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The Impact of Universal Motorcycle Helmet Regulation on Deceased Organ Donors

Carissa Jaehnert
Skidmore College, cjaehner@skidmore.edu

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Carissa Jaehnert
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Abstract

As of today, only one study (Dickert-Conlin et al., 2011) has analyzed the impact of a universal motorcycle helmet law on the number of donors who died from motor vehicle accidents (MVAs) and found that a universal law was associated with a significant decrease in MVA donors of approximately 10%. I update this study by using a difference-in-differences (DID) estimation procedure based on the methodological approach of Cheng & Hoekstra (2016) and by extending the time period analyzed to include the years 1994-2018. My estimations reveal that a universal law is associated with a decrease in MVA donors of roughly 12%, but that this result is not robust across different model specifications and time periods. I also find that a universal helmet law is associated with significant increases in both male and female MVA donors aged 11-17 and conclude from this unexpected result that my identification strategy--and that used by Dickert-Conlin et al. (2011)--is flawed. In addition, when I use motorcyclist fatalities as my dependent variable, I find that a universal helmet law is associated with a significant decrease in motorcyclist fatalities of roughly 24% in earlier periods, but that this estimate is not generalizable to later, more current, periods. Therefore, my paper disconfirms the robustness of results found by past studies, highlighting areas for future research.

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I. Introduction

Most helmetless motorcyclists who die in motor vehicle accidents suffer from brain death, as opposed to cardiac death, which makes them the primary source of organ donations in the U.S. (Garrett, 2008). Yet as of today, only one study (Dickert-Conlin et al., 2011) has analyzed the impact of motorcycle helmet regulation on organ donations. The authors found that a universal helmet law was associated with a 10% reduction in the number of deceased organ donors who had died in motor vehicle accidents (MVAs). My paper tests this estimate using a differences-in-differences (DID) empirical strategy over a broader and more recent time frame.

To carry out my analysis, I use data from the Organ Procurement Transplant Network (OPTN) that records donor counts by donor state of residence and circumstance of death. My entire dataset contains 50 states, including the District of Columbia, across the time period 1994-2018, totaling 1,275 observations. I use a DID estimation procedure guided by the methodological approach of Cheng & Hoekstra (2016) to estimate the effect of a universal helmet law on the number of MVA organ donors. My main estimate shows that a universal helmet decreases MVA organ donors by roughly 12.46%, but that this estimate is not robust across different model specifications. In addition, I find evidence to believe that the estimate found by Dickert-Conlin et al. (2011) mentioned above is not generalizable to different time periods.

The motivation for my study stems from four main sources. First, the popularity of motorcycling is on the rise in the U.S. Between 2002 and 2009, the number of registered motorcycles increased by roughly 90%, from 4,189,088 to 7,924,034, rising to 8,392,682 by

2017.[1] Such a high number of registered motorcycles might suggest an increased probability of motor vehicle accidents and motor vehicle related fatalities. If this is the case, implementing motorcycle helmet regulations could significantly reduce motorcyclists' accident risk, but given the results of Dickert-Conlin et al. (2011), such policies could possibly harm organ donation recipients. Second, finding a way to increase organ donations in the U.S. is of concern given the substantial organ shortage that the country currently faces. From its inception in 1984, the OPTN has been unable to secure enough organs to meet demand and many studies have reported that the times for those on organ transplant waiting lists continue to increase (Klein et al., 2010; Siminoff et al., 1995). Since most helmetless motorcyclists die from brain death, which means that blood continues to flow after the brain dies, donations from motorcyclists could cover at least part of this shortage. Third, there is a need for a more accurate cost-benefit analysis of motorcycle helmet legislation. Past analyses have not accounted for motorcycle helmet regulation's negative externality on organ donations, resulting in a biased, overstated positive estimate. Fourth, my study seeks to contribute to the literature on motorists' behavioral responses to safety regulations, which is mixed in its findings, by analyzing motorcyclists' behavioral responses to helmet laws.

To provide context on the history of helmet regulation in the U.S., the first federal announcement to address helmet usage came in 1966, when the Highway Safety Act was passed. The act required states to implement some form of motorcycle helmet legislation in order to qualify for highway funds and other federal grants. As a result, 48 states enacted such laws by the end of 1975. However, by 1977, due to the lobbying efforts of motorcyclists and other interest groups, the federal government relaxed its policy by making it impossible to deny a state

[1] Data are from the Insurance Institute for Highway Safety website: https://www.iihs.org/frontend/iihs/documents/masterfiledocs.ashx?id=2145

funding on the basis of its helmet laws. Soon after, 17 states weakened their helmet laws, and 7 states repealed their laws entirely (Graham et al., 1986). By 1980, only 20 states still had laws mandating helmet usage by riders of all ages (Sass et al., 2001). States can therefore be separated into three groups: states with no helmet laws, states with (partial) laws that only apply to riders under a certain age, and states with (universal) laws that apply to all riders.

In Section 2, I provide a critical literature review of studies related to my research. As only one article so far (Dickert-Conlin et al., 2011) has analyzed the effects of motorcycle helmet regulation on organ donations, I cover other topics including the impact of helmet regulation on helmet usage, on motorcyclist fatalities, and on motorcyclists' behavioral responses. This literature is relevant given my assumption that helmet laws influence the number of MVA organ donors through their impact on motorcyclist fatalities. I also attempt to determine the organ donation policies that have been most effective at increasing organ donation rates. The last subsection of my literature review presents a brief overview of past cost-benefit analyses of motorcycle helmet regulation and highlights some of their flaws.

A considerable number of studies have found that both helmet laws and helmet usage significantly decrease the probability of a motorcyclist becoming involved in an accident. The consensus in the literature suggests that a universal helmet law significantly decreases motorcyclist fatalities by 22-50% (Graham & Lee, 1986; De Wolf, 1986) relative to no helmet laws or partial helmet laws. It is also widely accepted that the introduction of a universal helmet law, from no helmet laws or partial helmet laws, increases helmet usage among motorcyclists from 55% to 100% (NHTSA, 1984). The sudden take-up of helmets when they are made mandatory and the effectiveness of them at reducing fatalities suggests their significant impact on MVA organ donations.

In contrast, the literature on motorcyclists and drivers' responses to safety regulation is mixed in its findings. While those who support the risk homeostasis theory or the risk compensation theory believe that motorists, in general, respond to enhanced safety features by increasing their driving intensity, or risk-taking behavior, other researchers argue the contrary. Slovic & Fischoff (1982), for instance, claimed that safety devices serve as reminders to motorists that driving is a dangerous activity and concluded that safety devices curtail both crash frequency and severity. I test these theories later in my paper by determining the effect of a universal law on different types of deceased organ donors.

Furthermore, the papers studying organ donation policies found that the policies that have led to the most substantial increases in organ donations include mandated choice and presumed consent regimes in addition to organ donor registries. Since one of my main concerns is ensuring that the impact of a universal helmet law on MVA organ donors is not biased by changes in policies regarding organ donation, I control for whether a state has an organ donor registry in my model through a binary indicator variable. Controlling for the other two policies, mandated choice and presumed consent, is not necessary given that none of the states in my sample experimented with them.

In Section 3, I present my data and methodology. My summary statistics show that the majority of deceased organ donors die from natural causes (mean = 6.61 donors per million), while the second most common cause of death is motor vehicle accidents (mean = 4.75 donors per million). In Section 4, I show the results from my first model across different time periods. Although I find that a universal helmet law decreases MVA organ donors by roughly 12% in each time period, this estimate is not robust across various model specifications. I therefore conclude that my estimates cannot be extrapolated to different time periods and are not as robust as previously considered.

My paper contributes to the literature in three other substantial ways. Most interestingly, I find that, contrary to expectations, universal helmet laws are associated with significant increases in both male and female MVA donors aged 11-17. Such unexpected results are a possible indication that my identification strategy is flawed given that most people aged 11-17 are not legally allowed to operate motorcycles. In other words, perhaps a causal relationship between a universal helmet law and MVA organ donors does not exist because deceased motorcyclists might only make up a small proportion of this pool of organ donors. Using donors who died from accidents involving motorcycles as the dependent variable would thus provide a more accurate estimate, yet no such data currently exists. Second, my finding that helmet laws do not significantly increase the number of donors who died from accidents not involving motor vehicles shows that, consistent with Dickert-Conlin et al. (2011), helmet laws do not influence motorcyclists to act more risk-seeking in non-driving situations. And third, my paper contributes to the literature by showing that the impact of universal helmet laws on motorcyclist fatalities is fairly consistent across various model specifications and coincides with the results found by past researchers. However, I find evidence to suggest that my estimates lack external validity and may not be generalizable to later, more current, time periods.

In summation, my paper is structured as follows: Section 2 presents a literature review of papers related to my topic; Section 3 outlines my data and methodological approach; Section 4 shows my results; Section 5 discusses my results, identifies areas for future research, and presents a cost-benefit analysis of universal helmet regulation; and Section 6 concludes.

2 Literature Review

The papers that relate to my investigation of the impact of motorcycle helmet laws on organ donations can be separated into five categories. The first, and possibly most relevant, category includes studies by Dickert-Conlin et al. (2011), Fernandez & Lang (2015), and Bilgel (2018). These researchers were interested in determining whether health and safety laws had an effect on the number of deceased organ donors. The second category contains papers studying the technological effectiveness of helmets, the effect of helmet laws on helmet usage, and the impact of helmet laws on motorcyclist fatality rates. This strand of literature is well-documented and many papers have reached the same conclusions. On the other hand, the papers in the third category, which investigated motorcyclists' perceived risk and drivers' behavioral responses to safety regulations, reached a limited consensus. The fourth category provides a brief overview of organ donation policies, while the last category explores the costs and benefits of motorcycle helmet laws. I reference this category later in my paper when I present my own cost-benefit analysis of these laws.

2.1 The Impact of Safety Laws on Deceased Organ Donations

Dickert-Conlin et al. (2011) is the only study to date to empirically analyze the impact of motorcycle helmet laws on deceased organ donations. Using a DID estimation procedure and data from 1994 to 2007 on the number of deceased organ donors by circumstance of death, the authors found that the presence of a universal helmet law decreased the number of deceased MVA donors by roughly 10%. They argued that the mechanism driving this result was the reduction in fatalities due to increased helmet use after implementation of the law. Although they found this reduction to be significant, it should be noted that their empirical strategy suffered from a number of limitations. The first is that the authors failed to consider whether organ donation policies changed in coordination with the implementation of a universal helmet law. If such polices had changed across this time period, consequently altering the number of registered organ donors, their results could have been driven by this mechanism. The second limitation is that Dickert-Conlin et al. (2011) only accounted for whether a state had a universal helmet law for at least six months in a given year. Guided by the DID estimation approach of Cheng & Hoekstra (2012), I update their model by accounting for the proportion of the year that a state has a universal helmet law because I expect the law to take effect immediately following implementation. Last, Dickert-Conlin et al. (2011) aggregated Donation Service Areas (DSAs) data to the state level. This is problematic because some of the DSAs span multiple states, so some of the variation in deceased organ donations following implementation of a universal helmet law in one state may be explained by changes in the helmet law policy of a neighboring state. I account for this problem by using only state-level data on deceased organ donors provided by the OPTN.

