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Increasing Organ Donations in Maryland: An Interrupted Time Series Analysis

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Abstract

The state of Maryland has been unsuccessful in achieving its goal of registering all of its population as organ donors. The purpose of this correlational study was to understand if allowing registered donors to remain anonymous would increase donor registration rates.

The theoretical foundation of this study was the theory of planned behavior. Data were collected from the Motor Vehicle Administration of Maryland and the Division of Motor Vehicle of Virginia. The data were analyzed using regression displacement, interrupted time series analysis, auto correlation analysis, and Arima Box Jenkins methodology. According to the study findings, offering the option to remain anonymous and registering to be an organ donor with no heart icon on the driver's license did not have the immediate effect of encouraging more people to register as an organ donor. Parameter estimates from an Arima autoregression analysis did suggest that the impact of the removal of the heart icon may have a delayed impact, although data availability limited attempts at further investigation.

Objective

The insight of behavioral economics on the effectiveness of default options has led to the implementation of nudging programs in many programs ranging from benefit packages to organ donation. With respect to organ donation, a number of countries have an 'opt out' system in place. That is, you have to register not to be a donor, and in those countries, at least 90%, and in some cases almost a 100%, of the adult population are registered as donors. This simple difference in the default position appears to cause a dramatic difference in registered donors.

In the American states, organ donors have to opt in as a donor. Ninety-seven percent of all those that register as organ donors do so at their local Division of Motor Vehicles (DMV) [1].

The states have used multiple methods to try to increase the donor registration rates, ranging from web-based registration to marketing methods using social media. The results have been mixed. There is some evidence that social media can bolster organ registration rates [2].

Others have shown limited impact. In 2015, a study was done to learn if the effects of state policies provided incentives for people to register to donate. They learned these policies had no significant impact [3]. Another study [4], suggested that state policies had little impact on organ donation registration rates. Another study confirmed that policies to encourage registration as a donor had no effect on donation and transplantation [3].

The state of West Virginia launched a program to learn if web-based training of the staff at the DMV would improve registration rates.

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The results were positive [5]. The state of Massachusetts performed studies to learn if video messaging at the DMV would increase donor registration. While the DMV is a location to focus on increasing registration rates, this study did not have an impact on registration rates [6]. The New England Organ Bank partnered with the DMV and studied the impact of video messaging and how it equated to behavioral intent to register. They learned that one-minute videos can have a positive impact on organ donor registration [7]. New York State was interested in learning about reasons for not signing up as an organ donor. They partnered with the DMV and surveyed customers about donation [8]. The state of Florida studied the effectiveness of a statewide intervention with the DMV to increase registration rates [1]. In 2013, a study learned that even though asking for money to support organ donation relieves moral pressure on the applicant, it did not encourage more registrations [9].

Marketing programs can have an impact on donor registration. A study in Iowa learned that residents were receptive to direct mail campaigns to increase donor registration [10]. A direct-mail study in Illinois learned that an invitation via the U.S. mail resulted in increased registration rates [11]. A study with college students giving positive messaging promoted registration rates, regardless of the graphics used in the marketing materials [12]. A study of African Americans in Ohio learned that cues to action had a positive impact on registration rates [13]. In a 2012 study, it was learned that mass media campaigns can serve as a means for educating the public about organ donation [14]. Marketing results can be difficult to analyze and quantify, but organ donor campaigns can produce positive results in registration [15].

There are a number of possible reasons why these incentives have not worked. Some are plausible, but most are on the level of anecdotal belief. People's attitudes and beliefs play a large role in the decision to become a donor. One example is that doctors will not save the life of a registered donor [16]. Another widely held belief is that rich and famous people go to the top of the waiting list [17]. In addition, there are concerns that rich people can afford to buy organs, which is another myth [18]. These beliefs may affect the number of registered donors. The most common reason cited for not registering as a donor was religious views, even though most religions around the world support organ donation [19]. Religion is the most often noted barrier to registration to organ donation [16]. While religious leaders are noted as supporting organ donation, religion continues to be a reason not to register [20]. Confusion about religious support, family support, and the negative beliefs impact that decision. Concerns about the black market for organs continues to be a concern [21].

