downplay the need for kidney transplants, ignoring quality of life issues. As people do not paying directly for transplants or dialysis, they lack market power to demand better care from the clinics or hospitals. Certain goods, allow consumers to protest, not purchase goods, or boycott to gain ground in causing changes. The nature of dialysis requires continuing treatments; the necessity of care limits the patient's ability to force change.

The goal of this work is not to paint a bad picture of the health care industry, nor is it meant to discredit those who work with renal patients. The end goal is to analyze how the incentives of the dialysis market impact the final out come, kidney transplants. The services are necessary and vital to patients and their families. Services rendered through the ESRD have benefitted countless people over the history of the program. The intent is to examine the incentives and market structure existing in the market to determine if these factors have a significant impact on the outcomes in the market for transplants. Primarily if the size of a dialysis clinic impacts the number of transplants performed, and if the hospital offering peritoneal dialysis impacts the number of transplants performed.

Some of the work is rehashed from the author's prior work with factors impacting cadaveric kidney donation. This particular analysis will focus on total kidney transplants rather than analyzing the source of the donation. The number of transplants is highly correlated, if not perfectly related to the number of cadaveric and living donations. Granted some organs are not transplanted due to loss or other complication, but a sizeable majority of organs donated are transplanted.

Kidneys and How They Work

To understand why kidney dialysis and transplants are necessary, one must have an understanding of how the kidneys work, and what may cause failure. A high level overview is warranted too elaborate on the basic operations of the kidneys.

The most simplistic explanation of the function and purpose of the kidneys is they are one of the body's filtering mechanisms. Healthy kidneys function to remove excess water and wastes, regulate chemical balance by releasing hormones, and assist in regulating blood pressure. Williams summarized the primary function of the kidneys as filtering and waste removal, everyday processing 200 quarts of blood in order to filter waste products and excess water amounting to two quarts.

Greene summarized the functional unit of the nephron as follows:

> *The nephron is the functional unit of the kidney, that is responsible for the actual purification and filtration of the blood. About one million nephrons are in the cortex of each kidney, and each one consists of a renal corpuscle and a renal tubule which carry out the functions of the nephron. The renal tubule consists of the convoluted tubule and the loop of Heinle .*

While this is a very elementary view of the kidney function, it is worth mentioning for clarity. Normally, a quotation of that length is not preferred, to prevent loss of clarity the direct quote was used. Discussion is limited to avoid bogging down in medical terminology and details not required to proceed with the analysis of the market structure and related industries.

Kidney Failure

The primary reason one would require transplant and or dialysis, would be kidney failure either acute or chronic. DaVita reports that once a person's kidney function has dropped below fifteen percent a person begins dialysis . There are several primary causes for the loss of function. The first being chronic kidney disease, this occurs when kidneys are no longer able to clean toxins and waste product from the blood and perform their functions to full capacity (Williams). Chronic kidney disease usually happens over an extended period of time the reduction of functionality happens over a period of time. Generally speaking there are two main factors that contribute kidney disease. The first being as a result or side effect of diabetes, 40% according to DaVita's website The second referenced by the aforementioned source being hyper tension, more commonly known as high blood pressure, which is often linked to diabetes.

When kidney function decreases suddenly, primarily due to a toxin or large blood loss, this is called acute kidney failure. In many cases with acute failure, kidney function recovers partially, sometimes completely. Often dialysis is a short-term treatment for these patients, providing functionality until one recovers. Dialysis in these instances is used to offer additional filtration to "give the kidneys a rest" and a chance to recover (Web Md). Treatment for acute kidney failure, does not necessarily impact those with chronic failure. It seems reasonable to assume some excess capacity may be maintained to handle these cases; however there should be no correlation between these cases and transplants. Possible issues regarding this possible surplus capacity come into play later, as it may contribute to incentives to not pursue transplantable organs.

When chronic failure occurs, the option of transplantation exists as a long-term solution, along with perpetual dialysis treatment. Several factors are looked at when determining candidacy for transplantation. The age of the recipient, health of patient aside from the kidney failure, quality of life if they received the transplant, ect. If one is put on the list, they will remain on dialysis treatment until a match is found or they are removed. With either case, a summarization of the process can be explained as follows. Once kidney function has reached a certain threshold, normally fifteen percent functionality, dialysis treatment begins. Depending on the situation, including the cause of failure and the general health of the individual, they may be placed on the waiting list for a kidney transplant, if they are suitable candidates. If placed on the transplant list, dialysis treatments will continue until a suitable transplant is procured. If a person is not placed on the list due to continued low functionality, dialysis treatment will continue indefinitely.

Dialysis for most is not preferable to transplantation. For some situations, particularly given the procurement shortages, it makes more sense for a patient to continue dialysis treatment. The elderly for example, may not be suitable for transplant as their health may have diminished to the point where transplantation is no longer considered, either for a short predicted lifespan and/or the predicted ability to recover from the transplantation. Given the current shortage, many “possible” candidates are not considered viable as transplant recipients.

THE WAITING LIST

One issue that increases the relevancy of the topic is the waiting list for kidney donations. At present there are 86,833 people on the waiting lists for kidney transplantation (Bregel). The number may be somewhat inflated as some people may be on multiple transplant lists, however the estimate is slightly higher than the estimates on the UNOS website. Removal

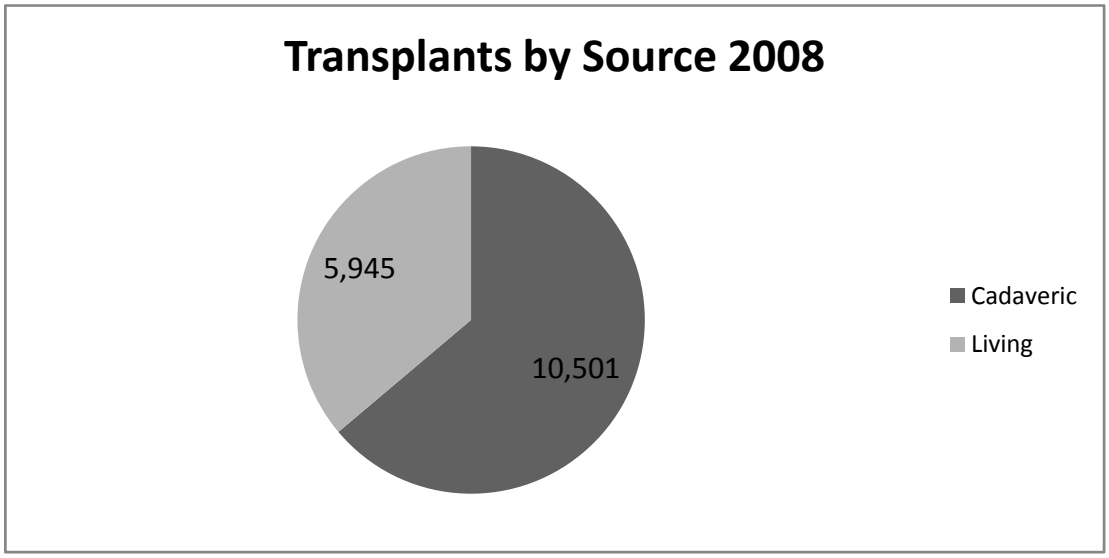
from the list will happen if a patient is no longer a suitable recipient, largely to further degradation of health. In some cases the lack of updates to various waiting lists presents a problem in finding a recipient in a timely matter. When a transplantable kidney is removed, there is a short window to perform the transplant, if several suitable recipients are called in, but they are no longer suitable for receiving, then too much time may have passed to allow transplantation.