Another important contribution of Dickert-Conlin et al. (2011) is their finding that the impact of a universal motorcycle helmet law on both motor vehicle fatalities and deceased organ donors was concentrated among men aged 18 to 34 years of age. This makes intuitive sense given that men accounted for more than 90% of annual motorcyclist fatalities in 2007 (Dickert-Conlin et al., 2011). They also found that there were no crowding out effects associated with universal helmet laws. In other words, despite the reduction in MVA donors following implementation of a universal helmet law, Dickert-Conlin et al. (2011) found no subsequent increase in Non MVA donors across that same time window. This is indication that motorcyclists do not become more risk-seeking in other, non-driving, situations following universal helmet law introductions. My paper also conducts robustness checks to determine whether universal helmet laws affect the number of deceased organ donors who died from circumstances other than accidents. I hypothesize these effects to be insignificant because a helmet law should only have a direct impact on the number of deceased MVA donors.

Furthermore, the authors studied the long-run effects of motorcycle helmet laws. They concluded that the effect of helmet law repeals was delayed for both motorcyclist death rates and organ donation rates. They attributed this delay to the gradual increase in motorcycle registration rates after the announcement of a repeal. Specifically, they found that registration rates increased by roughly 42% over the four years following repeals, which suggests that most motorcyclists are risk-seeking individuals. The delayed reaction following a helmet law repeal is also supported by Ulmer & Preusser (2003), who found that observed helmet usage decreased from 96-76% immediately following the repeal of Kentucky's universal helmet law, but continued to gradually decline over subsequent years. Likewise, Kraus et al. (1995) investigated the long term impact of helmet laws on helmet usage and found that implementation of a helmet law had an immediate effect, increasing helmet usage from 55 to 100%. Despite the intriguing findings of Dickert-Conlin et al. (2011), it is important to note that their estimates may have understated both the short- and long-term effects of helmet law introductions because the time frame of the OPTN data that they used only covered six repeals and one introduction.

Dickert-Conlin et al. (2011) inspired researchers in other fields to study the impact of health and safety laws on deceased organ donations. The two most influential papers include Fernandez & Lang (2015) and Bilgel (2018). The former analyzed the causal impact of mental health parity laws on suicide organ donors and found that these laws decreased female suicide donors by 28.4%, the first indication that the findings of Dickert-Conlin et al. (2011) could be extrapolated to different contexts. The latter paper assessed the impact of stricter gun control laws on the homicide organ donor supply in the U.S. using state-level data from 1999 to 2015. Bilgel (2018) found that although these gun control laws reduced total gun homicide rates, neither gun laws nor gun ownership levels significantly impacted the number of homicide organ donors. Yet it is possible that these results are underestimated due to the limitations of using state-level panel data in studying the effects of gun policy on violence. Nevertheless, the main takeaway from these studies is that more research is being conducted on the possible externalities of health and safety laws, which is important for policymakers to consider when analyzing the costs and benefits of such laws.

2.2 The Impact of Motorcycle Helmet Laws on Helmet Usage and Motorcyclist Fatalities

Since the reduction in MVA organ donors following implementation of a universal helmet law is most likely caused by the effects of these laws on fatalities, it is important to take a closer look at the literature studying these effects. Dickert-Conlin et al. (2011) found that the presence of a universal helmet law translates to a 39% reduction in motorcyclist fatalities. This finding is consistent with that of both Graham & Lee (1986) and De Wolf (1986), who found that helmet laws reduced motorcyclist fatalities by 12-22% and 24-50% respectively. In addition, there has been a plethora of literature studying the effects of helmet usage on fatality risk. Deutermann (2004), Dee (2009), Sass & Zimmerman (2000), Evans & Frick (1988), Houston & Richardson (2008), and French et al. (2008) found that helmet usage reduced fatality risk by

37%, 34%, 29-33%, 28%, and by at least 22% respectively. Therefore, there is a clear consensus in the literature that both helmet laws and helmet usage significantly decrease the probability of a motorcyclist becoming involved in an accident.

Despite this consensus, however, two studies found contradicting results. Sass & Leigh (1991), for example, accounted for selectivity bias in the implementation of motorcycle helmet laws by running a selection model. Their main finding was that if laws had been randomly assigned to states, fatality rates for states with helmet laws would on average be less than 1% lower for states without laws. Goldstein (1986) also argued against the effectiveness of motorcycle helmet laws on decreasing fatalities and concluded that helmet laws actually increase the severity of neck injuries at higher impact speeds. However, more recent studies have stated that the results of Goldstein (1986) are unfounded due to significant sample-selection problems (Dee, 2009). The dataset that Goldstein (1986) used only included those motorcyclists whose accidents met some criteria for severity (e.g., emergency room visit), biasing the results on fatalities downward because those for whom the laws were effective were excluded from the sample.

Moreover, previous literature has focused on the effectiveness of motorcycle helmet legislation on increasing the number of riders wearing helmets. Using data from the 2006 and 2007 reports of the National Occupant Protection Use Survey (NOPUS), Dickert-Conlin et al. (2011) estimated the helmet usage rate to be 97.8% in states with a universal helmet law, compared to 54.2% in states with partial or no laws. Similarly, a NHTSA (1984) contractor found that the average helmet-wearing rate was 99.5% in states covered by “strong laws” whereas the average helmet-wearing rate was 49.0% in states covered by “weak” or “no laws” (NHTSA, 1984). One can draw from this that partial laws are not any more effective than no laws on increasing the number of helmeted riders in a state. This may be due to the fact that it is hard to enforce helmet usage for riders under a certain age, especially when riders may appear older than they actually are (Graham & Lee, 1986). There is therefore a consensus in the literature that following the repeal of a universal helmet law, helmet usage drops from 100% to approximately 55% (Berkowitz, 1981; Dare et al., 1978; Gilbert et al., 2008; Kraus et al., 1995; Lund et al., 1991; Preusser et al., 2000; Ulmer & Northrup, 2005; Ulmer & Preusser, 2003).

Overall, regardless of the time period studied, the estimates for the impact of helmet laws and helmet usage on fatality risk and for the impact of helmet laws on helmet usage are fairly consistent. These results are important for my study because they indicate a causal relationship between the presence of a universal helmet law and a reduction in deceased MVA donors. Following Dickert-Conlin et al. (2011), my paper attempts to confirm these results by using an alternate DID estimation procedure to analyze the effect of a universal helmet law on motorcyclist fatalities. Given the consensus stated above, I expect my estimate to be significantly negative and within the range of 22-50%. The next subsection focuses on the behavioral responses of motorcyclists, and drivers in general, to helmet laws and safety regulations. By contrast, this strand of literature is much more mixed in its findings.

2.3 Behavioral Responses of Drivers to Safety Regulations

Throughout the past 40 years, there has been considerable literature written on the responses of drivers to safety regulations and several theories have been proposed. Wilde (1982) supported the risk homeostasis theory, which states that motorists have a target level of injury risk. This implies that motorists may behave more recklessly in response to safety regulation unless they lower their target level of injury risk. Another theory, along the same line of thought, is called the risk compensation theory, which is more commonly known as the Peltzman hypothesis (Peltzman, 1975; Adams, 1983). This theory states that drivers will trade all or some of their enhanced crash protection for the benefits of increased driving intensity, or risk-taking behavior. The underlying assumption of this theory is that there are inherent benefits to reckless driving, including shorter travel times due to increased speed and lower consumptions (or the sensation thereof) of mental energy (Graham & Lee, 1986). Slovic & Fischhoff (1982), on the other hand, disagreed with the theories mentioned above and claimed instead that safety devices serve as reminders to motorists that driving is a dangerous activity; they concluded that safety devices curtail both crash frequency and crash severity.

Since much of the literature mentioned above studied the impact of safety regulations on all drivers, it is important for my paper to examine the effects of this regulation on motorcyclists alone. Graham & Lee (1986) provided an effective method. Using FARS data from the period 1975 to 1984, Graham & Lee (1986) ran both an ordinary least squares (OLS) and a weighted least squares (WLS) procedure to determine the impact of helmet laws on motorcyclist fatalities. As was stated above, the authors found that a universal helmet law was associated with a 12-22% decline in motorcyclist fatalities, but their most intriguing finding was that there was a gradual decline in deaths following the huge increase in deaths after a helmet law repeal. This result on the long-term behavior of motorcyclists following a helmet law repeal both contradicts that of Dickert-Conlin et al. (2011), who found that the number of fatalities and MVA donors continued to increase four years after the repeal, and supports the risk compensation theory.

The main limitation of Graham & Lee's (1986) study was that the authors were unable to explain why motorcyclists gradually start to drive more cautiously following a repeal. For instance, due to limited data availability, Graham & Lee (1986) were unable to identify whether the sample of motorcyclists changed between the year of the repeal and subsequent years. Perhaps the most reckless motorcyclists had been involved in fatal accidents immediately following the repeal, leaving them incapacitated and excluded from the sample in later years. Or it could have been that motorcyclists and other motorists on the road gradually shifted their behavior over time; it is unlikely that a motorcyclist would have started voluntarily wearing a helmet, but he could have changed his behavior in other ways (i.e., by not riding at night). By contrast, Dickert-Conlin et al. (2011) used the number of registered donors as a proxy to explain their opposing result. They found that the number of registered motorcycles gradually increased following the repeal of a universal helmet law, suggesting that the newly registered motorcyclists were more risk-seeking or more inexperienced than those previously registered. This gradual increase in motorcycle registrations would explain why the number of fatalities and MVA donors continued to increase after the repeal.

The conflicting results from Graham & Lee (1986) and Dickert-Conlin et al. (2011) on the long term behavior of motorcyclists following a motorcycle helmet law repeal reveals a significant limitation of the literature. My paper attempts to overcome this limitation by expanding the time window to include the years 1994-2018, allowing me to study both the short term and long term effects of universal helmet laws on motorcyclists' behavior.

Mannering & Grodsky (1994) took a different approach to analyze how motorcyclists respond to safety regulations. Instead of observing motorcyclists' behavior following implementation of a universal helmet law, these researchers conducted a survey to determine how motorcyclists perceive the risks that they face while riding. To do this, a questionnaire was published in the 1993 issue of *Rider Magazine*. Readers were asked to estimate the likelihood that they would be involved in an accident if they were to continue riding for an additional 10 years. Choices presented ranged from 0% to 100%, in 10 percentage-point increments. Readers were also asked questions about their age, gender, and other factors that would likely be responsible for increasing accident risk.

The main result from this survey was that although there were a wide range of estimates of accident risk over 10 years, the average estimation was 32.5%. This translated to an annual accident probability of less than 4%, which was reasonably close to the national average probability of 4.9%. The authors argued that motorcyclists were, in general, aware of the risks that they faced because their underestimation of accident risk was slight and insignificant. Such a claim, however, does not necessarily contradict the consensus in the literature on risk analysis that drivers overestimate their driving abilities and consequently underestimate accident risk. McCormick et al. (1986) found that automobile drivers generally thought of themselves as superior to other drivers in many driving tasks, a finding corroborated by both Goszczynska & Roslan (1989) and McKenna et al. (1991). In addition, Groeger & Brown (1989) and Dejoy (1992) claimed that young men tend to overrate their driving skills and are more optimistic about their driving abilities than are females.