Family interactions can impact registration rates. Families with little knowledge about donation prior to the pending death of a loved one are more apt to decline donation [22]. This supports the research that education can improve registration rates. A family's wishes and working to find a way to mesh them with the donor's wishes at the time of death, can create a challenge to donation [23]. Another study supported the fact that the lack of family support for donation holds numbers down [19]. In 2013, a study learned that family influence can be positive, if they have been provided with knowledge about transplantation and donation [24]. A best practice is for families to discuss these wishes when registration is being considered. Research has shown that when family members know they have saved a life, they had no regrets about donation, while others felt regret when opting not to donate [22]. Inadequate support from family members adds to the feeling of being overwhelmed by the decision whether or not to donate a loved one's organs [25]. This study supported the need for more education and support around the decision to donate.

The States and Maryland

A regression displacement analysis using registered donations for 2014 and 2015 data from the 52 jurisdictions for all 50 states and the District of Columbia and Puerto Rico was conducted to get a sense of whether the states of interest, particularly Maryland exhibited any patterns worth noting. The regression equation $Y = \beta + BX + \varepsilon$ was fitted to the data 2015. The resulting equation $Y_{2015} = 7.934 + .879^{**} X_{2014}$, $R^2 = .90$ shows a strong linear pattern as shown in Figure 1.

Maryland appears in the middle of the pack, almost on the regression line. A scatter diagram of the forecasted values plotted against the actual value in Figure 2 shows the same pattern, very much the typical state in terms of donor registration rates.

Methods

Maryland was chosen for this study, as the only state to offer the option of registering and remaining anonymous. The heart icon on the driver's license is a nationally recognized symbol of registered organ donors. The state of Maryland's option to allow registered organ donors to opt of the heart icon program might serve as a test of whether anonymity increases the rate of organ donation. In an effort to address the problem, Maryland designed a program allowing registered donors to opt out of the heart icon program in an effort to overcome multiple myths about the impact of the heart icon on one's driver's license. The term "opt out" here is not used in the same manner as the better known "opt out" options in European countries but rather to denote that prospective donors in Maryland can decide to remove the heart icon from their driver's licenses.

The gap in research exists, as no other state in this country has offered the option of allowing registered donors to register but opt out of the heart icon program, allowing them to remain anonymous. In order to understand the impact of this program comparing the results to a state without this program could provide data to understand if providing this option had value. The state of Virginia was chosen as they have similar demographics and populations. A comparison of time series data on organ donations for Maryland and Virginia over a two-year period including the policy intervention, was conducted. Virginia originally was the control group and the periods before and after the intervention in both Maryland and Virginia would be