The transplant list has been increasing continuously for the past twenty years. Kaserman and Barnett (2002) produced a table illustrating the growth in the waiting list. Below is an updated version of a similar table and chart illustrating the kidney waiting list from 1998 to 2008.

Table 1 Kidney Wait List

Kidney Wait List										
	Year									
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
People	53,315	57,055	60,537	64,161	68,173	71,798	76,820	82,369	88,753	94,741
Source:http://optn.transplant.hrsa.gov/ar2008/503_age_ki.htm										

Chart 1 Breakdown of Donations



Dialysis

The impact of dialysis on kidney transplantation is the central topic of this work. Drawing conclusions of its impact is multifaceted. The focal hypothesis is that the size of a hospital affiliated dialysis clinic is inversely related to the number of transplants. In other words, as clinic size increases, the fewer transplants the hospital will perform, controlling for hospital size. Data is available for the number of kidney transplants performed at sanctioned kidney transplants from the American Hospital Association. The constraint in research was the fact that information on dialysis clinics directly affiliated with transplant hospitals was not available for all transplant hospitals. Nearly three hundred hospitals listed as being able to perform or have performed transplants in the past, only around a third had data published regarding dialysis facilities directly linked to affiliated transplant hospitals.

Presently there are 217,000 people in this country relying on dialysis (University of Chicago Medical Center). This reliance costs 11.1 billion dollars annually. One rather grim fact

found during research was “the U.S. mortality rate for dialysis patients is about 23 percent, twice the rate of patients in Western Europe or Japan(Williams).” This calls into question the quality of care, the same article references the quantity of hemodialysis given to US patients in relation to those in the referenced nations. Patients in the US received less time on a dialysis machine than those in other countries, according to Ford and Kaserman (1993) in their paper-evaluating certificate of need regulation on dialysis during the eighties.

The incentives regarding flat rate dialysis fees may also be the root cause of this issue. If clinics are paid on a per hour basis or quality metric, care may improve. With fees based upon time use, then the incentive could shift the focus from number of patients to quality, however the risk of over treatment may occur.

Hemodialysis vs. Peritoneal

Two types of dialysis treatments exists with the most popular being hemodialysis. Several sources list the around ninety percent of patients choosing hemodialysis. The choice of selection is chosen to best suit the patients in most cases, assuming it is offered in an area. DaVita in particular offers a selection program on its website to guide patients through the selection process.

Hemodialysis requires that a patient go to a clinic or center two to three times per week for several hours and receive treatment. One issue with hemodialysis is it is billed per session rather than per hour. This results in an incentive for the provider to “short change” the patients to increase profit margins. This has a negative impact on the patient’s quality of life, as their blood is not properly filtered due to the shorter treatment times. This issue aside, hemodialysis chosen for or by the vast majority of dialysis patients, some ninety percent use this process (Foundation).

The decision between the two treatments is not apparent at first, as it is not directly addressed in the general literature on dialysis. One major concern with peritoneal dialysis is the added risk of infection with the at home treatment, sanitation may eliminate this as a treatment option. If proper conditions cannot be met, then this form of treatment will be avoided, as the risk of infection would greatly increase. Estimates addressing the issue of cost, finding at one time **p**eritoneal dialysis was substantially cheaper, by estimates of Dor et al. costing around sixty-six dollars a treatment in 1992. The aforementioned estimates are costs to the facility for rendering care, not end cost to the individual. Estimated costs of providing an in center hemodialysis session was estimated to be around one hundred and four dollars at the time of the analysis.

One issue raised by Barnett et al.(1993) dealt with empirical evidence suggested the shortening of dialysis treatment lengths at least with hemodialysis, was an attributable cause of increased mortality rates observed among dialysis patients. The shortening of treatment times, was thought was in a part due to the set payment structure, and decreasing reimbursement rates set in place by the ESRD. During the 1980's the reimbursement rates of the dialysis clinics dropped in the neighborhood of fifty five percent when adjusted for inflation according to the analysis in Barnett et al. Given general upward pressure on prices of normal goods during the same time period, it seems counterintuitive the real price of medical care would decrease. Even taking into account economies of scale and technological advancements reductions that large are rare. There appears to be no large cost break for larger clinics, at least none evidenced in the author's research.

The structure of dialysis clinics also may play a part in the selection of treatment. As hemodialysis is the cheaper of the two, it would be more profitable given the flat

reimbursement system to perform that treatment. Eighty three percent of independent clinics in 1988, were ran on a for profit basis (Barnett et al. 1993). At that time, some 110,000 patients utilized the care with the End Stage Renal Disease Program, with the system paying out 3.7 billion dollars as its share of the dialysis cost. The rate of payment the program uses has been set at eighty percent since its inception. Leaving the remaining twenty percent to be covered either as an out of pocket expense or for private insurance to cover, primarily the latter. This twenty percent is also an interesting and possible problematic as estimates at one time claimed thirty-five percent of dialysis patients are unable to remain employed after they start treatment (Kaserman and Barnett 2002).

Referring back to the cost of dialysis care, the largest driver of costs for a clinic are labor costs. Barnett et al. (1993) estimated the labor costs of nurses and technicians at around seventy to seventy-five percent of costs of a dialysis clinic. Surprisingly the cost of the equipment is rather low, according to Ford and Kaserman, in1996 the price was around 15,000 dollars. In that paper, they argued certificate of need regulation had a negative impact upon dialysis care(Ford and Kaserman 1993). The increase in wages for registered nurses and licensed practitioners or technicians, considering at least one staff member must be employed for every two or three patients receiving care (Ford and Kaserman 2000).

Oddly enough, during the eighties when CON regulations were largely in place, dialysis clinic expanded from 1,041 clinics with 12,329 machines to 1,839 clinics with 23,654 stations in 1989(Health Service Report in 1990). Ford and Kaserman attributed this growth to the implementation of the End Stage Renal Disease Program under a Social Security Act Amendment in 1972. The number of clinics is now around 3,200 clinics nationwide (Hoovers).

The certificate-of-need regulation is also an interesting point as disincentives may result because of the existence of said regulation. A certificate-of-need (CON) regulation is widely used in the medical industry. CON regulations are put in place with the alleged goal to "reduce industry costs by preventing 'unnecessary duplication of facilities'" (Ford and Kaserman 1993) The CON works, by requiring a permit to operate a medical facility such as a hospital, to obtain said permit, one has to show a need for said facility. Requirements for CONs vary by state, some have the trigger price set at zero price, others at one time were over one million dollars. The points Ford and Kaserman (1993) used in disputing the CONs in brief are that: investors will have "vastly superior information" compared to regulators regarding capacity, incentive of the existing firm to oppose entry, and finally a reduction in supply that occurs as the end result of the regulation. While those are valid points, one aspect that they touched upon was expansion of existing clinics.

