Socioeconomic and Demographic Factors Orchestrating the Organ Shortage Crisis in the United States

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Atticus Lynch

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Atticus Lynch

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Abstract

In the United States 17 people die each day awaiting an organ transplant and only 56% of the population registers as organ donors. The purpose of this study is to assess whether socioeconomic and demographic conditions effect organ donation rates and if so, analyse which conditions have the largest effects. The hypothesis predicts there is an effect from socioeconomic and demographic conditions and specifically receiving more education, earning a higher income and being a Christian positively influences organ donation rates, while being a member of a minority group, receiving less education, and residing in a Southern state negatively influences organ donation rates. Using deceased organ donor data from 37 states along with socioeconomic and demographic data, this study used OLS regressions for its analysis. White, American Indian or Alaskan Native, and Black or African American populations residing in Southern states and lower incomes negatively influenced organ donation rates.

KEYWORDS: (Socioeconomic, Demographic, OLS, Organ Donation)

ON MY HONOR, I HAVE NEITHER GIVEN NOR RECEIVED UNAUTHORIZED AID ON THIS THESIS

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Signature

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Introduction

Since the first kidney transplant in the US in 1954, scientific discoveries continue to push the bounds of human capability to save the lives of people previously given a death sentence. In 2020, there were 37 possible organ and tissue transplants and 108,500 men, women, and children on the waiting list to receive an organ (Jealous et al 2020). The National Organ Transplant Act of 1984 established the systematic framework for organ transplantation and set forth a goal to ensure an equitable and efficient allocation system based on medical criteria. Part of this act named the United Network of Organ Sharing (UNOS) as the operator of the Organ Procurement and Transplantation Network (OPTN) which still coordinates organ transplants in the US today. In the 1980's, the potential for organ rejection limited the number of organ transplants performed (UNOS n.d.), and car crashes on US highways sufficiently fulfilled the limited demand for organs (Jealous et al 2020).

While our capabilities improve, there are insufficient organ transplantations because of an inadequate supply of organs combined with massive demand for transplantations. Unlike other markets where higher prices increase supply, the zero-dollar price ceiling in the organ market prevents the free market from increasing supply. Thus, the controlling factor for the supply of organs is people's willingness to altruistically donate their organs while they are alive or register as organ donors. This prompts the question of what socioeconomic and demographic factors influence people's decision to donate their organs or refuse to do so?

Wadhwani et al (2020) found that while 70% of the population claim they are willing to donate their organs, only 56% of eligible adults register as organ donors. The remaining 44% of unregistered organ donors are the solution to increasing organ supply

and addressing the organ shortage in the US. Although the choice of whether to register as an organ donor is exceptionally personal, this study looks to test the hypothesis that socioeconomic and demographic conditions influence organ donation rates in the US. Specifically, receiving more education, earning a higher income and being a Christian positively influences organ donation rates, while being a member of a minority group, receiving less education, and residing in a Southern state negatively influences organ donation rates.

Identifying groups that donate fewer organs can help the US deploy Organ donation education and resources in a targeted and effective manner across the country. Each day 17 people die waiting for an organ transplant (Health Resources and Service Administration, n.d.). Each organ donor can save up to 8 lives and enhance the life of 75 more people (OPTN, n.d.). Any increase in the number of organ donors positively impacts the US as a whole which makes the organ shortage a serious crisis to address. Previous literature attempts to identify specific factors influencing people's decisions and this section provides a survey of this literature.

1. Literature Review

The literature examined observes several socioeconomic and demographic conditions that may influence a person's decision of whether or not to donate. To investigate if socioeconomic and demographic factors influence organ donation rates, this literature review breaks down factors influencing organ donation into religion, race, socioeconomic, and experience with the US healthcare and organ donation system. The literature review concludes with a discussion of the previous models used to understand people's willingness to donate their organs.

Religion

During the decision of whether to be an organ donor or to receive a transplant religion influences people's choices (Irving et al. 2012). Similar to many other choices about their bodies religious followers look to a higher power to guide their decision. While many religions take a firm stance on abortion and diets, the guidance provided on organ donation by many religions is less direct. The composition of US religion followers is 70% Christian, 23% unaffiliated, 2% Jewish, 1% Muslim, and the remaining follow different religions (Pew Research Center, 2014). For the majority of the US population religion influences their lives and possibly their decision of whether to be an organ donor.

In the Christian faith, different sects of Christianity provide different guidance to their followers on the organ donation decision. Protestants and Catholics compose 45% of Christians and their leaders agree that "organ donation is an act of selflessness and endorse transplantation" (Oliver et al. 2010). Pope Benedict XVI praised organ donation as an example of Christian love and announced he carried a donor card with him at all times. The Church of Jesus Christ of Latter-Day Saints and the Quakers fail to directly guide their followers, but they do not object to organ donation and believe

it is an individual's decision (Oliver et al. 2010). Christian Scientists also view organ donation as a personal choice even though their principal belief is that prayer is the best way to heal. Overall, the most popular religion in the US does not explicitly object to organ donation and many sects make an effort to encourage their followers to donate.

The morals of Judaism come into conflict with organ transplantation and make it ambiguous as to which is the right or wrong decision. The treatment of a Jewish body after death is an important tradition in their faith and three prohibitions interfere with organ donation of the deceased. In Judaism, cadavers must not be desecrated or buried more than 24 hours after death, and no one can receive benefit from a cadaver (Oliver et al. 2010). In conflict with these traditions is a Jewish law that permits the violation of commandments if the result is saving a person's life. Living organ donation does not conflict with these morals, however, the question of deceased donation remains unanswered.

Similar to Judaism, Islam has strict burial guidelines, but an emphasis on altruism in the Islamic faith makes the decision of donating organs difficult for followers (Oliver et al. 2010). Muslims in different regions of the world possess different beliefs, but internationally Islamic scholars endorse organ donation. Although with this advice, Muslims still hesitate to register for deceased donations because of their personal beliefs. In Iran, a majority Muslim country, only 13% of kidney donations were from deceased donors (Oliver et al. 2010). Padela (2020) conducted a study in the US and found that Muslims found organ donation permissible if there is "first person authorization, that donation occur either while living or after circulatory deviation of death, harm to the donor is minimized and

reproductive organs are not donated". While these conditions eliminate donations from patients with brain death, they still permit Muslims to register as organ donors.

Amongst the three most popular religions in the US, none outright prohibit their followers from organ donation. Christianity goes to the extent of encouraging donation while Judaism and Islam provide ambiguous guidance to their followers. As a factor influencing a person's decision to donate an organ, religion may positively influence organ donation rates.

Race

Although people of different races share similar features and lives, the impact of organ donation and transplantation has varying effects depending on a person's race. From necessitating an organ transplant to choosing whether to donate an organ, race plays a role. An important factor in organ transplantation is the matching of antigens between a donor and arecipient. Antigens or human leukocyte antigens (HLAs) are molecules found on the surface of most cells in the body that make up a person's tissue type (National Cancer Institute, n.d.). When the antigens of a donor and recipient do not match this triggers a transplant rejection and the recipient's immune system attacks the transplanted organ (National Library of Medicine n.d.). While it is possible for someone to receive an organ from a person of a different race, the likelihood of an antigen match is low, so this rarely occurs. The necessity for antigen matching means that it is important that there are sufficient donors of a race to donate to those in need of the same race.

For one group in particular, a drastic difference in the number of donors and the number of people awaiting a transplant is causing a major shortage. People with an end-stage renal disease no longer have functioning kidneys and either need dialysis or a kidney transplant to stay alive (Centers for Medicare & Medicaid Services).

Black Americans comprise 12% of the population and are 30% of end-stage renal disease patients (Reitz and Callender 1993). The likelihood for a black person to suffer kidney failure is three times that of a white person (Jealous et al 2020). Then, once a black person suffers from kidney failure and lands on the waiting list their average wait time is 1,335 days compared to 734 for white individuals (Siminoff et al. 2006). A black person's extended waiting time is a combination of two problems. First, black people suffer from kidney failure at a high rate so there are more people on the waiting list. Second, fewer black people register as organ donors so there is not enough supply to meet the demand. In a study conducted by Shah et al in 2018, they found that only 39% of black people registered as organ donors. These two problems create the perfect storm for an organ shortage and adisproportionate number of black people dying while on the wait list for a kidney.