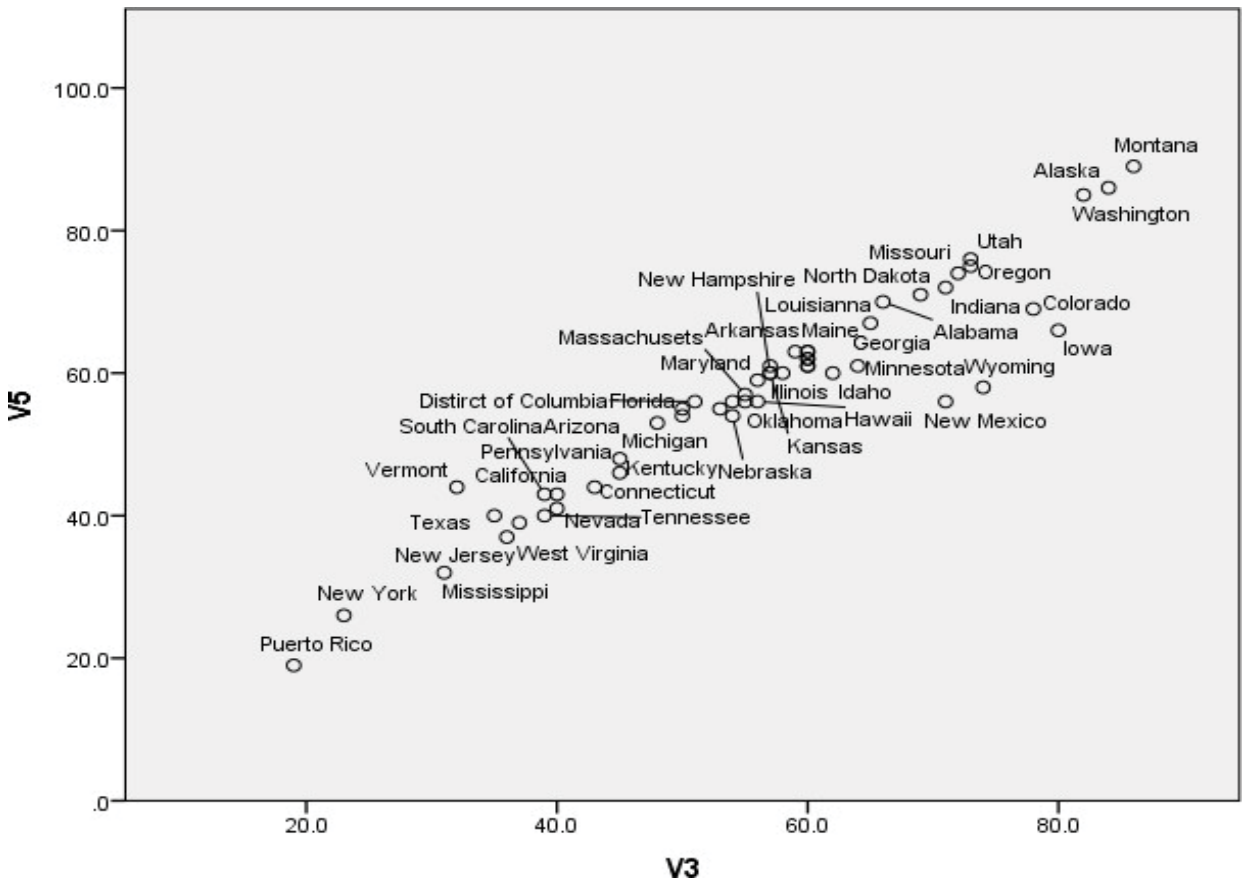


Figure 1: Organ Donor Registrations in the American States 2014-2015.