Often a clinic could expand operations without triggering a CON hearing or filing, because of the low cost of expansion, assuming new machines were the only outlay, rather than building expansion. One possibility that is contradictory to Ford and Kaserman is theory that possibly that patients are given shorter treatment intervals as a justification should a CON process be started. If a clinic shorts patients by an hour or so per treatment, they can serve more patients. If time is reported as allotted or prescribed, they would in turn appear busier than they actually are. The plausibility of this theory would be difficult to quantify. The plausibility of the skirting CON regulations by expansion is not, as searching through CON filings reveals the relatively low cost of equipment compared to buildings, in states with high CON triggers.

The decreased running times, also had been hypothesized to have a direct relationship with patient life. In areas, where few dialysis clinics operate, the lack of competition may cause reduction in care. A minimal level of patient health must be maintained in order to prevent hospitalization. Barnett and Kaserman (1993), acknowledged some level of quality for the sake of maintaining a minimal health is required as hospitalization will result if health diminishes past a certain point. The lack of competition may allow a firm to reduce quality to some degree, without serious threat of entry by competitor firms. If CON regulations are in place, the threat of entry may all be but eliminated. A recent article in Salon magazine called written by Jennifer Nix touches on the possible disincentive existing regarding the time a patient receives on a machine, as it "cuts into the bottom line". Issues regarding costs also exist with the availability of nurses, and their increased wages. According to the article, results in some firms, such as DaVita, replacing nurses with technicians.

One possible solution is to have a fixed and variable portion of the fee. Compensation for the hookup, then a portion related to the time a person is connected to a machine. This would allow pricing structure would not offer as much incentive to shorten treatment time for the sake of profitability. Granted it still may exist, depending upon the amounts but is presumably fairer than a flat fee reimbursement.

One issue beyond the cost of dialysis that must be addressed is the quality of life that a patient has while under the treatment. Many homeostasis dialysis patients complain of a wash out feeling in the days between treatment and after treatment. Kaserman referenced only thirty-four percent of patients were able to maintain employment while on the dialysis treatment. This raises the appeal of peritoneal dialysis as the washed out feeling is not as prevalent, as treatment occurs every day, rather than a few times a week The diet is also less

restrictive, which is seen as a benefit to some (DaVita). However, the suicide rate is higher among peritoneal dialysis patients, Ford and Kaserman wrote on this topic, and attributed the increased rates to a several factors. One being that a community bond develops with homeostasis dialysis as those receiving treatment often go at the same times. The shared time aides in forming a support group. They believed the group setting had a therapeutic effect. The second theory with peritoneal dialysis is the patient is more often reminded of a life threatening medical problem. To summarize the effects of either treatment, a table from Ford and Kaserman (2000) is listed below.

Table 2

A Comparison of Alternative Dialysis Treatment Regimens

Hemodialysis	Peritoneal Dialysis
Administered at a clinic.	Self-administered at home. May yield a feeling of isolation.
Provides an oppurtunity to interact with other patients	
Leaves patient "washed out" until following day.	No "washed out" feeling.
Three treatments per week-four "days off."	Several exchanges every day-no "days off."
Stringent dietary restrictions, particulary fluid	Less stringent dietary restrictions

Sourced: Ford Kaserman (2000) Suicide as an Indicator of Quality of Life:Evidence from Dialysis

Transplantation

Before discussion about transplants can proceed, the organ procurement shortage and its causes must be discussed. Many go on dialysis because they do not meet the criteria for kidney donation under the current shortage. Daniel Fisher, one of the founders of the transplant center in Chattanooga, Tennessee, estimated that only around half of the city's dialysis patients were considered healthy enough for a transplant consideration (Bregel). While this is not necessarily representative of the nation as a whole, Chattanooga is fairly average city with regards to many demographic variables.

Some background on the history of organ transplantation is needed to understand the existence of the current shortage. Initially when the first organ transplantations first occurred decades ago, there was no issue of shortages (Kaserman 2006). This was due to a recipient's responsibility of securing the donor organ, and general limitations of the medical technology. Constraints of the medical technology were primarily due to limitations of available immunosuppressive drugs. Illustrating this limitation were the initial transplants being performed on close relatives, with the first transplant being performed between a set of twins. Three main arguable causes of the shortage stand out to the author. The first, which some economists have been discussing, is the regulated legal price of organs. The second, primarily those in the medical profession, is the lack of education and education expenditures regarding donation, the latter being the point of analysis for Beard, et al (2004). The third is failure to obtain consent for donation, from either prior knowledge of an individual's wishes such as a driver's license donor card or making wishes known to survivors (Kaserman and Barnett 2002). The regulation placed on the price of organs will be the first topic discussed.

In the United States we have a regulated price set on donated organs, cadaveric or

living. This is arguably one of the main causes of the transplant shortages and waiting lists we now face. The failure of hospitals to ask the families of the deceased to donate, has also greatly contributed to the estimated 6,000 annual fatalities (Beard, et al). The National Organ Transplant Act of 1984 prohibits the sale of organs. The prohibitions on the sale of organs equates the market price too zero. The market place is constrained with a price ceiling set at zero. The fact that an effective price ceiling results in a shortage is an important fact that an undergraduate should know at the conclusion of a basic microeconomics course.

Under the National Organ Transplant Act, the sale of an organ is a felony. According to Kaserman and Barnett (2002) some supporters of the regulation, most notably the American Medical Association, justify it based on moral grounds. One common argument is restrictions are in place to protect the poor from extortion or some form of injustice in the purchase or sale of an organ. The basis for this belief on the purchasing side is the price of a legal organ will be as high as black market prices. While this could be true, evidence is pointing in the opposite direction. According to an Economist article in 2006, Iran has implemented a government-regulated market for organ sales. The market is specifically for kidneys, and the prices have ranged from two to four thousand dollars. While this system is different than many have proposed in the U.S., it shows that a market price is probably much lower than black market prices. Kaserman and Barnett (2002) speculated in their book the going black market price for kidneys was around forty thousand dollars, citing observations of willing patients trying to obtain a kidney domestically and internationally. They estimated the black market price would be around ten times the legal market price. This estimate would be inline with the findings of the Economist article.

The lack of a legal pricing mechanism is one of the contributing factors of the organ

shortage. The importance of the organ shortage on dialysis is simple, the more people waiting for a transplant, the more people on dialysis. This brings into issue whether the hospitals have an incentive to keep patients on dialysis rather than encourage transplantation/donation. At first the idea of hospitals intentionally keeping patients on dialysis may rather odd, and fairly grim. The reason for the speculation is the hospitals have built dialysis clinics themselves or are affiliated with local clinics to provide services. This research will focus on the first type of clinic. The costs of dialysis and kidney transplant costs are then bore by the federal government.

Payment by the government while easing the financial strains on some patients brings about inefficiency due to the third party payment system. It reduces some of the social inequity some fear could result in an open market. However, instead of bidding up the price, people compete via entry on multiple waiting lists. With the price of kidneys set at zero, the market is not allowed to work, as it should. At present one who is on dialysis and on the wait list for a transplant is subject to the waiting list. The system while well intentioned has a notable flaw in a sense. The government pays for dialysis, and also for the medical costs associated with a kidney transplant. The operation, being the bulk of the transaction costs aside from immunosuppressive drugs.