Experiences in healthcare, historical discrimination, and culture prompt black people to scepticism over registering as organ donors. Black males are the least likely group to register as organ donors and the main reason is because of their concerns over discrimination in hospitals (Ebony Boulware et al. 2002). The media and TV perpetuate the idea of discrimination in hospitals by primarily showing organ donation benefitting white people. This leads minorities to the misconception that participation in organ donation will only come to benefit white people (Irving et al. 2012). Also, in black American culture, there is superstition surrounding the discussion of death and the signing of a donor card. Some black people are hesitant to sign a donor card or allow a loved one too because they believe it could potentially lead to death (Irving et al. 2012). Unfortunately, the lack of black organ donors is especially harmful because of the disproportionate number of black people awaiting organ transplants and the necessity for antigen matching.

While the organ shortage has an especially large impact on black people, people of other races also wait years to receive a transplant and there is a lack of donor participation. Shah et al. (2018) found that 64% of white people are likely to register as organ donors and Wadhwani et al (2020) found that higher registration rates associate with predominantly white areas. 56% of Asian Pacific people and 44% of Hispanic people were likely to register as organ donors (Shah et al 2018). Asian Americans and specifically Chinese and Korean Americans have low donor registration rates and the reasoning for the most part is misunderstood (Li 2019). Haustein (2004) found that people exposed to organ transplantation in the last 30 days were more likely to be organ donors. However, knowledge of organ donation and the organ shortage negatively impacted organ donation intent amongst Korean and Chinese Americans (Li 2019). Surveying the literature on the impacts of race on organ donation there is a general trend of mistrust in the healthcare and organ donation system amidst minority groups and higher rates of organ donation from white people.

Socioeconomic

Multiple studies focused on socioeconomic effects on organ donation show that income, employment, education, and geography impact one's decision to register. Addressing socioeconomic impacts broadly Wadhwani et al. (2020) found that a decrease in socioeconomic deprivation associates with an increase in donor registrations. Also, people residing in more disadvantaged zip codes were less likely to register as organ donors (Shacham et al. 2018). On the transplantation side, groups that "experience subordination and exclusion in many aspects of their lives are more represented among patients diagnosed with organ failure than on waiting lists" (Kizer

et al. 2022). These studies show that socioeconomic factors affect both the supply and demand for organs, but within this, each component has a unique impact.

Income and levels of poverty affect rates of organ donation and authorization across the country. Conducted in Kentucky, a study by Shah et al. in 2018 found families with an income above $45,000 authorized the donation of their loved one's organs at a higher rate, and those residing in areas with high poverty rates authorized at a lower rate. Another study found higher concentrations of individuals living below the poverty line, receiving SNAP benefits, and higher unemployment rates associate significantly with lower donor registration rates (Shacham et al. 2018). There is evidence that the effect of income on organ donor registration is stronger than the effect of race. When controlling for race, living donation rates were lower for white and black populations in lower-income zip codes and there was a high rate of organ donation from black people in higher-income zip codes (Gill et al. 2013). Gill et al. (2013) examined living donation rates and noticed that expenses related to living organ donation make it especially difficult to donate an organ living on a low income. Living organ donors lose 1 month of salary recovering from surgery and spend money on lodging, travel, and childcare. Income has a serious effect on organ donation; however, socioeconomic factors overlap with one another and work together to impact someone's decision.

Research from the Federal Reserve Bank of St. Louis indicates that "the level of education is strongly related to both income and wealth" (Wolla et al. 2017). Multiple studies find that more education associates with higher rates of organ donation (Reitz and Callender 1993, Shah et al. 2018, Shacham et al. 2018). Shah et al. (2018) specifically found that people with a college degree or higher are much more likely to donate. A few studies focus directly on how education on organ

donation affects registration and donation rates. Adolescent organ education programs in nine different countries increased knowledge and the intent to donate organs (Li et al. 2013). Black people in the US historically receive less education on organ donation and are also one of the least likely groups to register as organ donors (Reitz and Callender 1993). Organ donation education has the potential to increase organ donation rates because it can demystify many of the misconceptions about registering as an organ donor. For instance, a common misconception is that registering as an organ donor leads to receiving worse care in a hospital (Irving et al. 2012). People believe that nurses and doctors have more interest in harvesting the organs of registered donors than providing the care necessary to keep them alive. Education correcting these factual errors and higher levels of general education can positively influence organ donation rates.

Connected Linkedto income, education, and someone's decision of whether to donate an organ is where someone lives. Wadwhani et al. (2020) analysed organ registration data from five different states and found large differences in organ donor participation. Oregon had the highest donor registration percentage of 56.7% while New York's fell far below half at 22.7%. Inner city hospitals typically serving minority populations are the lowest providers of organ transplants (Reitz and Callender 1993). New York City alone composes 43% of the population of New York and 60.2% are minorities (US Census, 2020). The high urban and minority population of New York may explain the state's low organ donor participation. The rural setting is also another location where "organ consent rates are traditionally low" (Bean 2006). While it is difficult to predict organ donation solely based on where someone lives, geography affects education and income which influence a person's decision to register as an organ donor.

Experience in Healthcare and Organ Donation Systems

The structure of the US healthcare system and people's previous experiences with the system affects many people's decision to register as organ donors. In a qualitative study exploring community attitudes towards living and deceased organ donation Irving et al. (2012) saw that previous negative experiences in the healthcare system make people sceptical of donating their organs. Respondents did not believe in donating their organs to a system that they do not trust. Black Americans express higher distrust in the US healthcare system than most groups and have a lower rate of organ donation (Wadhwani et al. 2020). The distrust motivating people not to donate their organs stems from the structure of the US healthcare system and the discrimination within it.

Throughout the US organ donation system, there are examples of structural issues and discrimination that affect organ donation rates. Transplant coordinators communicate with the family and friends of the deceased to gain consent for organ donation. They play a pivotal role in organ procurement and have difficult conversations that have the potential to save many lives. Only 5% of organ transplant coordinators are black (Reitz and Callender 1993). In addition to this, transplant coordinators approach black families about organ donation less frequently than other families because of a stereotype that they always refuse (Reitz and Callender 1993). Kizer et al. (2022) posit that systemic healthcare issues exist because "acknowledgment of individual health disparities have taken over attention to structural and systemic solutions to inequities". These inequities affect people's opinions on organ donation and contribute to the organ shortage in the US.

The imperfections of the US healthcare and organ donation system make it important to look at other countries and their approach to saving lives through organ

donations and transplantations. The US currently has an “opt-in” organ donation system that requires people to take action to demonstrate they consent to the donation of their organs after they die. “Opt-out” organ donation systems are growing in popularity across the globe. In “opt-out” systems, the assumption is that adults are organ donors unless they take an action to show that they do not want their organs used. Since 2018, England and the Netherlands switched to an “opt-out” system and the first signs of the impact on organ donation rates are positive (Jansen et al. 2022). England reached its highest consent rate on record in 2022 at 70.3%. “Opt-out” systems have positive impacts on donor registration rates, however, Shepherd et al. (2023) observed lower numbers of living donors in “opt-out” countries compared to “opt-in”. About 6,000 of the 20,000 organs transplanted in the US per year come from living donors (CDC) so a switch to “opt-out” in the US could have an overall negative effect on organ donations.

China takes a unique approach to solving its country’s organ shortage by harvesting the organs of executed prisoners. Each year China harvests 2,000 organs from deceased prisoners (Wong 2009). The government of China expanded its list of capital crimes in what many believe to be an effort to accommodate the country’s demand for organs. While this approach may seem foreign, in 2023 the Massachusetts state government proposed a bill to allow prisoners to donate their organs in exchange for shorter sentences (Munez 2023). The ethics of utilizing prisoner’s organs is a frequent discussion, however in the context of economics, the utilization increases supply.