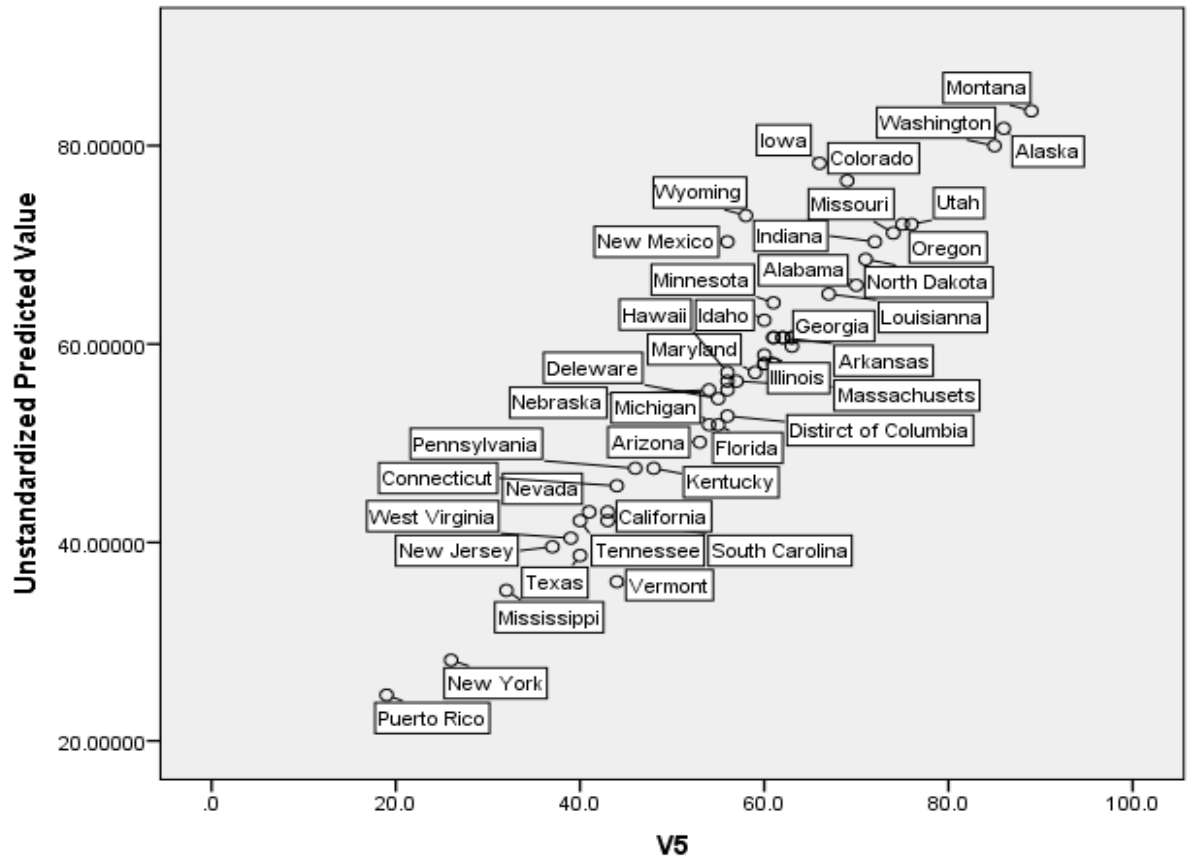


Figure 2

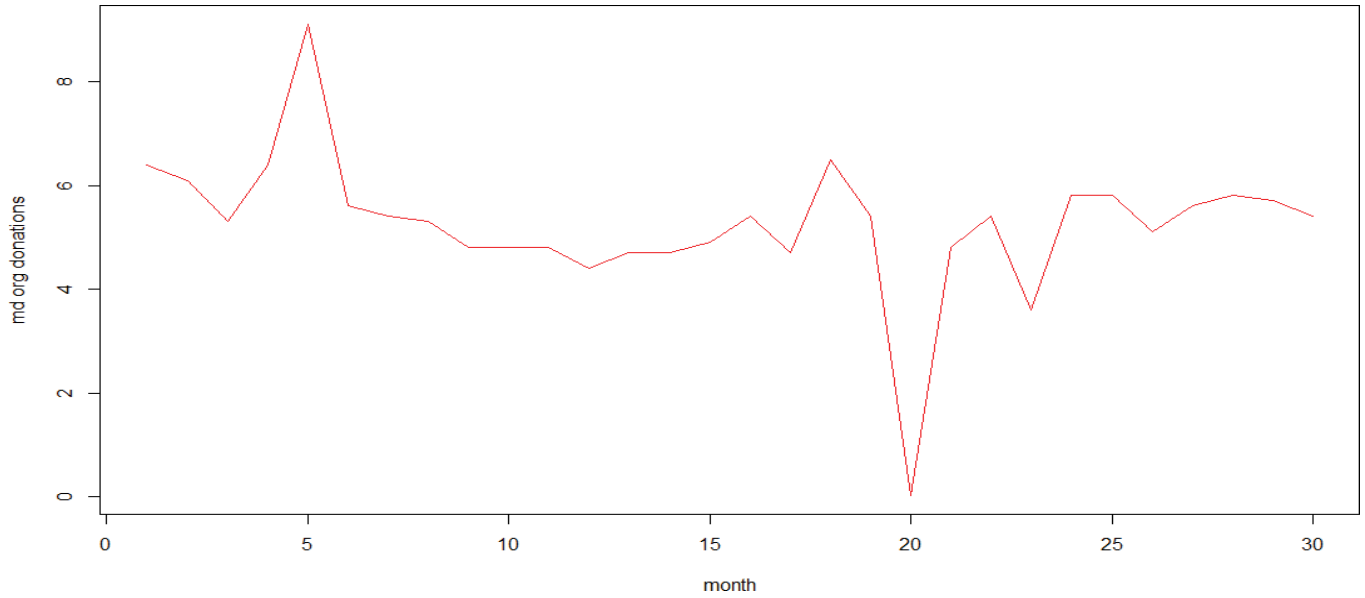


Figure 3: Maryland Organ Donor Registration Rates as percent of total DMV transactions 2014-2016.