As a side note, it worth mentioning that over the last few years, some allowances have been made to allow for trials allowing various forms of compensation. None have been implemented, judging by current literature as of this writing. Technological innovations have allowed new means of communication between patients. One example of this is websites established to facilitate kidney swaps.

The main shortcoming of all donated kidneys is the expected useful life of the kidney is not the remainder of the individual's life. This is due to two primary issues one being the single

replacement kidney is doing the work normally performed by two kidneys. Secondly, are the limitations of immunosuppressive drugs, while greatly and continually improving are not perfect. Over time, the body eventually rejects the organs. These and other factors shorten the life expectancy of the replacement organ. Often the organ lasts around a decade according to Marcotty in their article highlighting the current shortage.

Under the current procurement system, and given current technology, it is feasible and practical to keep a patient on dialysis for many years while waiting on a transplant. As previously addressed, the life of a dialysis patient is by no means one of high quality, but it allows a reasonable quality of life a few days a week with either type of treatment. Quoting Kaserman in a 2006 lecture, “they’re waiting for an organ or death” in reference to those on the waiting list. However using the ability of those on dialysis to maintain employment as an indicator, it appears those on dialysis treatments have a poorer quality of life compared to transplant recipients. Many patients cite the “washed out” feeling, and other concerns, but it is also not very quantifiable in traditional senses, so the employment serves as an indicator. There may be other biases at play in the ability to maintain employment, as the time required for treatments, two to three days a week, could be difficult for many schedules. Some employers would not be a flexible in working with their employees, operational hours of the clinics also factor into this.

The previous raises the question as to whether incentives exist to keep patients on dialysis either hemodialysis or peritoneal dialysis. If the treatments produce such poor side effects, why is there not a larger push to perform transplants? Kaserman and Barnett (2002) discussed issues regarding the number of families asked about cadaveric donation. If the rather simplistic solution of asking all possible donors is not implemented, it begs the question as to whether a reason exists. Why are so few patients asked about donation of their loved ones?

While the position of asking is a rather awkward one for hospital staffing, great benefit can come from it. Incentives appear to be in place for hospitals to keep patients on dialysis. The cost of one year of homeostasis dialysis is nearly comparable to a transplant as illustrated in the table below, using numbers Kaserman referenced in 2005 lecture. While the upfront cost is higher with a transplant, the average and total costs are lower. When a patient is on dialysis for several years, the hospital will reap significantly higher revenue compared to performing a transplant and providing proper medication over the course of a few years.

Table 3 Cost of Dialysis Treatment

Year	1	2	3	4	5	6	7	8	9	10	Sums
Immuniosupressive Drugs	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	100,000
Transplant Cost	60,000	0	0	0	0	0	0	0	0	0	60,000
											160,000
Dialysis:Direct Cost**	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	400,000
**Cost of treatment only							Savings over ten years of transplant*				240,000
Using numbers from Kaserman (2005) Brown Bag Seminar							*Assumes no discount rate and does not take into account inflation				

This rather simple example, does not take into account any form of interest, inflation, or discount rate however it illustrates the nominal savings possible. Beyond the difference in revenues, other possible reasons exist to keep patients on dialysis treatment. One reason is as a justification for the dialysis clinics themselves. It seems reasonable to assume excess capacity has to be built for the clinics to handle the necessary number of patients, growth, as well as emergency cases. The machines while not extremely costly to purchase relative to other modern medical equipment. Maintenance and operation costs for the machines and clinics themselves are costly. The operation expenses stem from the staff requirements at a clinic, and variable cost incurred per patient. Barnett et al. list labor costs as 70-75% of the total costs facing a clinic.

The same paper states clinics must maintain a staff to patient ratio of three to four nurses or technicians for every ten patients undergoing treatments at one time. If this holds true, it is beneficial for the clinic to be operating near sustainable capacity, assuming the staff can handle the aforementioned load with no degradation in care rendered. This means the hospitals have incentive to keep patients on dialysis, even though this is not the most cost effective or best for their patients gauging by quality of life.

The author recognizes that not all dialysis patients are candidates for kidney transplants; however a great many are as do many others. Bregel quotes transplant surgeons speculating half of dialysis patients are eligible for transplants, but many of those are not on the list due to current shortages. Kaserman speculated in lectures of similar occurrences he believed were occurring. An additional incentive is for expansion of existing dialysis facilities. As more transplants occur, fewer patients would be on long-term dialysis, if fewer transplants occur the demand for dialysis care would increase. The author is not trying to dispute the need for dialysis clinics, merely stating the incentives in existence, which may result in inefficient outcomes. Some patients, even in the absence of a shortage are simply not candidates for transplants. The goal of this thesis is not to solve the kidney shortage, but to examine if the current system if the rather perverse outcomes are the result of the system in place. Some explanation of the causes of the organ shortage is warranted to better understand the problem.

Price

A common notion is that payment for organs would encourage illegal organ harvesting, possibly resulting in someone forcibly kidnapped. This belief is probably agitated by urban legends and Internet rumors, of people being drugged and waking up in a back alley without

their kidneys. One could also speculate that poorer people would begin selling organs to pay their bills. The main point of this line of thought is that people should be protected from the repercussions of the sale of organs; whether those repercussions are of their own doing or not. The ban on organ sales was passed in part due to the response to a doctor buying college student's kidneys and transplanting them into the highest bidder.

If allowing the market to work naturally is deemed perverse, what else can be done to alleviate the shortage? One idea is to enforce the laws regarding organ donor cardsi and to also ask families of the deceased if they would like to donate. Those measures would aide in easing the shortage, yet may not solve the problem. One other issue is it is hard to analyze the impact of donor cards and asking for family consent. The reason for this difficulty is according to Kaserman (2002); donor cards are often overridden by the family's wishes, against Federal law. He also said families of up to half of potential donors may not be asked to donate the organs of the deceased.

Some in the medical community have speculated programs that educate the general public and better educate the medical professionals about organ donation will have a large impact on organ donation. While the idea behind increasing education seems very logical, it may be not be the perfect solution. Due to the insignificance of educational expenditures in prior analysis, Beard et al. (2004) and Lawson, the variable was not included. Also recent data is not readily available; the data used in Beard et al. (2004) was obtained through the Freedom of Information Act (FOIA), time constraints prevented obtaining more recent figures.

Discussion of the moral implications of organ donation policy is not the aim of this paper, nor is proposing a solution. Basic discussion of the problem is warranted to better grasp the arguments for and against different programs and policies regarding organ donation. Data

availability and the practicality of testing some solutions hinder analysis of proposed solutions greatly. While a market works in other nations, due to legal reasons, solutions of this sort may not be tested due to legal restrictions. While some restrictions have been relaxed over the past few years, primarily to allow compensation trials. However, none have been tested as of this writing. Enforcing donation cards and consent laws, is problematic at best. As these are required now and various estimate only 50% of families are approached after a death allowing transplantation. However we can however look at demographic variables and educational expenditures and determine their relation to donation. From this we may be able to learn which groups are less prone to donate, and craft incentives to reach these groups.