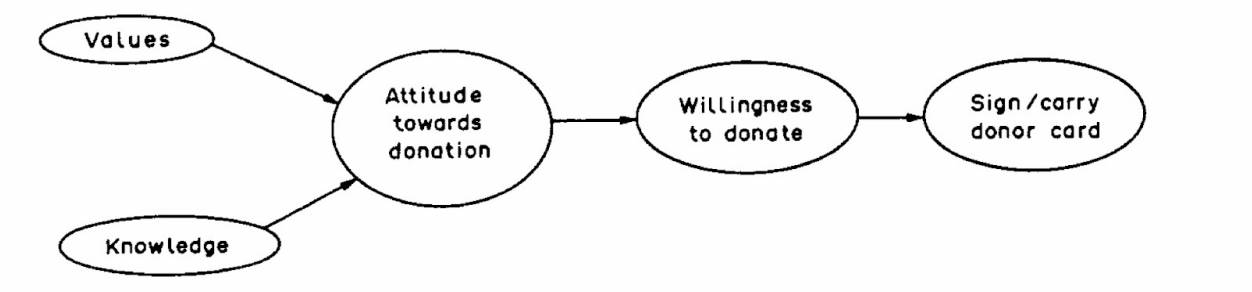
Models of Organ Donation

Much of the literature modelling Americans' decision to donate their organs focuses on individuals' beliefs that direct their decision. Organ donation researchers gather data by surveying small geographic areas and asking specific questions such as "Do you believe that organ donation is a natural way to prolong life?" (Morgan et al 2003). Siminoff, et al (2006) conducted a phone survey of 1,283 subjects in Ohio, Boulware et al (2003) received 385 responses to a questionnaire from residents of the Baltimore, Maryland metropolitan area, and Morgan et al (2003) surveyed 798 employees of a large national corporation. These studies yield engaging results; however, they reveal little about national trends in organ donation rates. Contrary to these previous studies, this study attempts to uncover national socioeconomic and demographic trends that may influence groups' decisions on whether to donate their organs.

While the overarching goal of this study differs from previous works it remains important to examine and extend existing models of the willingness of people to donate their organs. Horton and Horton (1991) established a framework for many other studies to come. These two authors believed five conceptual variables influenced one's decision to donate their organs and those were "values, factual knowledge regarding donation, attitudes, willingness to donate, and whether the subject carried an organ donor card or requested one when given an opportunity to do so" (Horton and Horton 1991). The justification for these conceptual variables was that each functions as a component in the decision-making process to donate an organ. "Values" and "knowledge" build an attitude towards donation which determines someone's willingness to donate which leads to whether someone signs or

carries an organ donation card. The authors diagrammed this model as shown in in Figure 1, below.

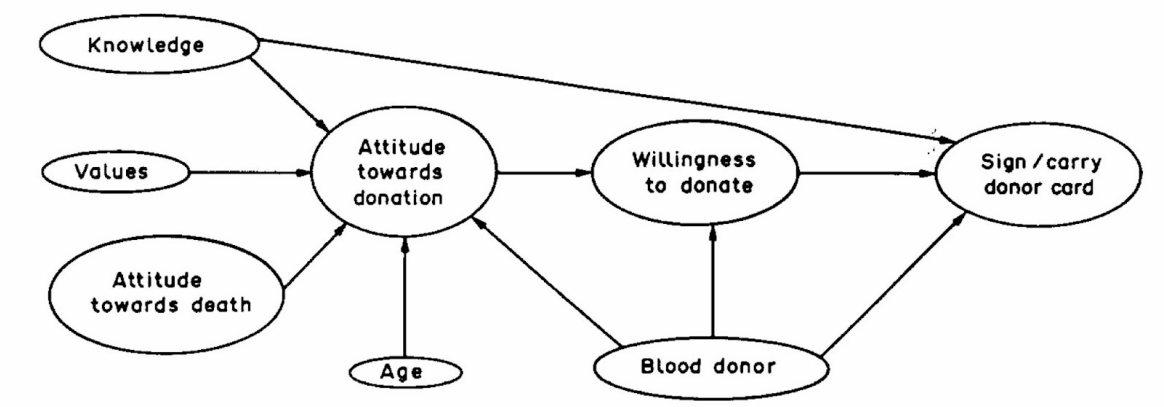
Figure 1: A model of willingness to become a potential organ donor



Source: Horton and Horton, 1991

Horton and Horton hypothesized that all coefficients in this model were positive and tested this hypothesis by surveying 295 undergraduate and MBA students at Eastern University with questions about organ donation. After regressing their survey data, the evidence showed that the act of carrying or requesting an organ donor card relates to "values" and factual "knowledge" regarding organ donation. The authors extended their original model by adding attitudes toward death, prior blood donation, and the age of the subject.

Figure 2: Adapted model of willingness to become a potential organ donor

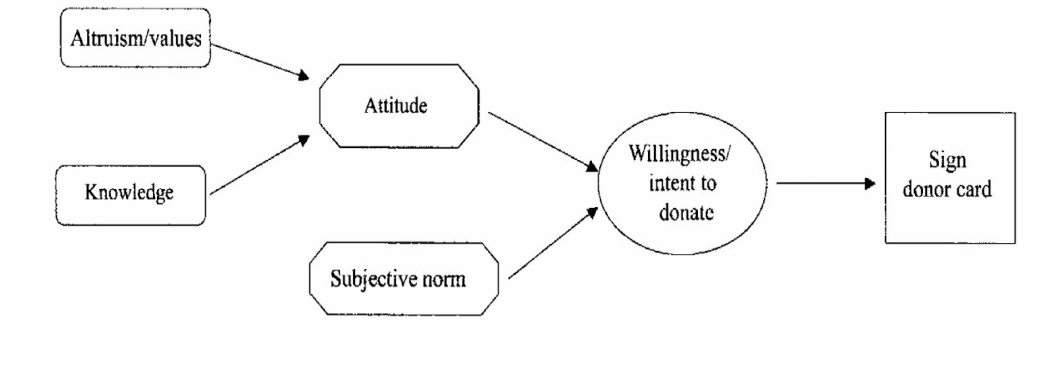


Source: Horton and Horton 1991

They tested this model by surveying 365 adults in their local community and found the path between knowledge and carrying or signing a donor card as nonsignificant with the addition of other variables. Overall Horton and Horton's empirical studies provided evidence for their model and their work laid the foundation for an in-depth model of the organ donor decision-making process that aided many researchers who followed.

Morgan et al (2003) took a step beyond Horton and Horton's research by examining similarities and differences between African Americans' and European Americans' attitudes about organ donation. Their model followed a highly similar pathway to Horton and Horton's however with the addition of a "subjective norm" conceptual variable that Kopfman and Smith proposed in 1996.

Figure 3: Adapted Donor Willingness Model



Source: Morgan et al. 2003

The "subjective norm" variable is the "perception that important people in a person's life would approve of a particular course of action, compounded by an individual's motivation to comply with these wishes" (Morgan et al 2003). The definition of "important people" in Morgan et al's explanation of their model is unclear, however, the assumption is that this group includes family members, religious leaders, teachers, or anyone that a person may seek for approval. With this model in place, Morgan et al hypothesized that there is a lower likelihood of African

Americans donating their organs than European Americans and a higher likelihood that African Americans hold misconceptions regarding organ donation. To test this hypothesis 798 adult employees of a large national corporation completed a questionnaire testing their organ donation knowledge, values, and levels of altruism.

The results showed that African Americans possess more reluctance to become potential organ donors due to less favourable attitudes towards organ donation, lower levels of knowledge about organ donation, and less perceived social support for organ donation. Morgan et al's research addresses how a demographic factor affects organ donation and provides a basis for this study which dives into how many demographic and socioeconomic factors affect someone's decision to be an organ donor.

Next Steps

This literature review summarizes the previous studies focused on identifying socioeconomic and demographic factors influencing Americans' decision to register as organ donors. Most of the literature analysed isolated the impact of one socioeconomic or demographic factor on organ donation. This study takes a broader approach and examines how all of the factors influence organ donation rates together. The following section presents a theoretical model to investigate what factors effect organ donation rates.