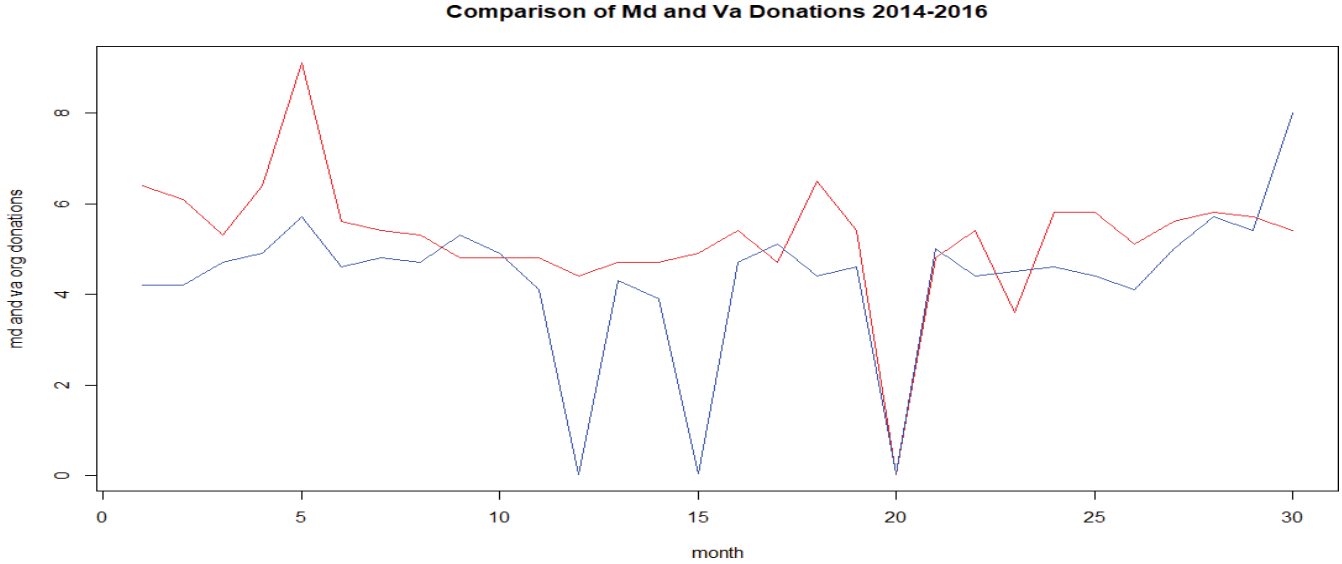


Figure 4: Virginia Donor Registration Rates.