Transplant Market Structure

Rather than division solely along state or county lines, the nation is divided it up into Organ Procurement Regions, at the time of this writing there are twelve listed on the United Network for Organ Sharing(UNOS). Within each UNOS region, there are multiple Organ Procurement Organizations (OPOs) that are not profit entities. The territories of the OPOs may or may not encompass an entire state. Some states may have several areas; Tennessee for example, has two. Some OPO's may encompass sections or entire parts of multiple states. Some of the prior research, primary Beard et al. (2004) in Limits to Altruism, used the OPO territories as the unit of their analysis, as data on cadaveric kidney donation was available by that particular unit. The use of OPOs added a minor level of complexity, as demographic variables are available on state and sometimes-county levels. To create data exactly for the OPO's would be laborious if not impossible, as existing research has noted

Factors that Impact Transplantation

Much of the following comes from work regarding organ donation. The belief held by the author is that the factors that contribute to organ donation are also correlated to transplantation and the dialysis information. The demographic variables included were percentage of population that is African American, below the poverty level, with an affiliation with a Christian denomination, and with a college degree. Dummy variables were also added for geographic regions. These were added to account for regional differences in collection attitudes and policies.

The logic behind the demographic variables is certain demographics were acknowledged by Siminoff, et al. (2001) in to be more apt to donate than others. Siminoff, et al.'s data was collected from interviews with Organ Procurement Organization (OPO) staff and families of all donor eligible deaths at hospitals in parts of Pennsylvania and Ohio. They analyzed the results from interviews to determine the demographics of the organ donors, to see if certain demographics where more prone to donate. The studies showed higher income individuals were more apt to donate. However they did not imply poverty or lower incomes would decrease donation, as Beard, et al. had hypothesize. When racial background and education level are controlled for, poverty should positively impact donation. The intuition behind this belief is the group in question may be more generous with non-monetary gifts. In a sense, they are giving what they can to help. While there is not much resource to support the stance, it seems reasonable. Under the current system, a donation is solely done as an act of generosity. This could also be capturing some aspects of family size, as poverty is generally correlated to higher birthrates.

Minorities, particularly African and Asian races were found less likely to donate, in

multiple studies. Yeun et al (1998) wrote a paper entitled “Attitudes and beliefs about organ donation among different racial groups” attributing hesitance of African Americans to fill out donor cards on distrust of the government and hospitals. They believed this to be one of the larger contributing factors to poor donation. They analyzed survey data from Bronx health clinics, to determine why there are discrepancies in donation among races. African Americans were found to have very similar attitudes as other races toward donation, but a vast majority had refused to sign donor cards. Others commented they did not trust hospitals or the government, holding the belief that medical staff would let them pass to harvest their organs. This distrust is a common misconception among all races, not just African Americans. The misconception is misguided, as the doctor performing the transplant is generally a specialist in that field. While the doctors providing care rarely have any relation if any to transplant centers or transplant operations.

The incidence of kidney failure among African Americans was higher than among other races. Donor and transplants being of the same ethnic background often have better success rates than those of differing races. Given the distrust, and correspondingly low donation rates, dialysis treatment among minorities becomes even more critical. Minorities, especially those in rural areas, benefitted greatly from the End Stage Renal Disease Program, as this funded more clinics to be built, especially in the rural areas. This was one issue that was analyzed by Ford and Kaserman (1993), as they found that the percentage of the population that was black was positively correlated with the number of dialysis clinics in a state. Given the greater need for transplants among African Americans, it is hypothesized a positive relation exists between the percentage of a state’s population that is African American and the number of transplants performed in a state.

The variable for education used was percent of the state population over twenty-five that had earned a bachelor's degree or higher. Siminoff, et al (2001) found that many of the donors in her study held college degrees. This variable was found to be positive and significant in the model of Beard, et al. (2004). Note this variable only takes into account higher levels of education. Given the correlation between education and donation, it is assumed the trend will continue with transplantation.

State dummy variables were added to control for the possibility of state and possible regional differences in varying attitudes toward organ donation and transplantation. Beard et Al. (2004) used regional dummy variables in their paper Limit to Altruism. They found that there were statistically significant variations between the base and four other regions. Also, the use of the Organ Procurement regions in their analysis, prevented the use of state dummies, as the areas often do not coincide with state boundaries.

In this analysis, it was decided to use a set of regional dummies as well, though not of the same creation as in Beard et al. (2004). The hospitals were sorted by state, then grouped by region into the following five groups based upon their location: Southeast, West, Midwest, Great Lakes, and North East. The North East was chosen as the base, and was not included in the regression input. No prior expectations are made about the dummies.

The following are variables created to further elaborate on the model of Beard et al. (2004) and Lawson (2008). The main difference being this analysis is looking at transplants in 2008 and their models evaluated cadaveric donations in 1995. While reading about organ donation, one factor that has been empirically ignored is the impact of religious affiliation on donation in the United States. The hypothesis is people with a religious affiliation will be more inclined to donate, bar the vast minority with affiliation denominations that do not

endorse or permit transplantation of organs. Often the perceived issues revolve around the acceptance of blood from another person According to the group, Transplant for Life's summary of major religions, almost all of the major religions practiced in the United States either have no official negative opinion or openly encourage donation. Many such as the Catholic and Episcopal Churches openly encourage organ donation. Some such as the Quaker and Pentecostal denominations do not directly or openly address the issue, leaving the decision to the individual. Many of the "neutral" groups, those that have not officially endorsed a position, recognize the benefits, and take the stand that donation is ultimately a personal choice.

Some analysis exists on the topic, Randhawa (1998) in his analysis of the influence of religion on donation, found many derive their views toward donation from the stance of their religion's attitude toward donation. While his study was limited to a sample of the Asian population in the United Kingdom, it is reasonable to infer other people place emphasis on the opinion of their faith. One point of interest, over half of the respondents in his study did not know the official stance of their religion. In reality, most of those were of faiths that had either publically advertised their support and or openly encouraged donation through other means. While this may not correspond perfectly to a more diverse sample, the merits of the findings warrant some further evaluation.

Accurate data on Christian affiliation is available from the census by state. Only one Christian sect has a strictly negative attitude negative attitude toward organ donation. They constitute a miniscule part of the U.S. population, and would not be expected to a have a significant impact. It is hypothesized Christian affiliation will be positive, as most Christian and Jewish groups encourage organ donation. It is important to note that data was also available on the percentage of the population that consider themselves religious. The affiliation and religious

variables both have some degree of bias. The generic religious variable, is vague, but captures a larger set that may be missed in the affiliation variable. The variable also is more prone to a response bias, as someone may say yes to give a politically correct or accepted answer. The affiliation, appears to overlook smaller denominations or independent churches, but in many regards more precise in that it looks at membership numbers, rather than a generic question. The affiliation data is also from a census study.. The result of using the affiliation data is that some states, particular those with high percentage of Catholic, Episcopalians, Lutherans, and others groups with a formal confirmation process, will be inflated in comparison to those with a percentage that attend smaller, possibly unaffiliated churches This hypothesis was confirmed with cadaveric donations in Lawson (2008).