2. Theory

Base Model

While Morgan et al analysed how being white or black effects organ donation, this study investigates how five different racial groups, 15 religious' groups, income level, marital status, education level, and age affect organ donation rates in 37 different states. Since this investigation takes a broader approach to assessing how organ donation decisions are made, it requires manipulation of the previous models used to research this subject. Morgan et al's model is the base model in this study and the findings from Morgan et al's study permit certain assumptions that allow this study's model to function

The literature review describes the diagram of Morgan et al's (2003) approach to assessing people's willingness to donate organs but does not lay out the empirical model used in the study. Morgan et al. (2003) do not explicitly display their empirical model in their paper, but inferring from the description of their regression their equation is as follows:

$$ISO = \beta_0 + \beta_1 Kn + \beta_2 Alt + \beta_3 Att + \beta_4 Sub + \varepsilon$$

Where **ISO** is the dummy dependent variable which is 1 if someone intends to register as an organ donor and 0 if not.

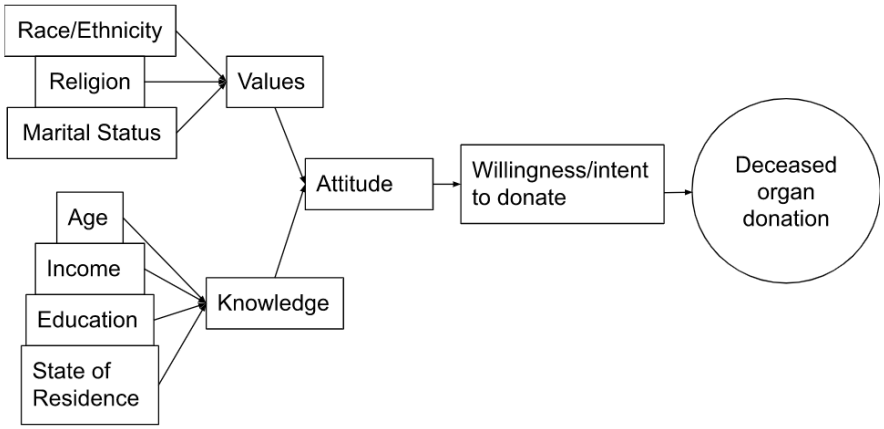
- **Kn:** variable measuring the general knowledge someone possesses about organ donation
- **Alt:** variable measuring altruistic values
- **Att:** variable measuring attitude toward organ donation
- **Sub:** variable measuring subjective norm

The “Kn” and “Alt” variables are exogenous and the “Att” and “Sub” variables are mediating variables. This study chooses to extend the Morgan et al. (2003) empirical model because the studies regression results support the utility of the model, and the model unravels the process of an individual deciding whether to donate their organs. Understanding how an individual decides to donate organs allows this model to extend further and analyse the socioeconomic and demographic conditions impacting organ donation rates across different groups.

Modifications to the base model

The simplest way to describe the model of this study is by zooming out of the Morgan et al model and analysing the broader influences on people. This study examines what socioeconomic and demographic factors formed the “values” and “knowledge” that guide people when deciding whether to be an organ donor. Are there certain cultures associated with racial groups that promote organ donation? Does receiving more education increase the likelihood that someone will register as an organ donor? These are just a few of the more nuanced questions that the results of this study hope to answer. The model for this study is diagrammed below in figure 4.

Figure 4: Organ Donation Rate Model



Source: Generated by Author

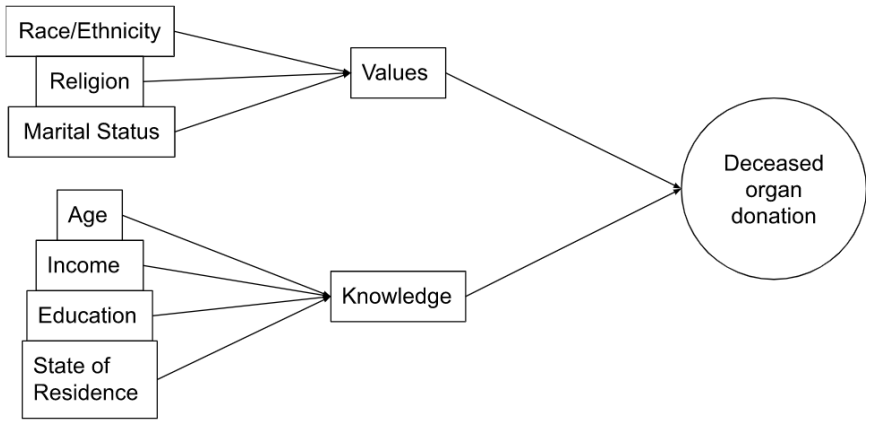
The modifications to the base model include the relabelling of one variable, the addition of new variables and the removal of variables previously included in the base model. The dependent variable in Morgan et al's model is whether someone physically signs a donor card. In this study due to data constraints the dependent variable is "deceased organ donation". All the additions to the model are variables that affect the "values" and "knowledge" that people possess about organ donation. The pathway from "attitude" to "signing a donor card" remains the same and the variables added do not affect any of these steps. The variables with the possibility to affect the "values" of someone are their race/ethnicity, religion, and marital status. Income, education, age, and state of residence are the variables that may affect the "knowledge" someone has about organ donation.

There is only one variable removed from the Morgan et al. model and that is the "subjective norm". The Morgan et al. study found the relationship between "attitude" toward organ donation and "willingness to donate" to be significantly stronger than the relationship between "subjective norm" and "willingness to donate". Additionally, many of the variables affecting the "values" and "knowledge" of an organ donor could potentially affect the "subjective norm" variable as well. For example, religion clearly influences one's "values" since many religious teachings gear toward morality. Religion also impacts the "subjective norm" variable because people seek to impress and gain approval from their religious leaders. Since the "subjective norm" variable lacks a strong relationship to a willingness to donate organs in previous studies and would complicate the model, this study excludes the variable.

Assumptions

While the overall goal of Morgan et al.'s study is to identify differences between African American and European American beliefs about organ donation, another component is confirming the utility of the model of organ donation willingness. Morgan et al. confirmed the utility of this model which permits this study to assume that this model functions. The meaning of this assumption is that the pathway from "knowledge" and "values" to "signing a donor card" is all true. That is if someone has positive "knowledge" and "values" about organ donation, they will donate their organs when they die. Reconstructing the original model to reflect this assumption results in the diagram below.

Figure 5: Organ Donation Rate Model with Assumptions



Source: Author generated

In addition to the assumption that there is utility in the willingness to donate model by Morgan et al., this study assumes the relationship between the added variables and "knowledge" and "values" about organ donation. Race/ethnicity relates to "values" because within each race/ethnicity, an underlying culture of that group frequently influences members' life decisions. One example previously mentioned in the literature review was the culture of black people feeling hesitant to speak about death because of a fear that it will bring death soon. This group values avoiding

discussion of death which in turn affects their “attitude” toward organ donation. Religion provides the foundation of many people's values and guides them in many decisions when it comes to their bodies or cadavers. Finally, the transition from being single to being married can affect one's values. This comes either from adopting the values of one’s partner or changing values because of having a life partner. Once values form from these three variables, they then influence whether someone decides to register as an organ donor.

Income and education link closely with a person’s “knowledge” about organ donation. Receiving more education opens the door to learning more about the organ shortage crisis in the US and the necessity for people to register as organ donors. As previously mentioned in the literature review income and education closely relate. A person’s age relates to their “knowledge” in a couple of different ways. First, younger people between the ages of 18-22 may know less about organ donation because they are still in school and receiving their education. Next, different age groups consume different types of media and learn in different ways. Younger people may gain more exposure to national issues from social media while an older person may not gain this exposure because of their lack of social media consumption. Finally, different states have different programs to increase awareness about the organ shortage crisis in the US. At least eight states (Arkansas, Indiana, Iowa, Minnesota, Mississippi, Ohio, Texas and Wisconsin) require organ donation education in drivers’ education classes (Madigan, 2003). These education programs directly influence the level of “knowledge” that someone possesses about organ donation. Like values, knowledge about organ donation affects people’s decision in the end of whether they register as an organ donor.

Empirical Model

Drawing on the diagrams above this analysis uses the following empirical model:

$$DR = \beta_{0it} + \beta Re_1 + \beta_2 St + \beta_3 Inc + \beta_4 Age + \beta_5 Sex + \beta Mar_6 + \beta Smk_7 + \beta Urb_8 + \beta Edu_9 + \beta Bud_{10} + \beta Cat_{11} + \beta Ep_{12} + \beta Hin_{13} + \beta Hbp_{14} + \beta Jh_{15} + \beta Jw_{16} + \beta Mp_{17} + \beta Mor_{18} + \beta Mus_{19} + \beta Oc_{20} + \beta Otc_{21} + \beta Of_{21} + \beta Owr_{22} + \beta Unf_{23} + \beta Dk_{24} + \varepsilon_1 \quad \text{[Equation 1]}$$

Where **DR** is a continuous variable for donation rate, which is a measure from 0 to 1 of the percentage of people that donate their organs given the specified variables that describe their socioeconomic and demographic conditions.