Mannering & Grodsky (1994) also used a multinomial logit model to determine factors that influence motorcyclists' estimates of their likelihood of being involved in accident. Their most intriguing finding was that young riders were more likely to place themselves in the medium to high risk categories. This is consistent with Dejoy (1989), who found that college-aged drivers' perception of risk decreased with increasing age and driving experience, and Berger & Persinger (1980), Johan & Dawson (1982), Matthews & Moran (1986) and Finn & Bragg (1986), who found that younger drivers perceived themselves as having a higher likelihood of being involved in an accident. Douglas & Wildavsky (1982) and Rothe & Cooper (1987) also claimed that motorcyclists, in specific, underestimate accident risk to justify increased risk-taking behavior.

Although Mannering & Grodsky's (1994) findings corroborate the claims of past literature, it is important to recognize the limitations of their survey. First, their questionnaire introduced selectivity bias because the people who responded to the survey were most likely interested in safety regulation. Second, the survey had a low response rate as only 1,373 readers responded, slightly more than 1% of the magazine's circulation. Third, since readers can be dishonest and not always report accurate information, the survey responses may have been unreliable. Finally, the average age of respondents was approximately 46 years, which is unrepresentative of the motorcyclist population as a whole. Despite all of these limitations, it is fairly clear that motorcyclists have a reasonable understanding of the factors that increase or decrease risk, and that in terms of the hypothesis that risk-seeking individuals are attracted to motorcycling, Mannering & Grodsky (1994) claimed that "some supportive evidence exists." This is because motorcyclists are for the most part aware of the high risks that they face while riding but choose to ride nevertheless. This study therefore provides us with insight into why the number of registered motorcycles increased after the repeal of a helmet law, as was observed in Dickert-Conlin et al. (2011) mentioned previously.

Overall, the literature on behavioral responses of drivers to safety regulations is mixed in its conclusions for both the general driver population and motorcyclists more specifically. While Dickert-Conlin et al. (2011) found no evidence of risk-compensation behavior, Graham & Lee (1986) argued in support of it. However, by narrowing our view to motorcyclists even further through an analysis of their perceived accident risk, it is clear that these riders are risk-seeking individuals. Taking all of these factors into account, I hypothesize that the risk-compensation theory does not accurately describe motorcyclists' long term behavior following a repeal.

2.4 The Impact of Organ Donation Policies on Organ Donors

Because my paper deals with the impact of motorcycle helmet laws on the number of deceased organ donors who died as a result of a MVA, it is important to consider whether helmet laws and organ donation policies change at the same time. If so, the variation in the number of deceased organ donors could be explained not by a new helmet law, but rather by an alteration in organ donation policy. This section provides a brief overview of organ donation policies in the U.S. and identifies those that have been most successful at increasing donation rates.

Although organ donation policy in the U.S. is a reserved power of the state, all states passed into law the Uniform Anatomical Gift Act (UAGA), establishing gift law as the central leading principle in the U.S.'s informed consent system of organ donation. A gift is "the legally binding voluntary transfer of something from the donor to the donee without payment" (Glazier, 2018). Under the system of informed consent, an individual may give her consent, or opt-in, to become either a deceased or living organ donor. For deceased organ donors, the family, or next-of-kin, is contacted before the organ procurement process begins. However, it should be noted that a donation from a registered donor may not proceed over family objection, which is a major problem facing organ donation rates today. In fact, several studies have reported an overall family refusal rate near 50% (Gortmaker et al., 1998; Siminoff & Lawrence, 2002). To overcome high family refusal rates, many states adopted organ donation registries, allowing an individual's donation preferences to be known, and First Person Consent (FPC) legislation, permitting donations from a deceased donor to proceed, even over family objection, as long as the donor's consent to donation had been clearly documented.

Callison & Levin (2016) exploited the varied timing in state adoption of organ donor registries and FPC legislation between the years 1988 to 2006 to examine corresponding changes in the supply of deceased organ donors. Their first main finding was that organ donor registries significantly increased the number of deceased organ donors, which is consistent with Bilgel (2010), who found that presumed consent, or opt-out, policies were effective at increasing donation rates only if family consent was routinely sought and a combined registry was maintained. Such studies point to the importance of documenting deceased donors' intent to donate prior to death. Yet Callison & Levin's (2016) second main finding was that FPC laws had no significant effect on the supply of deceased organ donors. They attributed this result to the ineffective enforcement of the law, as an anonymous survey in 2013 revealed that by the time most states had enacted FPC legislation, 20% of procurement organizations were still unwilling to proceed with donation without familial consent. In my paper, I account for these policy changes by including a binary indicator variable in my model that equals one if state has an official organ donor registry and zero otherwise. I do not include a binary indicator variable for FPC laws in my model since, based on my research, I do not expect these laws to have a significant impact on organ donations.

Despite the low success of FPC legislation on increasing donation rates among deceased organ donors, there is a consensus in the literature that presumed consent policies lead to higher organ donation rates than informed consent policies among both deceased and living donors (Bilgel, 2012; van Dalen & Henkens, 2014; Abadie & Gay, 2006). Many scholars attributed this finding to the observation that people are indecisive and rely on default options when making important decisions. Hence organ donation rates will be higher in places where the default is to donate as opposed to places where the default is to not donate. In addition, van Dalen & Henkens (2014) suggested that donation rates are lower for informed consent policies due to procrastination and a lack of motivation among potential donors to register.

In particular, van Dalen & Henkens (2014) compared the impact of three policies--presumed consent, informed consent, and mandated choice--on organ donation rates. Using a survey among the Dutch population, the authors randomly separated 2,069 individuals into four groups to measure whether people's willingness to donate changes when faced with different default options. The four groups included presumed consent, informed consent, mandated choice, and a neutral setting. The authors concluded that the Netherlands--a country with an informed consent system--would benefit from implementing either a system of presumed consent or a system of mandated choice, in which an individual must state his preference, in order to increase the number of organ donations. They also found that default options had a larger influence on those who were not registered organ donors prior to the study. Among this group, the donation rate was higher under a presumed consent or mandated choice regime (37% and 39% respectively) than under an informed consent regime or neutral setting (10% and 20% respectively). Though van Dalen & Henkens' (2014) study may be limited in that it lacked external validity, other researchers have confirmed the effectiveness of presumed consent policies and mandated choice on increasing donation rates in other contexts, including Stutzer et al. (2011), who studied the effect of active choice on the decision to donate blood.

Despite the well-documented benefits of mandated choice and presumed consent regimes on increasing the number of organ donations, relatively few U.S. states have experimented with these policies, and among those that have, success stories have been few and far between. For example, van Dalen & Henkens (2014) stated that "the experience of Texas has been disappointing and has led the state to abandon [mandated choice]." In addition, Bilgel (2012) suggested that presumed consent regimes may not be as effective at increasing organ donation rates as has been previously shown because rates not only depend on the consent of the donor but also on the consent of the donor's next-of-kin.

Other studies provided alternative solutions to increase the number of registered organ donors. As mentioned before, Callison et al. (2016) found that donor registries increase the number of deceased organ donors because the preferences of deceased individuals become known to their families who must give or refuse consent on their behalf. A case study from Israel also showed that the establishment of a priority system--in which priority is given to those on organ donor waiting lists who were previously registered as organ donors--leads to a significantly higher number of registered donors. Thus, it seems that a number of solutions are available to policymakers to increase the number of motorcyclists registered as organ donors. Though as of yet, only two states (California and New Mexico) have proposed bills targeting this population and, in both cases, the bills failed to pass (Dickert-Conlin et al., 2011).

2.5 Cost-Benefit Analysis of Motorcycle Helmet Regulation

Past literature analyzing the costs and benefits of motorcycle legislation failed to account for the law's impact on deceased organ donors. Muller (1980), for example, estimated that at least $61 million (in 1979 dollars) could be saved annually if all motorcyclists were to wear helmets. In addition, he concluded that helmet law repeals may produce annually $16-18 million of unnecessary medical expenses. Yet Muller (1980) only weighted the costs of helmet consumption against the benefits of medical costs averted resulting from the introduction of a universal helmet law. The cost-benefit analysis would be more accurate if other factors, such as the law's negative externality on organ donation rates, were considered. I present such an analysis at the end of my paper.

3 Data and Methodology

3.1 Organ Procurement Transplant Network (OPTN)

Data for deceased organ donors come from the Organ Procurement Transplant Network (OPTN) website, which was established by the U.S. under the 1984 National Organ Transplant Act. This act divided the country into mutually exclusive donation service areas (DSAs), each belonging to an organ procurement organization (OPO). The OPOs were assigned with facilitating donation services and collecting data on every organ donation and organ transplant occurring within their jurisdictions. Today, there are 57 operational DSAs that provide data to the OPTN.

Although the OPTN collected donor counts from 1988 onwards, donor counts by circumstance of death were not reported until April 1, 1994, making 1994 the first year studied in my analysis. Circumstances of death include motor vehicle accidents, child abuse, homicide, natural causes, accidents not involving motor vehicles, and suicide. Table 1 presents the number of organ donors per million persons by circumstance of death and gender for the entire U.S. from 1994 to 2018. As mentioned above, my paper extends the analysis of Dickert-Conlin et al. (2011) by studying the years 1994-2018.

Table 1 shows that the counts for donors per million who died from motor vehicle accidents remained relatively constant throughout 1994-2018. Such a trend provides support for my assumption that changes in organ donation policies are not affecting organ donation rates among MVA donors throughout this time frame. Donations from MVAs increased by only 7.5% during this time period, from 4.0 to 4.3 donors per million. When broken down by gender, the data show similar trends. Both male MVA donors and female MVA donors per million increased slightly before decreasing to their 1994 original values in 2018. These trends are shown graphically in Figure 1.

Table 1: Organ Donors by Year, Gender, and Circumstance of Death, per Million Persons

	Motor Vehicle Accidents			All Others		
Year	**All Genders**	**Male**	**Female**	**All Genders**	**Male**	**Female**
2018	4.3	3.0	1.3	49.3	24.6	24.7
2017	4.3	3.0	1.3	46.3	23.2	23.1
2016	4.2	2.8	1.4	45.2	22.5	22.7
2015	4.1	3.0	1.1	42.9	21.1	21.8
2014	3.9	2.8	1.1	41.3	20.3	21.1
2013	4.1	2.8	1.3	41.0	20.1	20.9
2012	4.0	2.7	1.3	40.6	19.7	20.9
2011	4.1	2.9	1.2	41.3	19.9	21.4
2010	4.1	2.8	1.2	42.8	20.3	22.5
2009	4.0	2.7	1.3	43.7	21.2	22.5
2008	4.2	3.0	1.2	42.5	20.7	21.8
2007	5.2	3.7	1.6	42.6	21.4	21.2
2006	5.5	3.8	1.7	43.9	21.5	22.4
2005	5.1	3.5	1.7	43.9	21.1	22.8
2004	5.2	3.5	1.7	43.1	20.7	22.4
2003	4.9	3.3	1.6	40.9	19.6	21.3
2002	5.1	3.5	1.6	39.5	19.1	20.4
2001	4.8	3.3	1.5	39.7	19.0	20.7
2000	5.1	3.5	1.7	37.2	18.1	19.1
1999	4.8	3.2	1.6	34.1	16.6	17.6
1998	5.1	3.3	1.8	32.5	15.9	16.6
1997	5.1	3.3	1.8	29.9	15.1	14.9
1996	5.0	3.3	1.7	29.2	14.6	14.7
1995	5.3	3.4	1.9	28.0	14.2	13.8
1994	4.0	2.6	1.3	27.2	14.5	12.8

Note: This dataset comes from the OPTN. Reporting of circumstances of death began on April 1, 1994. For the first three months of 1994, all donors are included in the "All Others" category. The "All Others" category includes donors who died from child abuse, homicide, natural causes, Non MVAs, suicide, unreported circumstances of death, and none of the circumstances listed above. The counts of organ donors for each year is then divided by the U.S. resident population in millions. Population data come from the U.S. Census Bureau, which was last updated February 2019.