The age of patients is also a contributing factor to the number of transplants. Older transplants may not be the best candidates for transplants, however they may still receive them. To account for the health of the population, the mean life expectancy of a state is used to measure health. While it does not necessarily capture the age of an area, it does provide a representation of the health of the area. The coefficient of this variable was somewhat unknown. If people love longer, it could be assumed they are healthier, either through their own actions and or as a result of the health care system in the area. As life expectancy decreases, one would suspect the demand for kidneys and renal care would increase as many common health concerns facing this nation at present stem from the largest contributing factors to kidney failure.

Attributes of the hospital themselves must be captured. The sheer size of the hospital also has a certain impact upon transplantation. Speaking in general terms, smaller hospitals will not perform as many transplants as a large hospital. To account for this, two hospital

demographic variables were obtained from the American Hospital Directory. Those were variables taking into account the number of staffed beds at the hospital and the total patient revenue of the hospital. Both of the variables are hypothesized to have positive coefficients. There might be some exceptions regarding the revenue with children and Veteran's Administration hospitals, as there revenue might not reflect true revenues.

General health of the population also has an impact upon kidney dialysis. The leading contributors, as mentioned prior, for kidney failure are diabetes and hypertension. These are often associated with other characteristics reflecting poor health of the population. If the populous of a state is less healthy overall, the supply and demand curves for kidneys will be altered. As the population lives longer, the general inference is the population is relatively healthier, and the corollary is also true. If the population is healthier, it seems reasonable to assume the population would then be better candidates for donation. If the population has poorer health, then it seems reasonable to infer fewer transplantable organs could be sourced from the population. The argument is best illustrated based on the impact on African Americans. Factors leading to kidney failure are more prevalent than among African Americans and other minorities, as such the incidence of kidney failure is higher. Corresponding to the higher incidence of failure is a disproportionately large shortage compared to other races.

The final three variables deal with the affiliated dialysis clinics themselves. They are the non-profit or for-profit status of a clinic, the number of hemodialysis machines, and the offering of peritoneal dialysis. There were some issues regarding the availability of the data, which will be addressed later in the next section. The number of hemodialysis machines is expected to be negatively correlated with the number of transplants performed at a particular hospital. As previously mentioned, the incentives of the dialysis industry have an incentive to retain patients

on dialysis care. For the same reasons, the dummy variable for the offering of peritoneal dialysis is expected to have a similar signed coefficient. The reasoning behind hemodialysis applies to peritoneal dialysis. The incentives may in fact be stronger as previously mentioned papers estimate the average cost of peritoneal to be lower than hemodialysis. The dummy variable representing the for-profit status has been included to evaluate the impact of the profit motive of the clinic.

Data

The data regarding the number of kidney transplants was acquired from the Medicare website. The program keeps records of all legal transplants, as they fund the procedures through the End Stage Renal Disease Act. The data was listed by transplant hospital, through 1988. While the data went back to 1988, it is overly optimistic to believe that many of the hospitals performing transplants where even open at that time or even capable of the performing the transplants. Similarly, it is unrealistic to believe that all hospitals operating in the late 80's are still in operation or performing transplants. Given data limitation for the hospital statistics it was decided that 2008 would be the best year to analyze. This is because the data regarding hospital revenue, patient days, discharges, and staffed beds was available for 2008.

Revenue and staffed beds may fluctuate more so than demographic variables. The data regarding dialysis clinics as of the last report to Medicare, most had been updated within the last two calendar years. The assumption being that the number of machines in a clinic would not vary over the course of a maximum time frame of two years.

The general demographic variables, were sourced from the US Census website. A limiting factor with the data is that it is largely grouped to 2000, or prior data as is the case with information on religious affiliation being sourced from a 1997 study. It has been previously

argued that religious affiliation is fairly constant. By this it is meant that one does not change faith often, changes in denominations may occur frequently. However, there are not traditionally large swings in general affiliation over a ten-year period.

Another issue with the data was the availability of dialysis clinic data. The main reason for analysis was to analyze the impact of clinics directly affiliated with hospitals. Separating the clinics not affiliated directly with hospitals was done by hand. Information on Medicare approved clinics was listed on the "Dialysis Facility Compare" webpage on the Medicare website. In many cities, no clinic appeared to be directly link to a hospital; in others the hospitals had obvious direct affiliation, either confirmed by name of the clinic and or address of the clinic and the hospital. This was referenced manually, by cross-referencing the information on the Medicare website and that provided to the American Hospital Directory. Care was taken to insure affiliation of a clinic directly with a transplant hospital. In many cases, where machines were not listed with a hospital, research was done to determine if the hospital had dialysis machines. The research methods involved using internet search engines, to locate the information if it was listed on alternative sources, then the hospital's own website was examined for information regarding dialysis machines. In most cases, this research turned up little information. Data for three or four hospitals was obtained via this method, and was not denoted in the research process.

All hospitals have dialysis machines if they perform kidney transplants; this is necessary, as patients would require the machines prior to the transplant, and for a short time post transplant. The issue was that not all hospitals listed dialysis clinics that were of direct affiliation. Often there would be clinics in the same neighborhood, but under private ownership, under companies such as DaVita. This was rather unscientifically determined as the listing of clinic

listed street addresses in the listing for a city. Often, clinics would have addresses that were a block or two over from the main hospital building. Because of the lack of direct affiliation, these clinics are ignored, as the focal point is examine the impact of direct affiliation This could be for one of a couple main factors, either hospitals do not offer traditional dialysis care, they have arrangements with private companies “across the street”, or possibly the names were not obviously linked with the hospital. Time constraints prevented research on every hospital having an “official clinic”. What is believed to be the case for most is that they have machines but are not used for long-term patients; they are referred to separate clinics.

The disconnect between hospital affiliated clinics and hospitals caused a large reduction of observations having complete data sets. A hospital may also be listed as a qualified transplant hospital but elected not to perform transplants in the given year. For most, however, there were no transplants performed in prior years, or trend downward trending of transplant numbers.

In some cases, the patients may have been transferred for simplicity; In the case of Chattanooga, TN many patients perceive a low transplant number with low quality (Bregel).

Empirical

Due to the count nature of transplant data, a Poisson Model was chosen. The model type is most useful when the dependant variable is a count, as the transplant data is. To test for biasness caused by the missing hospital demographics or dialysis clinic information, a binomial probit model was ran, with the inverse mills ratio being stored and used in the Poisson Regression to correct any possible biasness caused by the missing. The data availability for most observations is believed to be random.