- **St:** collection of dummy variables that identify the state of residence of a deceased donor. There 37 categorical variables corresponding to the 37 states examined.
- **Re:** collection of dummy variables that identifies donor's race/ethnicity. The categories are: American Indian or Alaskan Native, Asian or Pacific Islander, Black or African American, Hispanic or Latino, and White
- **Inc:** median household income by state and year measured in 2021 US dollars.
- **Age:** the median age for each state by year
- **Sex:** dummy variable identifying the gender of a deceased organ donor.
- **Mar:** percentage of a state's population that is married measured from 0 to 1.
- **Smk:** percentage of state's population that smokes tobacco measured from 0 to 1.
- **Urb:** percentage of state's population that lives in an urban environment measured from 0 to 1.

- **Edu:** percentage of a state's population that received a college degree or higher measured from 0 to 1.
- **Bud:** percentage of state's population that is Buddhist measured from 0 to 1.
- **Cat:** percentage of state's population that is Catholic measured from 0 to 1.
- **Ep:** percentage of state's population that is Evangelical Protestant measured from 0 to 1.
- **Hin:** percentage of state's population that is Hindu measured from 0 to 1.
- **Hbp:** percentage of state's population that is Historically Black Protestant measured from 0 to 1.
- **Jh:** percentage of state's population that is Jehovah's Witness measured from 0 to 1.
- **Jw:** percentage of state's population that is Jewish measured from 0 to 1.
- **Mp:** percentage of state's population that is Mainline Protestant measured from 0 to 1.
- **Mor:** percentage of state's population that is Buddhist measured from 0 to 1.
- **Mus:** percentage of state's population that is Muslim measured from 0 to 1.
- **Oc:** percentage of state's population that is Orthodox Christian measured from 0 to 1.
- **Otc:** percentage of state's population that is another denomination of Christianity measured from 0 to 1.
- **Of:** percentage of state's population that is of another faith measured from 0 to 1.
- **Owr:** percentage of state's population that is of another world religion measured from 0 to 1.

- **Unf:** percentage of state's population that is unaffiliated with a religion measured from 0 to 1.
- **Dk:** percentage of state's population that does not know their religion measured from 0 to 1.

This section analysed previous models used to investigate a person's willingness to register as an organ donor, and explained the modifications needed to create a model for this study. Compared to previous willingness to donate models, the model in this study takes a broader perspective focusing on the socioeconomic and demographic factors that may affect someone's decision to donate their organs. The following section describes the data used to estimate the model, the dependent variable and all the independent variables

3. Data and Methodology

This section outlines the dataset used for this study and defines each variable, its source, and its purpose. The conclusion of this section describes the advantages and limitations of the selected dataset as well as the methodology for the analysis.

Dataset

The dataset for this study includes 27 variables and 8,140 observations from 1999-2020. This study adopts many of the socioeconomic and demographic variables included in previous studies on organ donation, however, the data collection strategy differs. As mentioned in the literature review many of the previous studies collected survey data from around 1,000 survey participants. The dependent variable in these studies is whether a single individual decides to register as an organ donor. This study differs because the dependent variable is the organ donation rate of groups from different socioeconomic and demographic conditions.

Since many countries have different systems for organ donation this study focuses entirely on the United States. The dataset includes 37 states and for each state, there is a percentage of the people who died and donated their organs by race/ethnicity and gender for each year from 1999 to 2020. The exclusion of Connecticut, Delaware, Hawaii, Indiana, Kentucky, Maine, Montana, New Hampshire, North Dakota, South Dakota, Vermont, West Virginia, and Wyoming is due to missing death data across different years, racial groups, and genders.

The data ranges from 1999-2020 because this is the longest and most current timespan where there is data for the dependent variable and all the independent variables. Independent variables other than race/ethnicity and gender measure socioeconomic and demographic conditions at the state level. There are two categories of independent variables, and they are socioeconomic variables and

demographic variables. The data for both the dependent and independent variables comes from various sources that are detailed in this section.

Dependent Variable

The dependent variable in this study is a continuous variable which is the rate at which people from different socioeconomic and demographic conditions donate their organs. The rate comes from the following equation:

$$\frac{Total\ Deceased\ Donors}{Total\ Deaths} = Organ\ Donation\ Rate$$

The rate derives from two different data sources because of the necessity to have data on deceased organ donors and the total number of deaths in a year.

The number of deceased organ donors comes from the Organ Procurement and Transplantation Network (OPTN). This is the institution responsible for matching organ donors to those on the waitlist awaiting organ transplantation. By focusing on deceased donors and excluding living donor data, this study can focus on what socioeconomic and demographic conditions influence someone's decision of whether to register as a donor before they die. Living donations frequently come from the loved one of someone on the waiting list and inaccurately measure the altruistic decision to become an organ donor.

Total deaths by socioeconomic and demographic group come from the Center for Disease Control WONDER database. The WONDER database is "a system for disseminating Public Health data and information". The total deaths include deaths from any cause ranging from car crashes to disease. The OPTN and WONDER database both organize their data with the same filters for race/ethnicity and gender

allowing for the calculation of the organ donation rate dependent variable used in this study.

For many observations in the data set the dependent variable is zero. This means that none of the deceased members of a certain socioeconomic and demographic group donated their organs in a specific year. When the percentage is above zero this means there was at least one deceased donor in that socioeconomic and demographic group. Table 4.2.1 provides summary statistics for the donation rate dependent variable and table 4.2.2 shows the overall donation rate of each racial group from 1999-2020.

Table 4.2.1

Variable	Observations	Mean	Std. Dev.	Min	Max
Donor rate	8,140	.0101606	.014102	0	0.1967213

Source: Generated by author.

Table 4.2.2

Race/Ethnicity	American Indian or Alaskan Native	Asian or Pacific Islander	Black or African American	Hispanic or Latino	White
Deceased Donors	1268	8496	41138	39268	203343
Total Deaths	317083	1035394	6560789	3368666	44775553
Donation Rate	0.40%	0.82%	0.63%	1.17%	0.45%

Source Generated by author.

Independent Variables

Socioeconomic Variables. The model utilizes several socioeconomic variables for its analysis. The state of residence of a deceased donor is a socioeconomic variable along with other factors measured at the state level. Measurements at the state level are either a percentage of the state population or the median value in the population.

- **State dummy variables:** for each state, there is a dummy variable which is 1 if a group of deceased donors resided in that state and 0 if not.
- **Inc:** median household income by state and year measured in 2021 US dollars.
- **Educ:** percentage of a state's population with a college degree or higher.
- **Urb:** percentage of a state's population residing in an urban area.

The median household income, education, and urban population variables come from the United States Census bureau. More specifically the median household income data is from the historical income tables, education data is from the American Community Survey (ACS), and urban population data is from the decennial census. Since the urban population data is from the decennial census this means that there is data from a collection in 2000 and 2010. In the dataset years 1999-2010 are observations from the 2000 data collection and years 2011-2020 are observations from the 2010 data collection. Data for the state of residence of groups of organ donors come from the Organ Procurement and Transplantation Network (OPTN).

Table 4.3.1

Variable	Observations	Mean	Std. Dev.	Min	Max
Inc	8,140	65113.18	10311.85	37673	101283
Educ	8,140	.3382267	.0727783	.171	0.597
Urb	8,140	76.33882	11.89398	48.8	95

Source: Generated by author.

Demographic Variables. Demographic variables in this model use both state-level data and donor-specific data to see what effect they have on organ donation rates. Similar to the socioeconomic variables, demographic variables measured at the state level are either a percentage of the population or the median.