By contrast, donors per million who died from all other circumstances increased substantially over this period, from 27.2 donors per million in 1994 to 49.3 donors per million in 2018. This increase in donors per million of roughly 81% can be attributed to the increase in donors among both males and females. Male donors per million increased by 70%, from 14.5 to 24.6, while female donors per million increased by 93%, from 12.8 to 24.7. These increases are visualized in Figure 2.

Table 1 also shows that there are fewer MVA donors than donors who died from other causes. This makes intuitive sense since the "All Others" category includes donors who died from child abuse, homicide, natural causes, Non MVAs, suicide, and unreported/miscellaneous circumstances of death. Male MVA donors reached a peak in 2006 at 3.8 donors per million, while female MVA donors reached a peak in 1995 at 1.9 donors per million. On the right side of the table, however, both male and female who died from all other circumstances reached peaks in 2018, at 24.6 donors per million and 24.7 donors per million respectively. The higher number of donors in more recent years could be due to states' recent adoption of organ donor registries and FPC legislation. Figure 3 visualizes this trend.

Figure 1: MVA Donors per Million Persons, 1994-2018

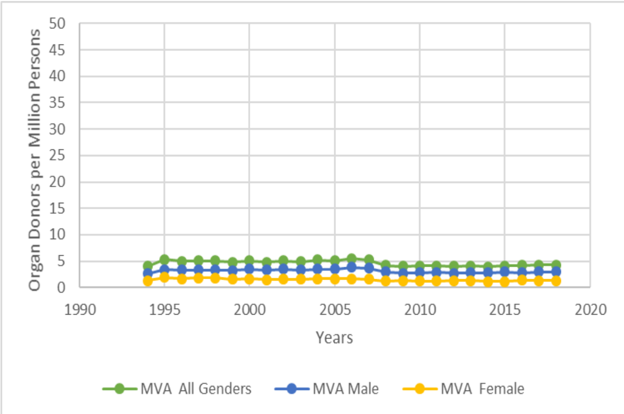
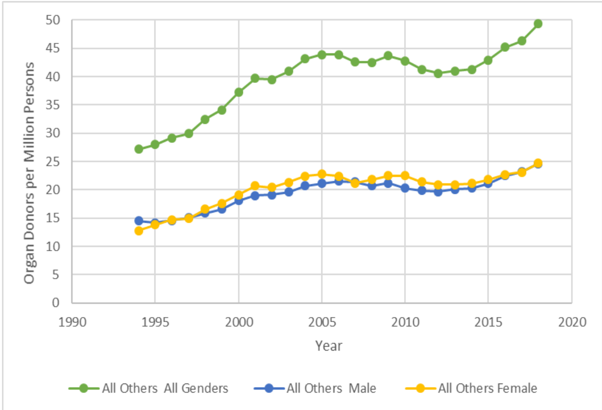
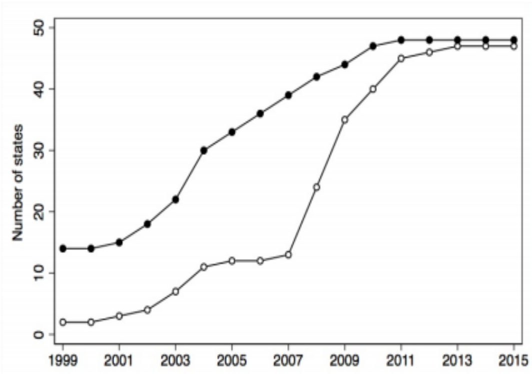


Figure 2: All Other Donors per Million Persons, 1994-2018



Note: The data come from Organ Procurement Transplant Network (OPTN).

Figure 3: State Adoption of Donor Registries and FPC Legislation



Note: Source: Bilgel (2018)

3.2 Fatality Analysis Reporting System (FARS)

I also collect data on motorcyclist fatalities from the Fatality Analysis Reporting System (FARS), available on the National Highway Traffic Safety Administration (NHTSA) website. FARS was created in 1975 by the National Center of Statistics and Analysis (NCSA) of the NHTSA to provide an objective basis for the evaluation of motor vehicle safety standards and highway safety programs. FARS contains data derived from a census of fatal crashes within the 50 states, the District of Columbia and Puerto Rico. To be included in the dataset, a fatal crash must occur on a public road and result in the death of at least one person (occupant of a vehicle or non-motorist) within 30 days of the crash.

Since FARS assigns a case number to each fatal crash and does not explicitly contain annual, state-level data on motorcyclist fatalities, I find this statistic by filtering the data. I only account for the fatal crashes that involve motorcycles and result in fatal injuries to the driver. This is an appropriate way to measure motorcyclist fatalities given that nearly 100% of male motorcyclist fatalities result in death to the driver. [2] Although my estimates may not be completely accurate, they are comparable to the data on motorcyclist fatalities published by the Insurance Institute for Highway Safety (IIHS). For example, if I sum the number of motorcyclist fatalities for all 50 states and the District of Columbia, I find that motorcyclist

[2] Insurance Institute for Highway Safety: https://www.iihs.org/iihs/topics/t/motorcycles/fatalityfacts/motorcycles

fatalities for the U.S. amount to 4,557 deaths in 2006. This is comparable to the estimate of 4,810 deaths displayed on the IIHS website. [3]

3.3 Methodology: Do Helmet Laws Reduce Organ Donation Rates?

As mentioned previously, I base my model on that used by Cheng & Hoekstra (2012). These authors applied a DID identification strategy to compare the within-state changes in outcomes of states that adopted castle doctrine laws to the within-state changes in outcomes of non-adopting states over the same period. They defined their variable of interest as the proportion of the year that a state has an effective castle doctrine law and included a vector of control variables in addition to state and year fixed effects in their model.

My dataset covers 50 states, including the District of Columbia, from 1994 to 2018. Note that my dataset includes 11 additional years and 13 additional states than the dataset used by Dickert-Conlin et al. (2011). The reason I am including these 13 states in my analysis is because state-level data is now publically available on the OPTN website, whereas Dickert-Conlin et al. (2011) aggregated DSA-level data to state level and restricted their analysis to DSAs that included only one state to avoid biasing the results. I begin by estimating the following model:

$$Donors_{st} = \beta_0 + \beta_1 Law_{st} + \beta_2 \boldsymbol{X}_{st} + \delta_t + \gamma_s + \varepsilon_{st},$$

where s indexes state and t indexes year, $Donors_{st}$ is a measure of deceased organ donors, Law_{st} is the proportion of the year that a state has a universal helmet law, $\boldsymbol{X}_{st}$ is a vector for time-varying state-level variables, δ_t and γ_s represent year and state fixed effects respectively, and ε_{st} is the stochastic error term. The vector $\boldsymbol{X}_{st}$ includes the log of state population; the

[3] Insurance Institute for Highway Safety: https://www.iihs.org/iihs/topics/t/motorcycles/fatalityfacts/motorcycles

proportion of the year that a state has a primary enforcement seatbelt law; [4] a binary indicator equal to one if a state has an official organ donor registry and equal to zero otherwise; the log of state GDP; and state-level data on the total number of registered motorcycles, fatal crashes involving motorcycles, and motor vehicle fatalities.[5] These controls differ slightly from those used by Dickert-Conlin et al. (2011), but such a difference in controls should not substantially alter the results of my analysis. I therefore predict that the presence of a universal helmet law will significantly reduce the number of MVA donors by roughly 10%. I also run the same model restricting my analysis to include only the years 1994-2007 to test if I can replicate the results found by Dickert-Conlin et al. (2011).

To observe whether motorcycle helmet legislation creates a trade-off between reduced motorcyclist fatalities and fewer organ donors, I follow the approach of Dickert-Conlin et al. (2011) in that I run the same regression as specified above but use motorcyclist fatalities as my dependent variable. Thus, the second model that I run takes the following form:

$$Deaths_{st} = \beta_0 + \beta_1 Law_{st} + \beta_2 \boldsymbol{X}_{st} + \delta_t + \gamma_s + \varepsilon_{st},$$

where $Deaths_{st}$ represents the number of motorcyclist fatalities in a given state in a given year. Given the results from past literature studying the impact of motorcycle helmet legislation on fatalities, I expect my estimate to be significantly negative and within the range of 22-50%.

Table 2 presents summary statistics of donor counts per million persons by circumstance of death. The table shows that my dataset contains 1,275 observations (=51 states*25 years) and

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[4] A primary enforcement seatbelt law means that a police officer is allowed to pull a car over solely on the suspicion that a passenger in the vehicle is not wearing a seatbelt.

[5] Population estimates come from the U.S. Census Bureau, whereas GDP estimates come from the Bureau of Economic Analysis (BEA). Information on whether a state has an official organ donor registry or a primary enforcement seatbelt law comes from Donate Life America and the Insurance Institute for Highway Safety (IIHS) respectively. Motor vehicle fatality data are available through the Fatality Analysis Reporting System (FARS), endorsed by the National Highway Traffic Safety Administration (NHTSA). Annual, state-level data on the total number of registered motorcycles and the number of fatal crashes involving motorcycles come from the Federal Highway Administration and the NHTSA respectively.

that most deceased organ donors die from natural causes as the mean (6.61 per million persons) is the highest. This makes intuitive sense because I assume that the other causes of death have a lower probability of occurring. The second highest mean comes from MVA donors, which shows that on average 4.75 donors per million persons die from accidents involving motor vehicles. Such a statistic provides rationale for why studying organ donations in relation to motor vehicle fatalities, and helmet regulation consequently, is important.

Table 2: Dataset Summary Statistics for Deceased Organ Donors (Measured in per Million Persons)

	Observations	*Mean*	*Standard Deviation*	*Min*	*Max*
MVA	1,275	4.75	2.07	0	14.17
Child Abuse	1,275	0.24	0.35	0	4.08
Homicide	1,275	1.20	1.06	0	10.48
Natural	1,275	6.61	6.10	0	34.12
Non MVA	1,275	2.48	1.97	0	26.12
Suicide	1,275	2.37	1.47	0	14.87

Note: Data on deceased organ donors come from the Organ Procurement Transplant Network (OPTN). Donor counts are divided by state population and multiplied by 1,000,000 to obtain donors per million state residents.