The specification for the Probit and Poisson models can be found below.

$$\text{PROBIT: PRODDUCO} = \text{one} + B_1\text{LIFEEXP} + B_2\text{BEDS} + B_3\text{TPR} + B_4\text{HEMO} + B_5\text{PERITO} + B_6\text{NONPROFI} + B_7\text{PCOLLEGE} + B_8\text{PCHRISTI} + B_9\text{PPOVERTY} + B_{10}\text{pblack} + B_{11}\text{west} + B_{12s}\text{east} + B_{13}\text{mwest} + B_{14}\text{glakes}$$

$$\text{Poisson: t2008} = \text{one} + B_1\text{LIFEEXP} + B_2\text{BEDS} + B_3\text{TPR} + B_4\text{HEMO} + B_5\text{PERITO} + B_6\text{NONPROFI} + B_7\text{PCOLLEGE} + B_8\text{PCHRISTI} + B_9\text{PPOVERTY} + B_{10}\text{pblack} + B_{11}\text{west} + B_{12s}\text{east} + B_{13}\text{mwest} + B_{14}\text{glakes} + B_{15}\text{seast}$$

The explanatory variable of the Poisson regression is binary and represents the availability of data for an observation. This variable, Prodduco, was creating by evaluating the product of three binary variables. The first one represents whether demographic data for the hospital was on reported. The second represents whether dialysis clinic information was available, a value of one represents known information about the clinic. The third and final variable was one capturing the performance of transplants in recent years, a value of one equates to having not performed any transplants since between calendar year 2004 and 2008. By doing this any observation that had missing data was included in the explanatory variable in the Probit model.

Conclusion

Most of the results came out as expected and as shown in the table below, a full output is shown in the Appendix, as is a listing of the descriptive statistics of the non-dummy variables.

Table 4 Regression Output and Expectations

Variable	Coefficient	Standard Error	T-stat	Probability	Mean of X	Results of the model	Predictions
Constant	-37.1493586	2.11892834	-17.532	0		-	
LIFEEXP	0.55698367	0.0271855	20.488	0	76.743038	+	-
BEDS	-0.00012206	.204319D-04	-5.974	0	661.126582	-	+
TPR	.167090D-09	.201748D-10	8.282	0	.430898D+09	+	+
HEMO	-0.0155795	0.00109396	-14.241	0	23	-	-
PERITO	-0.37856256	0.03472152	-10.903	0	0.6835443	-	-
NONPROFI	-0.84733203	0.05434405	-15.592	0	0.86075949	-	?
PCOLLEGE	-0.00762697	0.00489225	-1.559	0.119	29.2240506	-	+
PCHRISTI	-0.03196952	0.00211026	-15.15	0	49.8875012	-	+
PPOVERTY	0.07448478	0.00852484	8.737	0	12.3936709	+	+
PBLACK	5.0957579	0.39318071	12.96	0	0.13710477	+	+
SEAST	0.29870372	0.05802184	5.148	0	0.27848101	+	?
WEST	-0.35794327	0.06956301	-5.146	0	0.15189873	-	?
MWEST	0.59576008	0.06910843	8.621	0	0.16455696	+	?
GLAKES	0.94594354	0.06546048	14.451	0	0.16455696	+	?
MIsRatio	-0.72149793	0.04807735	-15.007	0	0.24347196	-	

The notable exception to the expectations was percent Christian having a negative coefficient. In prior analysis, Lawson 2008, the variable was found to be marginally significant and positive. This may be an issue relaying donation data, specifically cadaveric donation to total transplants. Also the use of OPO region in prior analysis rather than state level data may contribute to the discrepancy.

The variable indicating the number of homeostasis dialysis machines in or related to a hospital was negative as hypothesized, at the one percent significance level. This variable was the primary inspiration for the research. In the Probit model, the variable was significant, implying correlation existed between the missing observations.

Peritoneal dialysis surprisingly came back significant, implying that the offering of the treatment had an impact on transplantation. This is most likely to the disproportionate ratio between the two treatments, with peritoneal being the less frequent option of the two.

Rather surprisingly, the variables meant to capture the size of a transplant hospital came back with mixed signs. The number of beds was negatively correlated with transplantation. One possible explanation for this could be that some of the hospitals particularly may not be as large regarding the number of rooms and staffed beds, mainly dealing with out-patient care and not focusing on certain treatments that would require extended stays and the capacity to handle those impacts. Total patient revenue for 2008 was also significant, it was positive as expected, showing that correlation exists between a measure of size and the number of transplants performed..

One interesting finding was that the offering of peritoneal dialysis had a negative impact on transplantation. This was expected, as the incentives to offer this treatment are similar if not more enticing than peritoneal dialysis for many clinics. As estimated costs, at least at one time, placed the costs of peritoneal dialysis around half the price of an equivalent hemodialysis treatment.

The coefficient for dialysis clinics that affiliated themselves as non-profit was inversely correlated to the number of transplants performed at a hospital. The significance of this variable is rather troubling, as it does lend credit to a hypothesis that non-profit providers may sacrifice care for the sake of revenue or other purpose. Granted no real predictions were made about the variable as nothing lent toward signing the variable one way or another. One would hope to see a positive relationship between non-profit status and transplantation. This finding may be the result of an unknown separation of the clinics and the transplant hospital.

Percent African American was also another variable that had the anticipated sign. One concern with the sign of this variable was the greater shortages existing in the African American Community, as the incidence of hypertension and diabetes is higher. However, given

preferences and past success rates of transplantations, it is preferable for a recipient to receive a kidney from a donor of the same race as himself or herself. The preferences come from the decrease in complications when donor and recipient are of the same race. Percent poverty was significant, as it was in Lawson. The variable was positive in this analysis.

The results of the state dummies can be seen in the chart. Of the states with dummy variable, only four had negative and significant variables. The aforementioned states are Colorado, Massachusetts, and Oklahoma. No real explanation as to why those particular states have negative coefficients, particularly, Massachusetts. The state has eleven hospitals transplant hospitals in 2008, a possible explanation for this odd finding is that once size of the respective hospitals are accounted for they in fact perform fewer transplants.

The mills ratio was found to be negative and significant. The inclusion of the mills ratio compensates for possible bias caused by self-selection bias of either the hospital or dialysis data.

Take Away

The results of the empirical model show that correlation exists between the dialysis industry and the number of kidney transplant performed. The relation shows the incentives of the dialysis industry may be impacting kidney transplantation. The results show an inverse relationship between both the number of dialysis machines and the offering of peritoneal dialysis and transplantations. The correlation, does not guarantee a causation effect. The incentives of the market however, support the theory. A clinic has the incentive to perform fewer transplants, as the loss of a perpetual income stream is not an appealing prospective.

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Appendix

```
--> DSTAT;Rhs=t2008,LIFEEXP,BEDS,TPR,HEMO
    ,PERITO,NONPROFI,PCOLLEGE,PCHRISTI,PPOVERTY,pblack$
```

Descriptive Statistics
All results based on nonmissing observations.