- **Race/ethnicity dummy variables:** five racial categories identify the race of deceased donors. The racial categories are American Indian or Alaskan Native, Asian or Pacific Islander, Black or African American, Hispanic or Latino, and White. If a deceased donor is of a specific racial/ethnic group the value is 1 and 0 if not
- **Sex:** dummy variable that identifies the gender of a deceased donor. The value for females is 1 and the value for males is 0.
- **Mar:** rate based on provisional counts of marriage by the state of occurrence. Rates are per 1,000 total population residing in the area.
- **Smk:** percentage of the state's population that smokes tobacco measured from 0 to 1
- **Age:** the median age for each state by year
- **Religion variables:** the percentage of members in each state of 14 different religions and percentage of people unaffiliated with any religion or they do not know their religion.

The race/ethnicity and gender variables are part of the OPTN dataset of deceased donors. These independent variables are specific characteristics of deceased organ donors. The rest of the demographic variables come from state-level measurements. The source of the marital status data is the CDC which collected data in 1990, 2000, and 2010. All of the other years in the dataset come from their estimates of provisional counts of marriage in each state. The variable for the percentage of a state's population that smokes is from the CDC's "Behavior Risk Factor Surveillance System". The median age for each state comes from a US Census dataset. Finally, the independent variables for religion by state come from the Pew

Research Center which conducted religious landscape studies of the US in 2007 and 2014. Pew collected the data by surveying 35,000 Americans from all 50 states and then using this data they estimated religious followings by state. Since the data collections only took place twice between 1999-2020, the data from 2007 goes from 1999-2010 and the data from 2014 goes from 2011-2020 in the dataset for this study.

Table 4.4.1

Variable	Observations	Mean	Std. Dev.	Min	Max
Mar	8,140	7.923833	7.008025	3.2	82.3
Smk	8,140	18.90021	4.137995	6.7	30.25
Age	8,140	37.27101	2.095699	24.9	42.1
Bud	8,140	.0069717	.0045666	.0025	0.02
Cat	8,140	.197199	.0960071	.04	0.43
Ep	8,140	.272285	.1128284	.07	0.53
Hin	8,140	.0052826	.0053545	.0025	0.03
Hbp	8,140	.0682064	.0595936	.0025	0.24
Jh	8,140	.0074201	.0049301	0.0025	0.02
Jw	8,140	.0146192	.0187875	.0025	0.15
Mp	8,140	.1608845	0.0539594	0.06	0.32
Mor	8,140	.0301904	.0915324	.0025	0.58
Mus	8,140	.0068059	.0057217	.0025	0.03
Oc	8,140	0.0066032	0.0081601	.0025	0.05
Otc	8,140	.0060381	.0212582	.0025	0.25
Of	8,140	.0147666	.007803	.0025	0.04
Ow	8,140	.0072727	.0304156	.0025	0.12
Unf	8,140	0.2048894	.0580548	0.06	0.32
Dk	8,140	.008145	.0048789	.0025	0.02

Source: Generated by Author

Advantages

The distinguishing advantage of this study is that the broader approach to examining socioeconomic and demographic factors effecting organ donation allows for analysis of a larger dataset. Compared to previous studies the dataset for this one includes 8x as many observations. The results of a larger and broader dataset identify

the organ donation rate of socioeconomic and demographic groups rather than individuals. In the long run these results can help improve organ donation rates in the groups that donate the least organs.

Another advantage of this dataset is within the details of the dependent variable. Previous studies collected organ donor registration data; however, this study examines deceased donor data. When someone registers as an organ donor, dies, and their organs are eligible for donation this does not necessarily mean there is successful donation of their organs. Families of registered organ donors hold the power to refuse the donation of their loved one's organs. Deceased donor data includes the information of whether someone was a registered organ donor and if their family approved the donation of their loved one's organs. Assuming that organ donors' families share many of the same socioeconomic and demographic conditions, the results provide insight into organ donor registration and which families accept or refuse the donation of their loved ones organs.

Finally, this data addresses a larger number of independent variables than previously conducted studies. Wadhwani et al. (2020) and Shah et al. (2017) solely focused on socioeconomic factors, and Morgan et al. (2003) compared donation between two racial groups. This study combines both the socioeconomic and demographic factors influencing organ donation and the dataset includes numerous variables within these two categories. While the broader and larger dataset holds many advantages, the lack of detail of certain variables causes limitations.

Limitations

As mentioned earlier in this section the dependent variable is the percentage of deceased donors in the total deceased population for a given state, race/ethnicity and

gender. Making the percentage out of the total deceased does not account for deaths ineligible for organ donation. Dividing deceased donors by the total deaths eligible for organ donation eliminates this issue, however locating data for the total deaths eligible for organ donation was not possible. Overall, approximately 2% of Americans die in circumstances that allow for organ donation (Neergaard et al, 2019). By using a dataset that spans 21 years and contains many observations the idea is that each gender and racial group experiences on average the same number of deaths eligible for organ donation. The fact still remains however that in some years there is a probability that of all the deaths that occurred none of them were eligible for organ donation.

On the other side of the equation, the dataset only contains three independent variables specific to the deceased donors. The variables specific to deceased donors are their race/ethnicity, gender, and state of residency. Each independent variable outside of these three measures a percentage or median of a variable in the state which the deceased donor resided. Collecting national data that included deceased donors' education, religion, and income specific to each donor was not a possibility, so the next best option was to use data from the deceased donors state of residence. Using percentages and medians of state populations limits the strength of the coefficients significance when interpreting the analysis.

The lack of annual data for some independent variables also limits the dataset. The urban population and religion variables only had two data collections between 1999-2020. So, in the dataset these variables repeat the same observations for 10-year spans and there is no annual variance in the variables. The preference is to use data that captures the changes in urban population and religious followings each year,

however, the variance between years for these variables is likely low considering people tend to follow one religion their entire life and new housing takes a considerable amount of time to develop.

Methodology

To analyze the effect of different socioeconomic and demographic conditions on organ donation rates, this study uses three separate models. All three models utilize an ordinary least squares regression; however, the inputs and structure of the regressions vary between each model.

Model 1 details how each socioeconomic and demographic factor effects organ donation rates. This model assesses organ donation across every state included in the study and provides an understanding of each variable's effects throughout the United States. The primary hypothesis in this study is that socioeconomic and demographic conditions influence organ donation rates. The first goal of Model 1 is to test whether the data supports or refutes this primary hypothesis. Additionally, Model 1 provides an understanding of the role socioeconomic and demographic factors have influencing organ donation rates.

Model 2 conducts regional regressions separated by a Southeast, Southwest, West, Midwest, and Northeast region. Similar to Model 1, the ordinary least squares regressions in Model 2 are on donation rate for different socioeconomic and demographic factors. By conducting regressions for five different regions in the US Model 2 uncovers how socioeconomic and demographic factors effect organ donation in different parts of the country. The second part of this study's hypothesis is that residing in a Southern state negatively influences organ donation rates. This model

assesses whether the data supports this hypothesis and provides insight into organ donation rates in each region of the US. The regions used in Model 2 are as follows:

Table 4.7.1

Southeast	**Southwest**	**West**	**Midwest**	**Northeast**
Alabama	Texas	California	Kansas	Massachusetts
Arkansas	Oklahoma	Nevada	Michigan	New Jersey
Florida	Arizona	Utah	Minnesota	New York
Georgia	New Mexico	Oregon	Illinois	Pennsylvania
Louisiana		Washington	Nebraska	Rhode Island
Mississippi		Colorado	Missouri	
South Carolina		Alaska	Indiana	
Tennessee			Ohio	
Virginia			Wisconsin	
North Carolina			Iowa	

Source: Generated by Author

Finally Model 3 assesses the combined effect of race/ethnicity and state of residence on organ donation rates using interaction terms in the regression. Mentioned throughout this study is how the results potentially hold information on the socioeconomic and demographic groups who donate organs at low rates. Combining the effect of race/ethnicity and state of residence makes it possible to isolate racial groups in specific states and examine organ donation rates. This model along with Model 2 help address the aspects of the hypothesis regarding differences amidst states organ donation rates.

4. Results and Analysis

This section presents the ordinary least squares regression results of three models used to test the broad hypothesis that socioeconomic and demographic conditions influence organ donation rates in the US and the more specific hypothesis that more education, higher income, and Christianity positively influence organ donation rates, and being a member of a minority group, receiving less education, and residing in a Southern state negatively influences donation rates.