Table 3: Dataset Summary Statistics for MVA Organ Donors (Measured in per Million Persons)

	Male MVA					*Female MVA*				
Age Group	Obs.	Mean	Std. Dev.	Min	Max	Obs.	Mean	Std. Dev.	Min	Max
11-17	1,182	0.541	0.585	0	4.164	1,182	0.340	0.412	0	2.620
18-34	1,275	1.634	1.019	0	7.965	1,275	0.649	0.579	0	6.073
35-49	1,275	0.591	0.563	0	3.953	1,275	0.264	0.354	0	3.110
50-64	1,275	0.279	0.398	0	4.049	1,275	0.114	0.216	0	1.760
65+	1,184	0.036	0.126	0	1.598	1,184	0.028	0.124	0	2.181

Note: Data on deceased organ donors come from the Organ Procurement Transplant Network (OPTN). Donor counts are divided by state population and multiplied by 1,000,000 to obtain donors per million state residents.

Among MVA organ donors, males aged 18-34 have the highest contribution, as on average they represent 1.634 donors per million persons. This is expected since it has been documented that young men tend to be overconfident about their driving abilities and, by consequent, think that they are good drivers when they are not (Groeger & Brown, 1989; Dejoy, 1992). The second highest contribution comes from females aged 18-34, who on average account for 0.649 donors per million persons. Both of these estimates are presented in row two[6] of Table 3. On the opposite end, the age-gender groups that contribute the least to MVA organ donations are males and females aged 65 and older. Their means are 0.036 donors per million and 0.028 donors per million respectively. Yet such statistics are not surprising given that it is likely that as a person becomes older, he or she decides to drive less or to stop driving entirely.

Table 4: Dataset Summary Statistics for Independent Variables

	Observations	*Mean*	*Standard Deviation*	*Min*	*Max*	*Expected Sign on MVA*
Law	1,275	.424	.493	0	1	(-)
Primary Enforcement	1,275	.460	.494	0	1	(-)
Organ Registry	1,275	.685	.465	0	1	(+)
GDP	1,275	2.59e+11	3.41e+11	1.37e+10	2.91e+12	(-) or (+)
Population	1,275	5833297	6537864	480283	3.96e+07	(+)
MV Fatalities	1,224	765.358	782.106	15.000	4333.000	(+)
MC Fatal Crashes	1,173	77.412	94.492	1.000	625.000	(+)
Registered MC	1,116	181122	192519	12059	1313650	(+)

Note: Dataset includes 50 states, including the District of Columbia from 1994 to 2018.

Table 4 presents summary statistics for the independent variables included in my model. Note that the first three variables listed--Law, Primary Enforcement, and Organ Registry--are all binary indicator variables equaling one or zero, so their statistics are more difficult to interpret. Nevertheless, the means of the first two variables show that my dataset is roughly equally split

[6] Note that I reference the first row as the first row containing numeric entries.

between states with universal helmet laws and states without and between states with primary enforcement seatbelt laws and states without. Also notice that the observations in my dataset range in GDP and population, which is expected since my dataset includes both small and large states. GDP ranges from $137 billion to $2.91 trillion, while population ranges from 480,283 persons to 39,600,000 persons. The last column of the table records the signs expected on the coefficients of these variables when the dependent variable in my model is MVA donors.

Note that I expect the sign on law to be negative, as a universal helmet law would be expected to decrease the number of MVA organ donors through its impact on motor vehicle fatalities. I expect the coefficient on primary enforcement to also be negative because a state having a primary enforcement seatbelt law is an indicator that the state cares about the safety of its drivers. On the other hand, I expect an organ donor registry, a larger population, and an increase in motor vehicle fatalities, fatal crashes involving motorcycles, and registered motorcycles to raise the number of MVA organ donors. I expect the coefficient on GDP to be either positive or negative because it could be that a higher GDP is associated with states that have more regulation, resulting in a negative association between GDP and MVA organ donors, but it could also happen that a higher GDP leads to more organ donations because people are participating frequently in market activities.

4 Results

4.1 The Impact of Universal Helmet Laws on Organ Donations: 1994-2018

The results for my entire sample show that without controlling for any time-varying state observables, the presence of a universal helmet law decreases MVA donors by 12.46%

(=3.262/26.188) in absolute levels, and this estimate is significant at 5% level.[7] However, if MVA is measured in donors per million or in natural logs, my result is no longer statistically significant. The second row of Table 5 documents this phenomenon. In addition, column one[8] of Table 5 shows there is much heterogeneity in the magnitude of results across circumstances of death. Although all estimates are in the expected (negative) direction, with the exception for donors who died from homicides, there is evidence to believe that universal helmet laws have just as much impact on donors who died from causes not related to motor vehicle accidents. However, columns two and three show that the significance of these estimates is erased when the dependent variables are measured in donors per million and natural logs respectively. Similarly,

Table 5: The Impact of Universal Helmet Laws on Organ Donors across Circumstances of Death, 1994-2018

Dependent Variables	Absolute Levels	Per Million	Natural Logs
All Circumstances	-76.728*** (10.550)	2.121* (1.204)	0.063** (0.028)
MVA	-3.262** (1.363)	-0.173 (0.324)	-0.040 (0.064)
Child Abuse	-0.904*** (0.268)	-0.028 (0.065)	-0.111 (0.086)
Homicide	0.454 (0.713)	0.312** (0.151)	0.222*** (0.081)
Natural Causes	-65.740*** (7.615)	-1.763** (0.719)	-0.775*** (0.145)
Non MVA	-14.610*** (1.913)	-0.218 (0.314)	-0.021 (0.088)
Suicide	-5.050*** (0.972)	0.180 (0.232)	0.028 (0.076)
State & Year Fixed Effects	Yes	Yes	Yes
Controls for GDP and Population	No	No	No
Mean MVA	26.188	4.748	2.827

Table 6: The Impact of Universal Helmet Laws on Organ Donors across Circumstances of Death, 1994-2018 (GDP and Population Included)

Dependent Variables	Absolute Levels	Per Million	Natural Logs
All Circumstances	-77.490*** (10.390)	2.862** (1.193)	0.076*** (0.027)
MVA	-3.752*** (1.312)	-0.217 (0.326)	-0.054 (0.0638)
Child Abuse	-0.855*** (0.269)	-0.009 (0.065)	-0.087 (0.087)
Homicide	0.663 (0.710)	0.337** (0.151)	0.237*** (0.081)
Natural Causes	-65.100*** (7.642)	-1.565** (0.717)	-0.741*** (0.143)
Non MVA	-14.700*** (1.923)	-0.110 (0.314)	0.002 (0.088)
Suicide	-4.980*** (0.966)	0.200 (0.234)	0.031 (0.076)
State & Year Fixed Effects	Yes	Yes	Yes
Controls for log(GDP) & log(Population)	Yes	Yes	Yes
Mean MVA	26.188	4.748	2.827

Note: All estimations in Tables 5 and 6 consist of 50 states, including the District of Columbia, from 1994-2018. All of the estimations control for year and state fixed effects. The estimations in Table 6 also control for the log of both state population and GDP. The dependent variables, shown in the first column, include deceased donors who died from all circumstances, motor vehicle accidents (MVAs), child abuse, homicide, natural causes, accidents not involving motor vehicles (Non MVAs), and suicide. Columns 1-3 estimate the effect of universal helmet laws on donor counts (absolute levels), donors per capita, and the natural logs of donors respectively. * indicates that the result is significant at the 10% level, ** at the 5% level, and *** at the 1% level. Standard errors are located inside parentheses.

[7] Note that since my baseline category includes states that do not possess universal helmet laws, all estimates should be considered in relation to them.
[8] Note that I reference the first column as the first column containing numeric entries.

when I control for the log of both state GDP and population, the coefficients on Law for MVA donors per million and the natural log of MVA donors are no longer statistically significant. This is further indication that my results are not robust across different model specifications. These results are shown in row two of Table 6.

To further assess the robustness of my results, I add more regressors to my model. The results from my estimations are presented in Table 7. As stated above, without controlling for time-varying state characteristics, the presence of a universal law decreases MVA organ donors by 12.46%, and the result is significant at the 5% level. When I control for whether a state has a primary enforcement seatbelt law and for whether a state has a universal helmet law in addition to the log of state population and the log of state GDP, the estimate reveals that a universal helmet law decreases MVA organ donors by 14.61% (= -3.825/26.188), and the result is significant at the 1% level. The most intriguing result of this table, however, is located in the third column of row one. When motor vehicle fatalities, the number of fatal crashes involving motorcycles and the total number of registered motorcycles are added as controls, the coefficient on Law becomes significant in the unexpected (positive) direction. One potential explanation for this

Table 7: The Impact of Universal Helmet Laws on MVA Organ Donors, 1994-2018

Independent Variables	MVA	MVA	MVA
Law	-3.262**	-3.825***	3.064**
	(1.363)	(1.318)	(1.363)
Primary Enforcement		0.197	0.558
		(0.736)	(0.693)
Organ Registry		0.423	0.014
		(0.714)	(0.647)
log(GDP)		8.007**	-2.198
		(3.366)	(3.202)
log(Population)		36.920***	21.370***
		(4.849)	(5.059)
MV Fatalities			0.024***
			(0.002)
MC Fatal Crashes			0.058***
			(0.006)
Registered MC			-1.69e-05***
			(3.78e-06)
Constant	24.89***	-738.4***	-271.1***
	(2.238)	(80.990)	(86.580)
Observations	1,275	1,275	1,116
Mean MVA	26.188	26.188	26.188
R-squared	0.944	0.949	0.963

Note: All estimations consist of 50 states, including the District of Columbia, from 1994-2018. All of the estimations control for year and state fixed effects. * indicates that the result is significant at the 10% level, ** at the 5% level, and *** at the 1% level. Standard errors are located inside parentheses.

unexpected result is that since motor vehicles fatalities and fatal crashes are both mechanisms through which universal helmet laws affect organ donations, they are not considered ideal control variables.