Variable	Mean	Std.Dev.	Minimum	Maximum	Cases
All observations in current sample					
T2008	55.7491525	62.5855995	.000000000	347.000000	295
LIFEEXP	76.8047458	1.37965459	72.0000000	80.0000000	295
BEDS	450.908475	522.421470	.000000000	7020.00000	295
TPR	336195296.	880303274.	.000000000	.643111916E+10	295
HEMO	7.20000000	14.2982326	.000000000	93.0000000	295
PERITO	.271186441	.445327537	.000000000	1.00000000	295
NONPROFI	.322033898	.468049868	.000000000	1.00000000	295
PCOLLEGE	28.1366102	5.66862249	15.9000000	49.1000000	295
PCHRISTI	49.1445161	9.02724515	30.0608611	74.2798686	295
PPOVERTY	12.5864407	2.61275376	5.80000000	22.6000000	295
PBLACK	.129901011	.952569505E-01	.865646200E-02	.544107882	295

Matrix: La$
[11,7]

```
-> PROBIT;Lhs=PRODDUco;Rhs=one,LIFEEXP,BEDS,TPR,HEMO
    ,PERITO,NONPROFI,PCOLLEGE,PCHRISTI,PPOVERTY,pblack,west,seast,mwest
    ,glakes;hold$
Normal exit from iterations. Exit status=0.

+--------------------------------------------+
| Binomial Probit Model                      |
| Maximum Likelihood Estimates               |
| Model estimated: Nov 23, 2009 at 05:59:13PM.|
| Dependent variable            PRODDUCO     |
| Weighting variable                None     |
| Number of observations             295     |
| Iterations completed                 9     |
| Log likelihood function       -34.84278    |
| Restricted log likelihood     -171.4112    |
| Chi squared                    273.1369    |
| Degrees of freedom                   14    |
| Prob[ChiSqd > value] =          .0000000   |
| Results retained for SELECTION model.      |
| Hosmer-Lemeshow chi-squared =   4.07985    |
| P-value=  .66587 with deg.fr. =       6    |
+--------------------------------------------+
+---------+--------------+----------------+--------+---------+----------+
|Variable | Coefficient  | Standard Error |b/St.Er.|P[|Z|>z] | Mean of X|
+---------+--------------+----------------+--------+---------+----------+
          Index function for probability
 Constant      71.8791330     24.6131746     2.920   .0035
 LIFEEXP      -1.01441624      .32686577    -3.103   .0019    76.8047458
 BEDS           .00349763      .00066742     5.241   .0000    450.908475
 TPR         -.752243D-10    .246946D-09     -.305   .7607   .336195D+09
 HEMO           .13442201      .02608267     5.154   .0000    7.20000000
 PERITO         .08560137      .41703821      .205   .8374     .27118644
 NONPROFI      3.10922645      .59357885     5.238   .0000     .32203390
 PCOLLEGE       .07878563      .06260001     1.259   .2082    28.1366102
 PCHRISTI       .01249135      .02321334      .538   .5905    49.1445161
 PPOVERTY      -.18093325      .10264698    -1.763   .0780    12.5864407
 PBLACK       -4.59785149     4.46255072    -1.030   .3029     .12990101
 WEST          2.35992649      .93706357     2.518   .0118     .19322034
 SEAST          .83426349      .76271883     1.094   .2740     .30169492
 MWEST          .42151250      .78854109      .535   .5930     .13559322
 GLAKES         .16390178      .81163532      .202   .8400     .19322034


+----------------------------------------+
| Fit Measures for Binomial Choice Model |
| Probit   model for variable PRODDUCO   |
+----------------------------------------+
| Proportions P0= .732203   P1= .267797  |
| N =     295 N0=     216   N1=      79   |
| LogL =   -34.84278 LogL0 =  -171.4112  |
| Estrella = 1-(L/L0)^(-2L0/n) = .84300  |
+----------------------------------------+
|     Efron |  McFadden  |  Ben./Lerman  |
|    .81614 |     .79673 |       .92691  |
|    Cramer | Veall/Zim. |     Rsqrd_ML  |
|    .81542 |     .89445 |       .60382  |
+----------------------------------------+
| Information  Akaike I.C. Schwarz I.C.  |
| Criteria         .33792     154.99018  |
+----------------------------------------+
Frequencies of actual & predicted outcomes
Predicted outcome has maximum probability.
Threshold value for predicting Y=1 = .5000
           Predicted
------  ----------  +  -----
Actual       0    1  |  Total
------  ----------  +  -----
  0        210    6  |    216
  1          6   73  |     79
------  ----------  +  -----
Total      216   79  |    295
```

```
=========================================================================
Analysis of Binary Choice Model Predictions Based on Threshold =  .5000
-------------------------------------------------------------------------
Prediction Success
-------------------------------------------------------------------------
Sensitivity = actual 1s correctly predicted                   92.405%
Specificity = actual 0s correctly predicted                   97.222%
Positive predictive value = predicted 1s that were actual 1s  92.405%
Negative predictive value = predicted 0s that were actual 0s  97.222%
Correct prediction = actual 1s and 0s correctly predicted     95.932%
-------------------------------------------------------------------------
Prediction Failure
-------------------------------------------------------------------------
False pos. for true neg. = actual 0s predicted as 1s           2.778%
False neg. for true pos. = actual 1s predicted as 0s           7.595%
False pos. for predicted pos. = predicted 1s actual 0s         7.595%
False neg. for predicted neg. = predicted 0s actual 1s         2.778%
False predictions = actual 1s and 0s incorrectly predicted     4.068%
=========================================================================
```

```
--> poisson;Lhs=t2008;Rhs=one,LIFEEXP,BEDS,TPR,HEMO
    ,PERITO,NONPROFI,PCOLLEGE,PCHRISTI,PPOVERTY,pblack,seast,west,mwest
    ,glakes;selection;keep=yh$
```

```
+---------------------------------------------+
| Poisson Regression                          |
| Maximum Likelihood Estimates                |
| Model estimated: Nov 23, 2009 at 05:59:14PM.|
| Dependent variable                T2008     |
| Weighting variable                 None     |
| Number of observations              295     |
| Iterations completed                  6     |
| Log likelihood function       -1373.722     |
| Restricted log likelihood     -2085.415     |
| Chi squared                    1423.385     |
| Degrees of freedom                   15     |
| Prob[ChiSqd > value] =          .0000000    |
| Chi- squared =  2243.74073  RsqP=   .4434   |
| G  - squared =  2298.08747  RsqD=   .3825   |
| Overdispersion tests: g=mu(i)  :  6.986     |
| Overdispersion tests: g=mu(i)^2:  7.283     |
+---------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-37.1493586	2.11892834	-17.532	.0000	
LIFEEXP	.55698367	.02718550	20.488	.0000	76.7430380
BEDS	-.00012206	.204319D-04	-5.974	.0000	661.126582
TPR	.167090D-09	.201748D-10	8.282	.0000	.430898D+09
HEMO	-.01557950	.00109396	-14.241	.0000	23.0000000
PERITO	-.37856256	.03472152	-10.903	.0000	.68354430
NONPROFI	-.84733203	.05434405	-15.592	.0000	.86075949
PCOLLEGE	-.00762697	.00489225	-1.559	.1190	29.2240506
PCHRISTI	-.03196952	.00211026	-15.150	.0000	49.8875012
PPOVERTY	.07448478	.00852484	8.737	.0000	12.3936709
PBLACK	5.09575790	.39318071	12.960	.0000	.13710477
SEAST	.29870372	.05802184	5.148	.0000	.27848101
WEST	-.35794327	.06956301	-5.146	.0000	.15189873
MWEST	.59576008	.06910843	8.621	.0000	.16455696
GLAKES	.94594354	.06546048	14.451	.0000	.16455696
MlsRatio	-.72149793	.04807735	-15.007	.0000	.24347196