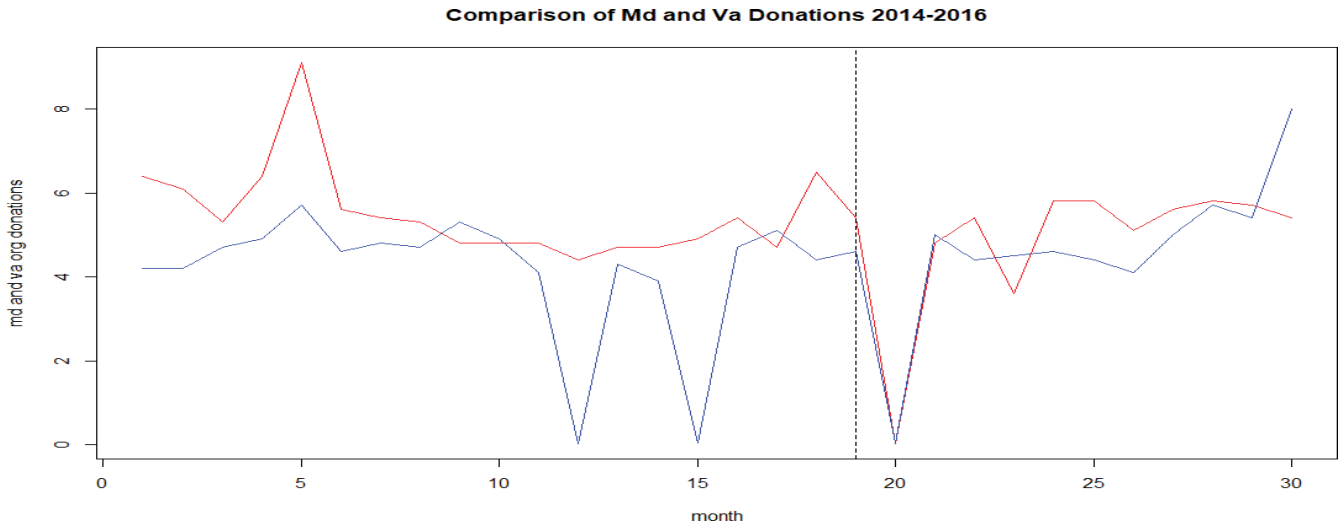


Figure 5: Donor Registration Rates with Policy Intervention.

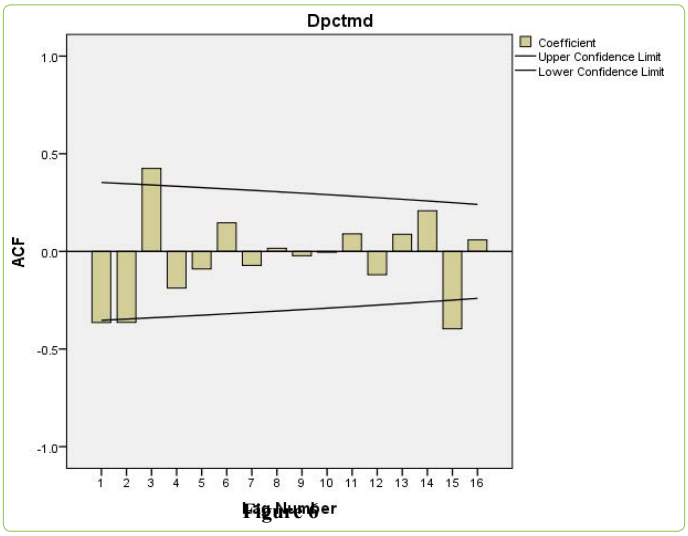
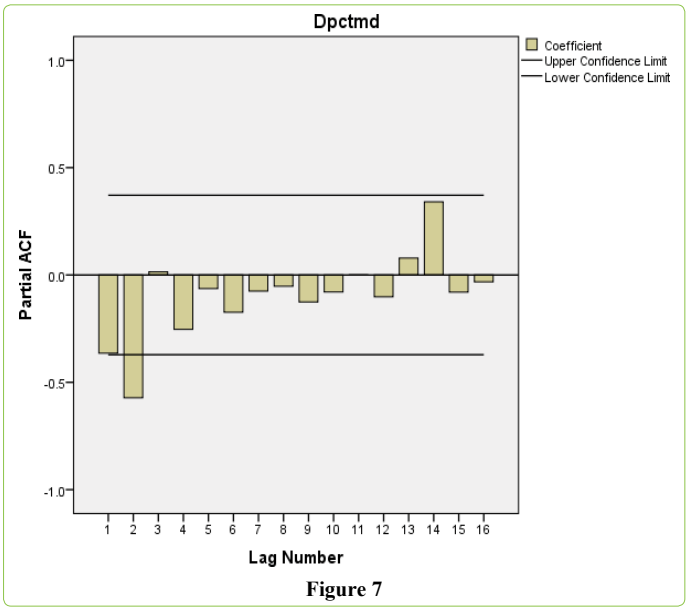