Table 8 shows the impact of universal helmet laws across age groups and gender. Most estimates are in the expected (negative) direction, but some results are counterintuitive. For example, the presence of a universal law significantly increases MVA male donors aged 11-17 and MVA female donors aged 11-17 by 58.32% (=1.592/2.730) and 93.16% (=1.635/1.755) respectively. These results are hard to explain, but they potentially indicate that the safety of children is less of a concern when helmet regulation is implemented In addition, the table shows that a universal helmet law decreases the number of MVA male donors aged 18-34 significantly by 44.98% (=4.080/9.070). However, unlike Dickert-Conlin et al. (2011), males aged 18-34 do not experience the largest decrease among MVA male donors. In fact, males aged 50-64

Table 8: The Impact of Universal Helmet Laws on MVA and Non MVA Organ Donors across Age Groups and Gender, 1994-2018

	Male		Female		Pooled	
	MVA	Non MVA	MVA	Non MVA	MVA	Non MVA
Overall	-5.375***	-9.595***	1.108*	-4.848***	-3.825***	-13.910***
	(1.030)	(1.369)	(0.609)	(0.785)	(1.318)	(1.915)
Age Groups:						
11-17	1.592***	0.0805	1.635***	-0.091	3.226***	-0.011
	(0.369)	(0.166)	(0.287)	(0.099)	(0.514)	(0.198)
18-34	-4.080***	-4.098***	-0.693*	-1.573***	-4.774***	-5.671***
	(0.699)	(0.637)	(0.397)	(0.363)	(0.846)	(0.915)
35-49	-1.497***	-2.509***	-0.462*	-1.134***	-1.959***	-3.643***
	(0.396)	(0.480)	(0.265)	(0.281)	(0.495)	(0.658)
50-64	-2.363***	-1.674***	-0.301*	-0.985***	-2.665***	-2.659***
	(0.308)	(0.390)	(0.167)	(0.247)	(0.380)	(0.527)
65 +	-0.017	-0.795***	0.191**	-0.448***	0.174	-1.242***
	(0.104)	(0.194)	(0.091)	(0.139)	(0.137)	(0.257)
Mean, Ages 11-17	2.730	0.727	1.755	0.242	4.486	0.969
Mean, Ages 18-34	9.070	3.188	3.615	1.085	12.684	4.273

Note: All estimations consist of 50 states, including the District of Columbia, from 1994-2018. All of the estimations control for year and state fixed effects. All estimations include binary indicators for primary enforcement seatbelt legislation and organ donor registries in addition to controls for the log of state GDP and the log of state population. * indicates that the result is significant at the 10% level, ** at the 5% level, and *** at the 1% level. Standard errors are located inside parentheses.

experience the largest reduction in MVA organ donors, with a decrease of 142.72% (=2.363/1.656), followed by men aged 35-49, with a decrease of 45.14% (=1.497/3.316). This result might seem counterintuitive at first glance. However, the fact that people aged 50 and older accounted for 36% of motorcyclist fatalities in 2017, a substantial increase from the 8% that they represented in 1994, may provide an explanation for my results.[9] There is also no evidence to suggest that motorcyclists respond to helmet laws by behaving more recklessly in non-driving situations. For instance, a universal helmet law is associated with a 128.54% (=4.098/3.188) reduction in Non MVA male donors aged 18-34, and none of the estimates in the columns called "Non MVA" are positive and statistically significant. The lack of a crowding out effect was also observed by Dickert-Conlin et al. (2011).

4.2 First Model, Restricting Sample: 1994-2007

Table 9: The Impact of Helmet Laws on MVA Donors (Absolute Levels), 1994-2007

Independent Variables	MVA	MVA	MVA
Law	-9.275***	-3.195*	1.207
	(1.722)	(1.653)	(1.772)
Primary Enforcement		0.592	0.888
		(1.077)	(1.104)
Organ Registry		-0.509	-0.227
		(0.839)	(0.831)
log(GDP)		-5.686	-12.800**
		(5.857)	(5.898)
log(Population)		-7.215	5.716
		(9.298)	(10.140)
MV Fatalities			0.022***
			(0.004)
MC Fatal Crashes			0.037*
			(0.019)
Registered MC			-5.78e-07
			(1.00e-05)
Observations	714	714	663
R-squared	0.168	0.326	0.263
Mean MVA	27.389	27.389	27.389
Number of States	51	51	51

Table 10: The Impact of Helmet Laws on MVA Donors (Natural Logs), 1994-2007

Independent Variables	log MVA	log MVA	log MVA
Law	-0.083	-0.065	0.050
	(0.079)	(0.0804)	(0.095)
Primary Enforcement		-0.017	-0.007
		(0.055)	(0.060)
Organ Registry		-0.015	-0.008
		(0.043)	(0.045)
log(GDP)		-0.274	-0.508
		(0.296)	(0.317)
log(Pop)		0.777*	0.427
		(0.445)	(0.500)
MV Fatalities			0.000**
			(0.000)
MC Fatal Crashes			0.000
			(0.001)
Registered MC			-5.39e-07
			(5.43e-07)
Observations	714	714	663
R-squared	0.071	0.076	0.049
Number of States	51	51	51

Note: All estimations consist of 50 states, including the District of Columbia, from 1994-2007. All of the estimations control for year and state fixed effects. Table 9 measures MVA organ donors in absolute levels, while Table 10 measures MVA organ donors in natural logs. * indicates that the result is significant at the 10% level, ** at the 5% level, and *** at the 1% level. Standard errors are located inside parentheses.

[9] Insurance Institute for Highway Safety: https://www.iihs.org/iihs/topics/t/motorcycles/fatalityfacts/motorcycles

Since my results are not robust across different model specifications, I restrict my sample to include only the years 1994-2007 to determine if I can replicate the results of Dickert-Conlin et al. (2011). Tables 9 and 10 report my estimates above. The first column of Table 9 shows that a universal helmet law is associated with a statistically significant decrease in MVA donors of 33.86% (=9.275/27.389). Yet when controls are added to my model in column two, this estimate is lowered to -11.67% (=3.195/27.389). It should be noted, however, that even this lower estimate is consistent with Dickert-Conlin et al.'s (2011) finding that helmet laws reduce MVA organ donors by roughly 12.7% when measured in levels. I am also able to replicate their results when MVA organ donors are measured in natural logs, though find evidence against their robustness. My estimations show that helmet laws decrease MVA organ donors by 8.3% when no time-varying state observables are accounted for and by 6.5% when they are. Much more important is the fact that my estimates are not statistically different from zero. Thus, there is a discrepancy between my results and those of Dickert-Conlin et al. (2011), who found that helmet laws significantly reduced MVA organ donors by roughly 9.7% when measured in natural logs. I discuss this discrepancy in the next section of my paper.

4.3 First Model, Eliminating 13 States: 1994-2007

I then proceed to restrict my sample even further to include only the states that contain their own Organ Procurement Organization (OPO) headquarter, as such was the strategy taken by Dickert-Conlin et al. (2011). Using the OPTN website,[10] I find that 13 states--including Alaska, Connecticut, Delaware, Idaho, Maine, Montana, New Hampshire, North Dakota, Rhode

[10]https://optn.transplant.hrsa.gov/members/memberdirectory/?memberType=Organ%20Procurement%20Organizations

Island, South Dakota, Vermont, West Virginia, and Wyoming--do not have an their own OPO headquarter, leaving 37 states and the District of Columbia in my analysis. Tables 11 and 12 present results that are similar to those shown above in Tables 9 and 10, but are, unexpectedly, far greater in magnitude than the results found by Dickert-Conlin et al. (2011). For example, columns one and two of Table 11 show that universal helmet laws decrease MVA donors by 24.66% (=8.562/34.724) and 24.93% (=8.655/34.724) respectively, and both estimates are significant at the 1% level. However, column three shows that this result disappears when more controls are added to my model. In addition, columns one and two of Table 12 show that universal helmet laws decrease MVA donors by 8.3% and 6.6%, respectively, but such results are insignificant. This is surprising given that I would expect significantly negative coefficients on the variable Law, as found by past researchers.

Table 11: The Impact of Helmet Laws on MVA Donors (Absolute Levels), 13 States Eliminated, 1994-2007

Independent Variables	MVA	MVA	MVA
Law	-8.562***	-8.655***	1.727
	(1.956)	(1.969)	(2.039)
Primary Enforcement		0.723	1.058
		(1.453)	(1.362)
Organ Registry		-1.497	-0.552
		(1.162)	(1.068)
log(GDP)		10.450	-19.32**
		(9.675)	(9.245)
log(Population)		26.840**	25.750**
		(13.220)	(12.710)
MV Fatalities			0.021***
			(0.004)
MC Fatal Crashes			0.061***
			(0.017)
Registered MC			6.77e-07
			(1.16e-05)
Observations	532	532	494
R-squared	0.198	0.223	0.273
Mean MVA	34.724	34.724	34.724
Number of States	38	38	38

Table 12: The Impact of Helmet Laws on MVA Donors (Natural Logs), 13 States Eliminated, 1994-2007

Independent Variables	log MVA	log MVA	log MVA
Law	-0.083	-0.066	0.024
	(0.064)	(0.065)	(0.077)
Primary Enforcement		0.016	0.022
		(0.048)	(0.052)
Organ Registry		-0.059	-0.066
		(0.038)	(0.040)
log(GDP)		-0.385	-0.715**
		(0.320)	(0.349)
log(Population)		1.330***	1.070**
		(0.437)	(0.480)
MV Fatalities			0.000***
			(0.000)
MC Fatal Crashes			0.000
			(0.001)
Registered MC			-4.39e-07
			(4.37e-07)
Observations	532	532	494
R-squared	0.111	0.133	0.090
Number of States	38	38	38

Note: All estimations consist of 50 states, including the District of Columbia, from 1994-2007. All of the estimations control for year and state fixed effects. Table 11 measures MVA organ donors in absolute levels, while Table 12 measures MVA organ donors in natural logs. * indicates that the result is significant at the 10% level, ** at the 5% level, and *** at the 1% level. Standard errors are located inside parentheses.

4.4 First Model, Restricting Sample: 2008-2018

I further restrict my sample to include only the years 2008-2018, as these were the years unstudied by Dickert-Conlin et al. (2011). Given that I can replicate the results of Dickert-Conlin et al. (2011) to some extent and that my results for the years 1994-2018 are not robust, I expect there to be something occurring in this interim time period influencing my results. Tables 13 and 14 present the results of my estimations. The results in the first row of the two tables show that regardless of the how my model is specified, helmet laws do not significantly impact the number of MVA organ donors. This is indication that the results of Dickert-Conlin et al. (2011) may not be extrapolated to different time periods and do not hold over the long run.

Table 13: The Impact of Helmet Laws on MVA Donors (Absolute Levels), 2008-2018

Independent Variables	MVA	MVA	MVA
Law	-1.268	-3.759	0.298
	(3.921)	(3.935)	(3.857)
Primary Enforcement		-1.650	-0.213
		(1.784)	(1.770)
Organ Registry		1.643	0.176
		(2.973)	(2.722)
log(GDP)		3.854	-3.475
		(6.555)	(6.851)
log(Pop)		64.350***	48.350**
		(16.380)	(20.710)
MV Fatalities			0.020***
			(0.005)
MC Fatal Crashes			0.050**
			(0.019)
Registered MC			-2.61e-05***
			(4.62e-06)
Observations	561	561	453
R-squared	0.043	0.087	0.278
Mean MVA	24.660	24.660	24.660
Number of States	51	51	51

Table 14: The Impact of Helmet Laws on MVA Donors (Natural Logs), 2008-2018

Independent Variables	log MVA	log MVA	log MVA
Law	-0.106	-0.068	-0.028
	(0.214)	(0.216)	(0.228)
Prim		-0.220**	-0.204*
		(0.098)	(0.105)
Organ Registry		0.084	0.087
		(0.163)	(0.161)
log(GDP)		1.145***	1.100***
		(0.360)	(0.406)
log(Pop)		0.333	0.554
		(0.898)	(1.226)
MV Fatalities			0.000
			(0.000)
MC Fatal Crashes			0.001
			(0.001)
Registered MC			-8.82e-08
			(2.74e-07)
Observations	561	561	453
R-squared	0.021	0.059	0.070
Number of States	51	51	51

Note: All estimations consist of 50 states, including the District of Columbia from 2008-2018. Time and state fixed effects are included. Table 13 measures MVA organ donors in absolute levels, while Table 14 measures MVA organ donors in natural logs. * indicates that the result is significant at the 10% level, ** at the 5% level, and *** at the 1% level. Standard errors are located inside parentheses.