Regression Models

Table 5.1.1 shows the independent effects of socioeconomic and demographic factors on organ donation from Model 1. Then, table 5.1.2 shows Model 2 data which separates the data into five regions of the United States and analyses the effect of socioeconomic and demographic conditions in each specific region. Finally, Model 3, shown in table 5.1.3, uses interaction terms between state of residence and race/ethnicity to see the combined effect of these variables on organ donation. Some of the variable's coefficients and their significance vary across the different models, while other variables maintain consistent significant coefficients.

Collinearity amidst the independent variables affected each of the three models and the removal of many variables took place to combat this issue. To detect collinearity this study used the variation inflation metric (VIF) and VIF metrics higher than 10 constituted the removal of the variable from the regression. Each model does not contain the percent urban population by state because of its consistently high VIF value and its high correlation with median income found in the correlation matrix. The analysis of each model includes a discussion of the specific variables removed from the model due to collinearity.

Table 5.1.1

VARIABLES	Organ Donation Rate	SE
Race/Ethnicity		
White	0.0590*	(0.0338)
Asian or Pacific Islander	0.858***	(0.0379)
Black or African American	0.248***	(0.0186)
Hispanic or Latino	1.421***	(0.0441)
American Indian or Alaskan Native	-	
Religions		
Buddhist	-0.517	(3.464)
Hindu	3.777	(3.349)
Historically Black Protestant	0.403	(0.423)
Jehovah's Witness	-4.935	(3.208)
Jewish	6.460***	(1.090)
Mainline Protestant	2.461***	(0.425)
Mormon	0.0233	(0.232)
Muslim	-4.710	(3.122)
Orthodox Christian	-7.856***	(2.658)
Other Christian	-2.062*	(1.253)
Other Faiths	-6.099**	(3.083)
Other World Religions	1.149*	(0.604)
Unaffiliated	-0.923**	(0.446)
Don't know	-0.307	(3.016)
Socioeconomic/Demographic		
Smoking Percentage	0.0680***	(0.00552)
Gender	0.0110	(0.0280)
Median Income	1.95e-05***	(2.27e-06)
Median Age	-0.127***	(0.0102)
Constant	2.422***	(0.479)
Observations	8,140	

Robust standard errors in parentheses

Source: Generated by author *** p<0.01, ** p<0.05, * p<0.1

Table 5.1.2

	(Southeast)		(Southwest)		(West)		(Midwest)		(Northeast)	
VARIABLES	Donation Rate	SE	Donation Rate	SE	Donation Rate	SE	Donation Rate	SE	Donation Rate	SE
Race/Ethnicity										
White	0.156*	(0.0798)	0.0705	(0.05)	0.140***	(0.05)	0.0205	(0.06)	0.173	(0.115)
Asian or Pacific Islander	1.077***	(0.0842)	0.949***	(0.13)	0.487***	(0.06)	0.902***	(0.08)	0.803***	(0.075)
Hispanic or Latino	0.0840***	(0.0368)	0.425***	(0.05)	0.246***	(0.06)	0.327***	(0.03)	0.278***	(0.039)
Black or African American	1.757***	(0.109)	0.793***	(0.06)	0.875***	(0.07)	1.536***	(0.07)	1.485***	(0.073)
American Indian or Alaskan Native	-		-		-		-		-	
Religions										
Evangelical Protestant					3.884***	(1.37)				
Catholic					2.264***	(0.42)	3.187***	(0.83)	-4.558**	(1.967)
Mainline Protestant	0.00747	(1.533)	0.523	(4.47)	1.889	(1.55)	-0.145	(1.23)	2.923	(2.179)
Historically Black Protestant			-3.399	(2.93)	10.71***	(3.04)	-0.320	(2.17)	-12.54**	(5.332)
Unaffiliated			-0.271	(1.60)	-0.329	(1.90)	1.401	(1.18)	-3.394*	(1.905)
Smoking Percentage	0.107***	(0.0223)	0.0658**	(0.03)	0.00698	(0.01)	-0.0154	(0.01)	-0.00297	(0.016)
Socioeconomic/ Demographic										
Gender	-0.0615	(0.0639)								
Marriage Rates	0.0862**	(0.0378)	0.0345	(0.05)	0.0193***	(0.004)	0.0670	(0.05)	-0.130**	(0.051)
Median Age	-0.0797***	(0.0135)	-0.162***	(0.06)	-0.223***	(0.02)	0.284***	(0.06)	0.296***	(0.054)
College degree or higher	-0.880	(1.530)	-1.188	(1.82)			-1.583	(1.43)		
Gender	-0.0438	(0.0596)	-0.114*	(0.06)	0.00454	(0.05)	-0.0848*	(0.05)	-0.115	(0.072)
Median Income	3.93e-05***	(4.65e-06)	1.04e-05	(7.89e-06)	7.97e-06	(4.84e-06)	1.34e-05**	(5.39e-06)	4.36e-06	(5.45e-06)
Constant	-1.327	(1.126)	4.850**	(2.09)	6.516***	(0.786)	9.985***	(2.15)	14.98***	(2.836)
Observations	2,200		880		1,540		2,200		1,100	
R-squared	0.279		0.327		0.313		0.311		0.269	

Robust standard errors in parentheses

Source: Generated by author *** p<0.01, ** p<0.05, * p<0.1

Table 5.1.3

State	White	Asian or Pacific Islander	Black or African American	Hispanic or Latino	American Indian or Alaskan Native
Alabama	-0.601***	0.911**	-0.549***	0.992**	-0.582***
	(0.188)	(0.414)	(0.123)	(0.387)	(0.124)
Alaska	-0.964***		-0.643**		-0.529**
	(0.155)		(0.298)		(0.220)
Arizona		0.746***	0.477***	0.542***	
		(0.241)	(0.153)	(0.146)	
Arkansas	-0.777***		-0.783***	0.934**	-0.883***
	(0.285)		(0.121)	(0.375)	(0.117)
California		0.489**		1.057***	
		(0.242)		(0.242)	
Colorado		0.702***	0.362**	0.539***	
		(0.205)	(0.178)	(0.174)	
Florida	0.374**	1.152***	0.381***	0.561***	
	(0.150)	(0.171)	(0.100)	(0.094)	
Georgia	-1.086***		-0.861***	1.353***	-1.008***
	(0.298)		(0.210)	(0.313)	(0.213)
Illinois		0.875***	0.506***	2.169***	
		(0.153)	(0.137)	(0.173)	
Indiana	-0.828***	0.931***	-0.420***	0.725***	-0.686***
	(0.217)	(0.314)	(0.099)	(0.176)	(0.097)
Iowa		0.931***	0.552***	1.418***	
		(0.314)	(0.136)	(0.238)	
Kansas		0.709***		1.503***	
		(0.238)		(0.218)	
Louisiana		0.518**		0.586***	-0.232*
		(0.231)		(0.169)	(0.127)
Maryland		0.670***	0.447***	3.161***	
		(0.221)	(0.140)	(0.541)	
Massachusetts		0.930***		2.056***	0.347**
		(0.159)		(0.218)	(0.161)
Michigan	-0.314**	1.047***		0.747***	
	(0.127)	(0.193)		(0.134)	
Minnesota	0.675***	0.910***	1.074***	2.195***	0.423***
	(0.177)	(0.193)	(0.142)	(0.262)	(0.133)
Mississippi	-0.639***	1.109***	-0.626***	0.863**	-0.616***
	(0.212)	(0.158)	(0.118)	(0.431)	(0.122)
Missouri	-1.664***	0.838***	-0.229**	0.645***	-0.507***
	(0.293)	(0.278)	(0.093)	(0.193)	(0.093)
Nebraska				1.577***	
				(0.284)	
Nevada	-1.664***	-0.547**	-0.978***		-1.489***
	(0.293)	(0.270)	(0.264)		(0.285)
New Jersey		1.263***		1.407***	
		(0.267)		(0.245)	
New Mexico	-0.418***	0.785*			-0.371***
	(0.142)	(0.403)			(0.138)
New York		0.605***	0.326**	1.102***	
		(0.149)	(0.154)	(0.145)	
North Carolina	-0.490***	0.354*	-0.478***	1.612***	-0.540***
	(0.116)	(0.205)	(0.097)	(0.352)	(0.095)
Ohio	-0.451**	0.480***		0.879***	-0.215*
	(0.190)	(0.178)		(0.182)	(0.118)
Oklahoma	-0.332***	0.424*		0.914***	-0.274***
	(0.093)	(0.241)		(0.192)	(0.096)
Oregon	-0.463***			0.838***	-0.304**
	(0.152)			(0.191)	(0.131)
Pennsylvania		1.294***	0.449***	2.143***	0.235*
		(0.190)	(0.127)	(0.213)	(0.123)
Rhode Island				1.254***	-0.252*
				(0.249)	(0.148)
South Carolina		0.911***	-0.251**	1.565***	-0.207*
		(0.254)	(0.119)	(0.285)	(0.110)
Tennessee		0.732***		3.274***	
		(0.185)		(0.569)	
Texas		0.482***		0.270**	-0.505***
		(0.168)		(0.119)	(0.137)
Utah				0.567*	
				(0.310)	
Virginia	0.962**	1.239***	0.214*	1.948***	
	(0.385)	(0.186)	(0.121)	(0.237)	
Washington				0.977***	
				(0.232)	
Wisconsin		0.662***	0.320***	2.244***	
		(0.179)	(0.077)	(0.372)	