Figure 6



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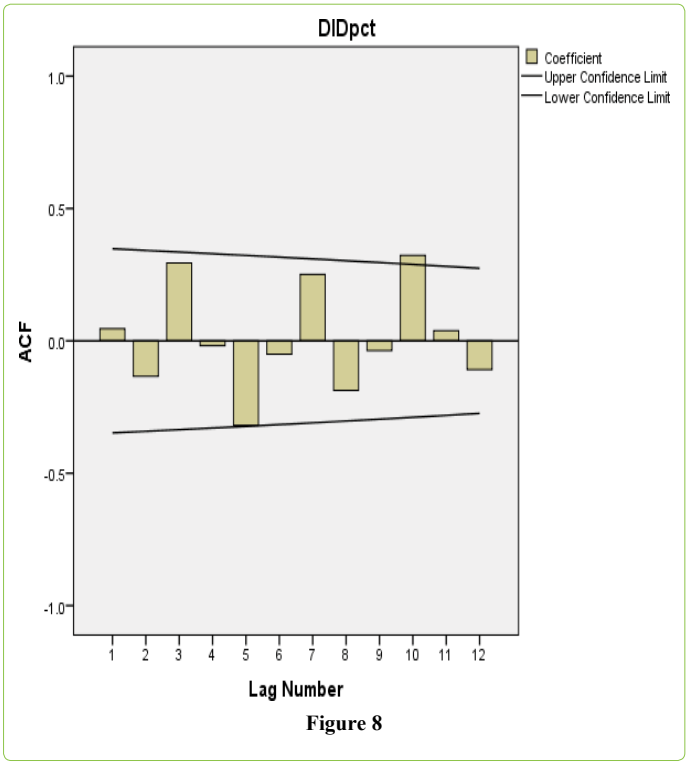

Figure 8

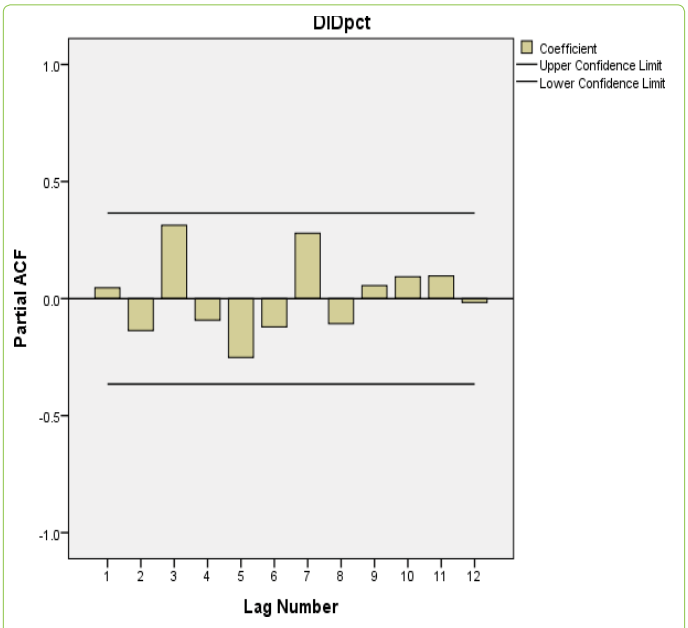

Figure 9

compared.

The data for the study encompasses 30 consecutive months for both Maryland and Virginia from April 2014 thru September of 2016. The intervention occurred in October 2015. Attempts to collect additional data both for earlier and later months of the intervention both for Maryland and Virginia were unsuccessful. The relevant time series graphs for the registration rates as a percent of total DMV transactions are depicted in Figures 3-9.

Results

The different plots, on visual examination show no discernible trends and quite a bit of noise. In addition to the registration rates, the program intervention HTOPT was coded as a dummy variable, coded 0 before the intervention and 1 on and after October 2015. This variable captures the interplay between the intervention and time. A time variable, Time was added to capture the overall secular trend over the 30 time periods. A variable TimeAft is coded 0 before the intervention and numbered sequentially after the intervention to capture the continuing effect of the HTopt program. Lastly a difference DID variable was added to measure the differences between Maryland and Virginia rates. It bears noting though that Virginia rates actually exceeded Maryland's in seven months out of the 30-month series.

Runs tests were calculated for the Maryland, Virginia and DID variables. The Runs test for randomness is a simple numeric check for the randomness of a time series. Table 1 shows the results.

The absence of significant p values for the Maryland and difference variable indicates there is no compelling evidence to reject the hypothesis of a random process. Despite this visual inspection of the Maryland data suggest

Table 1: Runs Tests.

Variables	Maryland Rates	Virginia Rates	Difference Variable
Mean	-1.512	-2.272*	-0.349
Median	-0.908	-1.224	-0.535
Mode	-0.908	-2.028	-0.77
*=P<.05			

Table 2: Interrupted Time Series Analysis: Impact of the Removal of the Heart Option.