4.5 First Model, Alternate Identification Strategy: 1994-2018

To determine whether my identification strategy is flawed, I generate a new dependent variable called "MC Donors", which approximates the number of donors who died from motorcycle accidents as opposed to motor vehicle accidents. I calculate this variable by multiplying MVA donors by the percentage of motor vehicle fatalities that are motorcyclist fatalities in a given state in a given year. Tables 15 and 16 present the results of my estimations. Ignoring the last column in each table, I find that a universal helmet is associated with significant decreases in MC donors of roughly 130% when measured in absolute levels and approximately 20% when measured in natural logs. The reduction in magnitude of the coefficient on Law when MC donors are measured in natural logs might be explained by outliers biasing my results. Nevertheless, the main takeaway from these tables is that when I target the motorcyclist population more precisely, my results are much more consistent. I conclude, therefore, that

Table 15: The Impact of Helmet Laws on MC Donors (Absolute Levels), 1994-2018

Independent Variables	MC Donors	MC Donors	MC Donors
Law	-3.382***	-3.342***	0.030
	(0.282)	(0.272)	(0.155)
Primary Enforcement		0.146	-0.007
		(0.153)	(0.079)
Organ Registry		-0.326**	-0.106
		(0.147)	(0.073)
log(GDP)		0.119	-0.0125
		(0.699)	(0.363)
log(Population)		9.436***	1.188**
		(1.024)	(0.573)
MV Fatalities			-0.001***
			(0.000)
MC Fatal Crashes			0.039***
			(0.001)
Registered MC			-2.26e-06***
			(4.29e-07)
Observations	1,224	1,224	1,116
Mean MC Donors	2.593	2.593	2.593
R-squared	0.843	0.857	0.967

Table 16: The Impact of Helmet Laws on MC Donors (Natural Logs), 1994-2018

Independent Variables	log MC Donors	log MC Donors	log MC Donors
Law	-0.208**	-0.212**	0.006
	(0.090)	(0.088)	(0.102)
Primary Enforcement		0.0217	-0.002
		(0.050)	(0.052)
Organ Registry		-0.087*	-0.087*
		(0.048)	(0.049)
log(GDP)		0.377	0.227
		(0.230)	(0.242)
log(Population)		1.857***	1.354***
		(0.336)	(0.381)
MV Fatalities			0.000
			(0.000)
MC Fatal Crashes			0.003***
			(0.000)
Registered MC			-3.94e-07
			(2.84e-07)
Observations	1,207	1,207	1,104
R-squared	0.873	0.878	0.883

Note: All estimations consist of 50 states, including the District of Columbia, from 1994-2018. Time and state fixed effects are included. Table 15 measures MC organ donors in absolute levels, while Table 16 measures MC organ donors in natural logs. * indicates that the result is significant at the 10% level, ** at the 5% level, and *** at the 1% level. Standard errors are located inside parentheses.

using MVA donors to measure the impact of universal helmet laws on organ donations is a flawed approach, and suggest that future researchers should explore other strategies.

4.6 The Impact of Universal Helmet Laws on Motorcyclist Fatalities: 1994-2017

To determine if a universal helmet law is associated with a significant decrease in motorcyclist fatalities, I run my model using motorcyclist fatalities and the natural log of motorcyclist fatalities as dependent variables. I control for whether a state has a primary enforcement seatbelt law because I expect that states with these laws are more concerned about drivers' safety and thus would experience fewer motorcyclist fatalities. I also control for the number of registered motorcycles in a state and the number of motor vehicle fatalities in a state

Table 17: The Impact of Helmet Laws on Motorcyclist Fatalities (Absolute Levels), 1994-2017

Independent Variables	MCfatals	MCfatals	MCfatals
Law	-81.640***	-82.330***	-75.420***
	(5.907)	(5.654)	(6.024)
Primary Enforcement		2.994	1.939
		(3.177)	(3.286)
log(GDP)		7.645	10.100
		(14.320)	(15.050)
log(Population)		201.100***	213.000***
		(21.320)	(23.120)
Registered MC			9.08e-05***
			(1.77e-05)
MV Fatalities			-0.009
			(0.008)
Observations	1,224	1,224	1,116
R-squared	0.425	0.481	0.486
Mean MCfatals	71.969	71.969	71.969
Number of States	51	51	51

Table 18: The Impact of Helmet Laws on Motorcyclist Fatalities (Natural Logs), 1994-2017

Independent Variables	log MCfatals	log MCfatals	log MCfatals
Law	-0.228***	-0.247***	-0.246***
	(0.051)	(0.050)	(0.054)
Primary Enforcement		0.025	0.022
		(0.028)	(0.030)
log(GDP)		0.411***	0.342**
		(0.127)	(0.136)
log(Population)		0.823***	0.915***
		(0.189)	(0.208)
Registered MC			1.58e-08
			(1.59e-07)
MV Fatalities			0.000***
			(7.56e-05)
Observations	1,224	1,224	1,116
R-squared	0.632	0.649	0.643
Number of States	51	51	51

Note: All estimations consist of 50 states, including the District of Columbia, from 1994-2017. Time and state fixed effects are included. Table 17 measures motorcyclist fatalities in absolute levels, while Table 18 measures motorcyclist fatalities in natural logs. * indicates that the result is significant at the 10% level, ** at the 5% level, and *** at the 1% level. Standard errors are located inside parentheses.

because I anticipate that an increase in either one of these variables would be associated with an increase in motorcyclist fatalities. The log of state population and state GDP are also included in my model. As seen from Table 17, the presence of a universal helmet is associated with a 104.80% (=75.420/71.969) decrease in motorcyclist fatalities when measured in absolute levels. However, this estimate must be driven by outliers given that I only find a decrease of 24.6%, significant at the 1% level, when motorcyclist fatalities are measured in natural logs. Note that this estimate is consistent with past literature as it falls within the range of 22-50%.

4.7 Second Model, Restricting Sample, 1994-2007 and 2008-2017

To determine if this result is robust across various times periods, I analyze the effect of helmet laws on motorcyclist fatalities in the time periods 1994-2007 and 2008-2017. As shown

Table 19: The Impact of Helmet Laws on Motorcyclist Fatalities (Natural Logs), 1994-2007

Independent Variables	log MCfatals	log MCfatals	log MCfatals
Law	-0.279***	-0.281***	-0.242***
	(0.066)	(0.066)	(0.074)
Primary Enforcement		0.056	0.063
		(0.045)	(0.048)
log(GDP)		0.209	0.042
		(0.239)	(0.251)
log(Population)		0.571	0.412
		(0.366)	(0.396)
Registered MC			-2.97e-07
			(3.13e-07)
MV Fatalities			0.001***
			(0.000)
Observations	714	714	663
R-squared	0.612	0.617	0.626
Number of States	51	51	51

Table 20: The Impact of Helmet Laws on Motorcyclist Fatalities (Natural Logs), 2008-2017

Independent Variables	log MCfatals	log MCfatals	log MCfatals
Law	-0.081	-0.128	-0.124
	(0.136)	(0.138)	(0.146)
Prim		-0.066	-0.050
		(0.063)	(0.067)
log(GDP)		0.304	0.164
		(0.232)	(0.257)
log(Population)		1.528**	1.577**
		(0.624)	(0.774)
Registered MC			1.69e-07
			(1.75e-07)
MV Fatalities			0.000***
			(0.000)
Observations	510	510	453
R-squared	0.095	0.123	0.149
Number of States	51	51	51

Note: All estimations consist of 50 states, including the District of Columbia, and control for time and state fixed effects. Both Table 19 and Table 20 measure motorcyclist fatalities in natural logs. Table 19 restricts the time period to the years 1994-2007, while Table 20 restricts the time period to the years 2008-2017. * indicates that the result is significant at the 10% level, ** at the 5% level, and *** at the 1% level. Standard errors are located inside parentheses.

in Table 19, when I restrict my time period to the years 1994-2007, my result remains robust. Column three of row one shows that a helmet law is expected to significantly decrease motorcyclist fatalities by 24.2%, which is significant at the 1% level and consistent with the estimate stated above. However, upon restricting my time period to the years 2008-2017, I find that the coefficients on Law are no longer statistically significant and are small in magnitude. For example, row one of Table 20 shows that a universal helmet law is associated with an 8.08-12.8% decrease in motorcyclist fatalities, but such results are not statistically different from zero. I conclude from this that my results from previous periods may not be generalizable to later, more current, periods.

5 Discussion

5.1 Discussing the Impact of Universal Helmet Laws on MVA Organ Donors

My estimates for the impact of universal helmet laws on MVA organ donors are extremely sensitive to both variations in the model specification and the time period studied. Analyzing my entire sample from 1994-2018, I find that a universal helmet law is associated with a 12.46% decrease in organ donors who died from motor vehicle accidents, which is significant at the 5% level. However, when more controls are included in my model, both the significance and magnitude of this result diminish. Such results are surprising given that past literature (Dickert-Conlin et al., 2011) emphasized the robustness of their estimates over the time period 1994-2007.

I attempt to explain the discrepancy in my results by following the same strategy taken by Dickert-Conlin et al. (2011). Restricting my sample to include only the years 1994-2007, I am able to replicate their results to some extent, but find evidence against their robustness. For instance, Tables 9 and 10 show that a helmet law is associated with reductions in MVA donors of 11.67% when measured in absolute levels, comparable to Dickert-Conlin et al.'s (2011) estimate of 12.7%, and approximately 8.3% when measured in natural logs, comparable to Dickert-Conlin et al.'s (2011) estimate of 9.7%. However, unlike those of Dickert-Conlin et al. (2011), my results are sensitive to slight modifications in the model specification. I am able to identify three potential reasons for this.

The first is that, unlike Dickert-Conlin et al. (2011), I include all 50 states, in addition to the District of Columbia, in my sample. To see whether my results would change if I use the same methodological approach as taken by Dickert-Conlin et al. (2011), I eliminate the thirteen states that do not possess their own OPO headquarters from my analysis. Yet when I do so, my results are surprisingly much greater in magnitude than those found by Dickert-Conlin et al. (2011) when MVA donors are measured in absolute levels and are insignificant when MVA donors are measured in natural logs. I therefore rule out this possibility and attribute the lack of robustness in my results to either the control variables that I include in my model or my identification strategy, the two other potential reasons that I will discuss later in this section.

Regardless of the underlying mechanisms driving my estimates, my study contributes to the literature by showing that the significant negative correlation between a universal helmet law and MVA organ donors is not as robust as previously considered. As described above, this estimate is prone to severe variation by slight modifications of model parameters and lacks external validity. When I restrict my sample to the years 2008-2018, I find that none of the coefficients on Law are statistically significant. I therefore conclude that my estimates from earlier periods may not be extrapolated to later, more current, periods. It is possible that during these later years, my results are being driven by a change in policy affecting organ donations or motorcyclist fatalities. Future research is needed to determine if this is the case.

Another important contribution of my paper is my finding that helmet laws do not encourage motorcyclists to act more risk-seeking in non-driving situations. This is clearly seen in Table 8, where none of the coefficients in the columns called "Non MVA" are positive and statistically significant. Such results are consistent with those found by Dickert-Conlin et al. (2011). However, Table 8 also shows that helmet laws significantly increase the number of both male and female MVA donors aged 11-17. This is surprising given that the majority of people within this age group are not old enough to operate motorcycles. It is possible, however, that the presence of a universal helmet law influences motorcyclists to pay less attention to the safety of children and, by consequent, drive with less caution. I therefore have evidence--albeit limited--to suggest that motorcyclists drive more recklessly in response to helmet regulation. This finding is consistent with the risk-compensation theory supported by some researchers studying drivers' behavioral responses to safety regulation (Peltzman, 1975; Graham & Lee, 1986).