Regression Analysis

The first part of this regression analysis details whether the regression results support of refute this study's hypothesis. The latter part of this analysis provides commentary on the notable coefficients that do not apply directly to the hypothesis.

Overall, the data supports the hypothesis that socioeconomic and demographic factors influence organ donation rates. Of the 23 variables included in Model 1, 2 had coefficients significant at the 1% level, 3 had coefficients significant at the 0.5% level and 10 had coefficients significant at the 0.1% level. The R squared values for Model's 1 and 2 were about 0.25 and the R squared for Model 3 was 0.33. This means that 25% of the variation in donation rates can be explained by socioeconomic and demographic factors in Model 1 and 2 and 33% in Model 3. The high number of socioeconomic and demographic variables with statistical significance and the R squared values support the hypothesis that socioeconomic and demographic conditions influence organ donation rates.

The specified portion of the hypothesis predicts that that more education, higher income, and Christianity positively influence organ donation rates, while being a member of a minority group, receiving less education, and residing in a Southern state negatively influences donation rates. Due to collinearity only the regressions in Model 2 included the education variable measuring the percentage of a state's population with a college degree or higher. In the regressions including the education variable none of the coefficients are significant. Since none of the results are significant the data refutes the hypothesis that more education positively influences organ donation rates.

Models 1 and 2 provide an array of information regarding the influence of Christianity on organ donation rates. While the hypothesis predicts that any form of

Christianity positively influences organ donation, the data shows that each sect of Christianity and Christianity in different regions effect organ donation rates differently. In Model 1, the two most popular sects of Christianity in the US, Catholic and Evangelical Protestant, contain high levels of collinearity so the regression does not include these variables. Orthodox Christian, Mainline Protestant, Historically Black Protestant and Other Christian faiths do not contain collinearity and remain in the regression. Three of these sects yield significant coefficients and paint part of the picture of how Christianity effects organ donation rates. Model 1's regression shows a coefficient of -7.856 for Orthodox Christian significant at the 0.1% level, and a coefficient for Other Christian of -2.062 significant at the 1% level. Interpreting these coefficients, a 1% increase in the percentage of Orthodox Christian's and Other Christian's in a state lead to a decrease in donation rate. The Mainline Protestant faith positively influences organ donation rates in Model 1 with a coefficient of 2.461 significant at the 0.1% level.

Model 2 shows the effects of the other sects of Christianity in each region of the country. Higher percentages of Catholics in the West and Midwest positively influence organ donation rates, while in the Northeast higher percentages of Catholics negatively influence organ donation rates. In the West, Evangelical Protestant positively correlates with organ donation rate with a coefficient of 3.884 significant at the 0.1% level. The Historically Black Protestant sect of Christianity coefficients vary dramatically between regions. Results from the West and Northeast are both significant at the 0.5% level, and their coefficients are high values. However, in the West a percentage increase in the State's Historically Black Protestant population leads to a 10 unit increase in the donation rate, and in the Northeast a percentage increase leads to a 12 unit decrease in the donation rate. In the context of the study's

hypothesis, the data refutes the hypothesis that Christianity positively influences organ donation rates because of both positive and negative coefficients reported for different sects of Christianity across Models 1 and 2.

The race/ethnicity dummy variables for minority groups in Models 1 and 2 yield significant results, and all coefficients are positive. There are no coefficients for the American Indian or Alaskan Native group because the regressions omit this variable due to collinearity. This study hypothesized that minority racial/ethnic groups negatively influence organ donation rates, and the data refutes this hypothesis. In model 1, the Hispanic or Latino dummy variable has the highest positive coefficient of 1.421 significant at the 0.1% level. In model 2, the coefficients for minority racial/ethnic groups are all positive and significant. The white race/ethnicity variable only yields one significant coefficient between models 1 and 2. This coefficient is in the West region and is smaller than the coefficients of the other race/ethnicities.

The hypothesis also predicted that higher income positively influences organ donation rates, and the data supports this prediction. According to model 1, a 1.95e-05 increase in income leads to a unit increase in organ donation rate. The coefficient for this variable is a small value, and this is due to the measure of income being in dollars rather than a percentage like many of the other socioeconomic and demographic variables.

The final component of the hypothesis to analyse is if residing in a Southern State negatively influences organ donation rates. Examining the results of model 3 reveals a trend of negative coefficients in Southern States for multiple race/ethnicities. Being White, Black or African American and American Indian or Alaskan Native in Alabama, Arkansas, Georgia, Mississippi, and North Carolina negatively correlates with organ donation rates. Some race/ethnicities in Southern States show positive

significant coefficients, however the overall trend in the data is a negative association between Southern States and organ donation which supports the hypothesis.

There are two notable demographic factors effecting organ donation rates included in this study that do not apply directly to the hypothesis. The first factor is the percentage of people in a state unaffiliated with any religious belief. In model 1 the unaffiliated variable yields a statistically significant coefficient of -0.923. The second factor is the median age of a state. In Model 1 and in three regions of Model 2 median age negatively associates with organ donation. This means that a one-year increase in the median age of a state's population negatively influences organ donation rates. In the following section there is a discussion of these notable factors along with commentary about why the data supports and refutes different parts of the hypothesis.

5. Conclusion

This study ventured to find whether socioeconomic and demographic conditions influence organ donation rates. The US is currently experiencing a national organ shortage crisis that negatively effects thousands of people each year. While scientists work to create artificial organs and use innovation to solution this problem, the only current solution is increasing the number of people who donate their organs. One of the first steps to increasing organ donation is identifying the factors that influence people's decision to register as organ donors. The results of this study not only found that there are socioeconomic and demographic factors influencing organ donation rates but identified a few specific factors with a negative effect.

The socioeconomic and demographic factors negatively effecting organ donation are the most important results because they show where to effectively deploy resources that could improve organ donation rates. The data reveals that white, black or African American, and American Indian or Alaskan Native people residing in Southern states donate organs at a lower rate. Additionally, if people in these groups come from a lower income there is an even higher likelihood, they are not donating their organs. The low donation rate of Black or African Americans is particularly concerning because this group makes up a disproportionately high percentage of the organ transplant waiting list.

Another factor negatively influencing organ donation is Catholicism in the Northeast. Even though the Catholic Church endorses organ donation, this factor contributes to the organ shortage crisis in the US. In this case, simply sharing this information with the Catholic Church holds the possibility of improving donation rates because the leaders in this group support the cause.

As the organ shortage crisis continues to build in the US some concerned people hope that the government adopts the “opt-out” program used by countries around the world. Considering the partisan political conditions in the US and the ethical debates tied to “opt-out” organ donation programs, the feasibility of this change in the near future is unrealistic. More important is addressing how to improve organ donation rates under the current framework and working to save more lives this way. Further studies necessitate a smaller geographic approach focusing on which socioeconomic and demographic conditions within a state effect organ donation. This will lead to efficient resource deployment that can truly improve organ donation rates across the whole country. The factors uncovered by this study lay the foundation for more focused research in the future.

6. References

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