	Coefficient	Standard Error
Maryland		
Time	-0.09	0.056
Hopt Intervention	-1.329	0.945
Time Aft	.312**	0.118
Intercept	6.369**	0.608
Rsquare	0.26	
Durbin Watson	2.202	
Difference Md Va		
Time	-0.006	0.694
Hopt Intervention	-0.447	1.078
Time Aft	-0.094	0.134
Intercept	1.433*	
R Squar e	0.175	
Durbin Watson	2.009	
**** p<.01 * p<.05**		

Table 3: Parameter Estimates for Maryland Registration Rates.

Variable	Parameter Estimate	Standard Error	P value
AR(1)			
Time	-0.006	0.053	0.101
TimeAft	0.316	0.11	.008*
HTopt	-1.349	0.902	0.147
AR(0,0)			
Time	-0.09	0.056	0.123

further examination. Regression equations using time as the independent variable prior to the month of the intervention and after the month of the intervention tests whether there are two different dynamic processes at work Prior to October 2015, the fitted regression;$Dpct\ md = 6.369 - .090Time$ suggests a negative if insignificant trend. After October 2015, the series for both states spike downward which could be attributable to chance but the fitted regression after the intervention; $Dpct\ md = -3.122 + .318Time^{*}$ shows a positive but significant slope which may be caused by the outlier at the very end of the series. Regressions were also fitted for the DiDpct variable. Prior to October 2015, the regression equation for the variable was $DiDpct = 1.433 - .006Time$. After that month the fitted equation was $Didpct = 2.638 - .099Time$. None of the slopes showed significance.

To analyze further the interrupted time series regression equation: $Y = \beta_0 + \beta_1 T + \beta_2 Hopt + \beta_3$ TimeAft was fitted to the both the Maryland rates and the difference in Maryland and Virginia rates. Table 2 shows the results of the interrupted time series.

The results show that the level of organ donation rates in Maryland showed a decrease of 1.3% after the intervention according to β_2. In addition, β_1 and β_3 show that rates decreased before the intervention point (-.090) but showed an increase (.312-.090=.222) afterwards.

Given the significance of the Durbin Watson statistics for both models, regression in this interrupted time series is normally estimated in autoregressive form, where: $Y_t = \emptyset_t Y_{t-1} + \emptyset_2 Y_{t-2} + \ldots \emptyset_p Y_{t-p} + \alpha_t$ the best predictor of the variable at time t is the variable at t-1 and α_t is the error term or white noise [26-54]. In accordance with the method correlograms and partial correlograms were generated for both the Maryland rates and the difference between the two state rates.

The ACF and PACF charts for both variables did not match patterns that are easily classified into autoregressive or moving average patterns. The estimation of the parameters using ARIMA modelling might be of some help. Parameters were estimated for ARIMA (0,0) and a first order ARIMA (1,0) process. Table 3 displays the results for the Maryland rate data only.

Results for the difference between Maryland and Virginia are not shown as none of the parameters showed significance both using the random noise model or the first order autoregression.

The parameter estimates for the variables show the sole significance of the TimeAft variable both in the first order AR process and in the random noise model. This suggests that there may be some significance to the erratic upward trend that starts about the 20th month after the intervention. The coefficient measures the continuing effect of the policy after enactment and should capture long term impact. The coefficient for Time here can be treated as a nuisance variable as it controls for any secular trend effect. The coefficient for the intervention variable again appears insignificant. There does appear to be some evidence, although weak, that there may be a long-term impact of the removal of the heart icon option.

Conclusion

It is unfortunate that data was not made available past September of 2016 to further investigate the viability of a long-term impact. There is no doubt that a more extensive time series could better explain what appears to be a volatile period within which the policy change took place. There is always the possibility of a history threat or possible cointerventions such as changes in variables that could affect changes in donation registrations. For example, Maryland state employees are almost convinced that increases in donor rates are in no small part due to the Governor's push to emphasize on line transactions for registrations. This policy push was initiated in 2014 prior to the beginning of our series and we were unable to obtain data for that period.

There are also other variables that affect donor registration but are beyond the scope of the data in this study. It is suspected that rates may vary on the basis of age, education and other relevant demographics.

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