Table 8 also highlights that contrary to expectations, helmet laws do not have the biggest negative impact on male MVA donors aged 18-34 among male MVA donors. In fact, the biggest impact is on males aged 50-64, who experience a decrease in MVA donors of 142.72%. Perhaps this unexpected result portrays an accurate representation of the sample since older riders account for a larger percentage of motorcyclist fatalities than ever before.[11] Yet this result, along with my surprising finding that universal helmet laws increase MVA donors aged 11-17, might also suggest that my identification strategy is flawed in that motorcyclists do not account for a significant proportion of MVA donors. If this is the case, using a dependent variable denoted as

[11] Insurance Institute for Highway Safety: https://www.iihs.org/iihs/topics/t/motorcycles/fatalityfacts/motorcycles

the number of donors who died in motorcycle accidents would produce a more accurate estimate. In fact, when I employ this approach, my results (as shown in Tables 15 and 16) are much more consistent and significant, providing further evidence that my identification strategy is not precise enough.

5.2 Discussing the Impact of Universal Helmet Laws on Motorcyclist Fatalities

My results from Table 18 show that when motorcyclist fatalities are measured in natural logs, the presence of a universal helmet law is associated with a decrease in motorcyclist fatalities of approximately 24.03% on average during the years 1994-2017. It should also be noted that this estimate is significant at the 1% level and is robust across various model specifications. I argue, therefore, that my estimate is consistent with the findings of past studies analyzing the impact of helmet laws on fatalities. As expected, my estimate is significantly negative and within the range of 22-50%. In fact, given the method I use for identifying motorcyclist fatalities, my estimate might give a lower bound.

The stark contrast between the consistent results that I find when using motorcyclist fatalities as my dependent variable and the inconsistent results that I find when using MVA donors as my dependent variable is yet another indication that MVA donors may not be used to determine the effect of motorcycle helmet laws on organ donations that come from deceased motorcyclists. This observation is one of the main contributions of my study.

Furthermore, Table 20 shows that upon restricting my sample to the years 2008-2017, the impact of universal helmet laws on motorcyclist fatalities is, surprisingly, small and insignificant. This result coincides with the insignificant estimates that I find on the coefficients of Law for MVA donors over the same restricted time period. Both analyses point to the curious trend that estimates from previous periods may not be generalizable to later periods.

5.3 Policy Implications

Universal Helmet Laws: Costs to Individuals on Organ Transplant Waiting Lists

It is important to consider both the costs and benefits of motorcycle helmet regulation in order for policymakers to make the most informed decisions. My main results show that a universal helmet law is associated with annual average reductions in state MVA donor counts of 3.825, 3.195, and 3.759 over the time periods 1994-2018, 1994-2007, and 2008-2018 respectively. Averaging these estimates, I find that a universal helmet law is associated with an annual reduction of 3.593 organ donors. Given the OPTN's estimate of 2.7 transplanted organs per donors, I multiply 3.593 by 2.7 to calculate the number of transplants forgone when a universal helmet legislation is implemented. This produces an estimate of 9.701 forgone transplants. I then multiply 9.701 by a range of estimates for the value of statistical life (VSL) to find the costs of lives lost among individuals on organ transplant waiting lists. As shown in Table 21, VSL estimates range from $1.1 million to $25.8 million in current (2019) U.S. dollars. My final calculation reveals that a universal helmet law yields an annual cost of $10,671,100 to $250,285,800 in current U.S. dollars. However, given that my estimates are not robust across various model specifications and time periods, it should be noted that perhaps this estimate should be taken with caution in the cost-benefit analysis of universal motorcycle helmet regulation. More research is needed to verify that this is the case.

Table 21: Estimates for the Value of a Statistical Life (VSL)

Study	Method	Value of a Statistical Life (in 1997 dollars)	Value of a Statistical Life (in 2019 dollars)	Forgone Transplants	Cost of Lives Lost
Kneisner & Leeth (1991-U.S.)	Labor Market	$0.7 million	$1.1 million	9.701	$10,671,100
Kneisner & Leeth (1991-Australia)	Labor Market	$4.0 million	$6.3 million	9.701	$61,116,300
Moore & Viscusi (1988)	Labor Market	$8.8 million	$13.9 million	9.701	$134,843,900
Leigh (1987)	Labor Market	$12.6 million	$20 million	9.701	$194,020,000
Garen (1988)	Labor Market	$16.3 million	$25.8 million	9.701	$250,285,800
Department of Transportation[12]	Unknown	$9.6 million (in 2016 dollars)	$10.2 million	9.701	$98,950,200

Note: Most of the estimates in Table 21 are listed in Exhibit 7-3 of the Environmental Protection Agency's (EPA) *Guidelines for Preparing Economic Analyses (2000)*.

Universal Helmet Laws: Benefits to Motorcyclists

My results show that a universal helmet law is associated with a decrease in motorcyclist fatalities of approximately 24.03% on average. I then multiply this percentage by the number of motorcyclist fatalities that occurred during the most recent year of my sample to find the number of motorcyclists' lives that are saved due to implementation of the legislation. I find that a universal helmet law saves the lives of 1180.59 motorcyclists (=0.2403*4913 fatalities) in 2017. Multiplying 1180.59 by the range of estimates for the value of a statistical life listed above, I calculate the annual benefit of a universal helmet law to be worth $12,986,490,000 to

[12]Department of Transportation, Value of a Statistical Life: https://www.transportation.gov/sites/dot.gov/files/docs/2016%20Revised%20Value%20of%20a%20Statistical%20Life%20Guidance.pdf

$30,459,222,000 in current U.S. dollars. It should be noted, however, that this estimate should also be taken with caution, especially when considering more recent years.

It should be noted that although the benefits of universal helmet laws outweigh the costs by over $30 billion in current U.S. dollars, policymakers should not ignore the potential negative externality of helmet regulation on organ donation recipients. In fact, perhaps it would be beneficial for policymakers to complement universal helmet regulation with presumed consent or mandated choice organ donation regimes to mitigate the effects of the negative externality.

5.4 Limitations and Areas for Future Research

Although my study contributes to the literature analyzing helmet laws' impact on deceased organ donations, it is essential to highlight the limitations. First and foremost, as mentioned before, my analysis is limited due to the identification strategy that I employ. Data on deceased organ donors who died from motorcycle accidents is currently unavailable. However, future researchers could approximate these statistics by multiplying MVA donors by the proportion of motor vehicle fatalities that are motorcyclist fatalities. My analysis is also limited in that I only control for seven time-varying state observables and, among the seven, two variables (motor vehicle fatalities and fatal crashes involving motorcycles) are the main mechanisms through which helmet regulation impacts organ donations. Given that these variables bias my results, I would advise against future researchers controlling for them in their models. It is also important to acknowledge that my analysis suffers from omitted variable bias, as I do not account for all state observables that explain, at least partially, the variation in MVA organ donations.

In addition, the only evidence I have for motorcyclists acting with less caution after implementation of a universal helmet law is the positive coefficient on Law when MVA donors aged 11-17 is used as my dependent variable. However, to learn more about motorcyclists' behavioral responses to helmet regulation, future researchers should investigate how helmet law repeals affect motorcycle registration rates. If rates were to increase after the repeals, as observed by Dickert-Conlin et al. (2011), this would provide evidence against the risk-compensation hypothesis. Also, since there is a lack of surveys on how motorcyclists perceive their accident risk and their risk-taking behavior, future research should focus on collecting more data. These surveys would contribute valuable insight to the behavioral literature. Furthermore, given that I find no significant correlation between universal helmets and MVA donors or motorcyclist fatalities during the time period 2008-2018, future research should attempt to identify any changes in policies or trends during this period that could explain such findings.

Last, it would be beneficial for future studies to analyze the effect of helmet policies on organ donations in a few, appropriately chosen, states to determine whether the trends in the aggregate data may be generalizable to individual states. Future research should also considering studying the potential negative externalities of other laws on organ donation rates, as did Fernandez & Lang (2015) and Bilgel (2018). For example, it would interesting to see whether curfew laws, limiting the hour at which people retire for the day, have an effect on donors who died from homicides through their impact on gun-related violence.

6 Conclusion

My paper seeks to answer the following question: Does the presence of a universal motorcycle helmet law reduce the number of organ donors who died in motor vehicle accidents? To answer this question, I exploit data from the OPTN, which records information on donor counts by donor circumstance of death and state of residence from 1994 to 2018. My study is the first to analyze the effect of motorcycle helmet laws on organ donations over a long time window, allowing me to subset my data into different time periods to determine if my results are generalizable to different time periods. In total, my dataset contains 1,275 observations, covering 50 states in addition to the District of Columbia from 1994 to 2018. The results from my DID estimations show that although I find a negative correlation between a universal helmet law and MVA organ donors, this relationship does not hold across various model specifications and time periods. Therefore, my study contributes to the literature by disconfirming the robustness of the results found by past researchers.

My paper also contributes to the literature in three other significant ways. First, by determining the effect of a universal helmet law on different age and gender groups of MVA organ donors, I find that, contrary to expectations, a universal helmet law is associated with increases in both female and male MVA donors aged 11-17. This result is counterintuitive given that the people within this age group are not old enough to operate motorcyclists. Perhaps this is indication that motorcyclists become less concerned with the safety of children when a universal helmet is implemented, but the more plausible explanation is that my identification strategy--and that used by Dickert-Conlin et al. (2011)--is flawed. Further evidence to support that my strategy is flawed comes from my consistent and significant coefficients on Law when I use an estimation of donors who died from motorcycle accidents, as opposed to motor vehicle accidents, as my dependent variable. Thus, future researchers should consider using another dependent variable in order to measure the effect of helmet laws on organ donations more accurately.

The second way that my study contributes to the literature is by showing that there are no significant crowding out effects associated with universal helmet laws. In other words, there is no evidence to be found that universal helmet laws are associated with significant positive increases in organ donors who died from accidents not related to motor vehicles. This is indication that safety regulation regarding motorcyclists does not encourage them to become more reckless in other, non-driving, areas of life. Yet nonetheless, my analysis of motorcyclists' behavioral responses is limited, and more research is needed to determine how motorcyclists and drivers in general respond to highway safety regulations. Perhaps disseminating more surveys to motorcyclists on their feelings towards these regulations would lead to deeper understanding.

Third, my paper contributes to the literature by showing that the impact of universal helmet laws on motorcyclist fatalities is fairly consistent across various model specifications and coincides with results found by prior literature. However, I find evidence to suggest that my estimates lack external validity and are not generalizable to later, more current, time periods.

My study also has important policy implications. Given that organ donation in the U.S. is already low, implementing a universal motorcycle helmet law in a state could impose significant externalities on individuals on organ transplant waiting lists. However, since my results are not robust, policymakers should take caution accounting for universal helmet regulation's impact on organ donations in their cost-benefit analyses. More research is needed to determine if the effect of universal motorcycle helmet regulation on organ donations across states is homogeneous.

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