UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

PROMOTING CITIZEN PARTICIPATION IN DISASTER MANAGEMENT: MOTIVATIONS FOR INDIVIDUAL AND COLLECTIVE PARTICIPATION IN EMERGENCY SERVICE DELIVERY

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

Degree of

DOCTOR OF PHILOSOPHY

By

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Norman, Oklahoma
2020

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PROMOTING CITIZEN PARTICIPATION IN DISASTER MANAGEMENT:
MOTIVATIONS FOR INDIVIDUAL AND COLLECTIVE PARTICIPATION
IN EMERGENCY SERVICE DELIVERY

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF POLITICAL SCIENCE

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Acknowledgements

I would like to express my deep sense of gratitude to my parents, sister, and brother in Korea. Without their support, guidance, and patience, I know I would not be able to get through this journey. I also thank my partner, Romit Maulik, and three furry friends, Gauss, Plato, and Leo for supporting me and keeping me sane all this time.

I would also like to take some time to thank my advisor, Dr. Scott Robinson, for his mentorship. I have been able to become who I am now and to achieve many things that I would not even imagine thanks to his endless support and advice. He will be my forever role-model in my professional life. I also feel lucky to be advised by all my committee members, Dr. Aimee Franklin, Dr. Alisa Fryar, Dr. Joe Ripberger, and Dr. Justin Reedy. Thank you so much for your advice, support, and patience. Also, I sincerely appreciate all the opportunities the Department of Political Science at the University of Oklahoma has provided me.

There are so many friends, colleagues, and collaborators whom I want to mention their name here and express my appreciation. However, they may not read my dissertation so I will have personally texted and emailed them.

I would not say that it was easy. It was tough and I doubted my decisions and my capability of finishing this many times. I am glad that I did not give

up and took the courage to start and complete this process. I believe that the completion of this dissertation is just the beginning of a new adventure. I will not give up and keep working for good changes.

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Abstract

This dissertation seeks to understand the determinants and motivations of citizens' individual and collective participation in the process of public service delivery through the lens of citizen co-production. While citizen participation has been highlighted particularly in the administrative decision-making process, citizen co-production literature emphasizes the role of citizens in the public service delivery process. This body of literature argues that citizens may contribute to public service outcomes by providing time, efforts, knowledge, and by cooperating with professional public service providers. Utilizing both a relatively uncommon machine learning technique in public administration, random forest regression, and traditional statistical approaches, I examine various factors shaping citizens' individual and collective participation in the process of emergency service delivery before, during, and after tornadoes. Three empirical chapters suggest that public trust in issue-specific agencies and social capital play significant roles in structuring citizens' individual and collective co-production of emergency service. The analyses of two methods utilized in this dissertation also suggest further investigation in quantitative methodology for a better understanding of citizen participation in public service delivery.

Chapter 1

Promoting Citizen Participation in Disaster Management

1.1 Introduction

Why do citizens decide to participate in the process of public administration? How can we promote citizen involvement in the public service process? In this dissertation, I posit that public trust, trust in the issue-specific agency and social capital play decisive roles in shaping citizens' decisions on individual and collective participation in the process of public service delivery. Following these arguments, I seek to investigate the decisiveness of public trust in structuring citizen' individual and collective participation in the process of public service delivery, particularly emergency service before, during and after tornadoes.

Citizen participation has a long tradition since the history of the United States started. While the degree and means of citizen participation have varied over time, scholars in public administration and political science in general have considered citizen participation in the public policy process as a primary interest and

objective (Strange, 1972; McGregor and Sundeen, 1984). Scholars have argued that citizen participation is an essential means to achieve core democratic values such as innovation, legitimacy, justice, and effectiveness of government actions (Olsen, 1982; Fung, 2015, 2006; Frederickson, 1996; Denhardt and Denhardt, 2015).

Despite the history of scholarly interest in citizen participation in public administration, a majority of interests and focuses have been primarily centered around the role of citizens in the context of administrative decision making and agenda-setting process (Ebdon and Franklin, 2006; Franklin, Ho and Ebdon, 2009; Fung, 2006; Frederickson, 1996; Strange, 1972). However, a body of scholarship in public administration have recently focused on the role of citizens in the process of public service particularly at the local level. This body of scholarship is denoted as "citizen co-production" and they have argued that citizens' individual and collective participation in the public service delivery process can improve various democratic values such as efficiency, effectiveness, innovation, citizenship, empowerment, and public trust to name a few (Osborne and Strokosch, 2013; Dunston et al., 2009; Levine and Fisher, 1984; Jakobsen and Andersen, 2013; Marschall, 2004). While the concept of citizen co-production is defined in somewhat different ways among scholars (Nabatchi, Sancino and Sicilia, 2017), citizen co-production may be defined as the contribution of resources by citizens and public service providers in the process of public service delivery (Brudney and England, 1983; Brudney, 1983). Scholars have argued that citizens, as co-producers of public service, can contribute to the public service process significantly by individually and collectively providing their knowledge, resources such as time, money and efforts, ideas, creativities and their cooperation with public service providers (Loeffler and Bovaird, 2016; Whitaker, 1980; Brudney, 1983).

The scholarly interests in the role of citizens in the public service process are primarily driven by the concept of "new governance" (Bingham, Leary and Nabatchi, 2005; Nabatchi, Sancino and Sicilia, 2017). New governance scholars have argued that given the complexity of social problems and an increase in public demand for public service, the government cannot solely provide public service and address problems. Instead, they have maintained that the collaborative efforts between public, private and nongovernmental policy actors and organizations should be guaranteed (Nabatchi, Sancino and Sicilia, 2017). Therefore, scholars have sought to understand inter-organizational and inter-sectoral relationships and networks for better governance Agranoff and McGuire (2003); Stoker (2006). While these efforts did not guarantee a substantial role for citizens in the public service process (Fung, 2015), this line of studies has opened more rooms for citizen participation in the public service process. Furthermore, fiscal pressures since 2008 have also contributed to the scholarly interest in citizen co-production to improve the efficiency in the public service process (Pestoff, 2012).

In this dissertation, I look at citizens' individual and collective co-production of public service, particularly emergency service in the context of tornadoes. Emergency service is a core function of government. While different levels of governments and agencies, particularly at the local level are the key actors to provide proper emergency service to the communities, governments cannot solely provide emergency service to address emergencies and disasters (Mees et al., 2016; Stallings and Quarantelli, 1985). Successful emergency service provision and delivery require contributions of various actors such as public, private and non-governmental organizations as well as individual citizens. Particularly, it has been widely observed that citizens and their cooperation can significantly

reduce the negative outcomes of emergencies and disasters such as mortality and property damages (Diekman et al., 2007). Furthermore, citizens can also significantly contribute to prevent disruptions in daily life after disasters (Peek and Mileti, 2002). Citizens may participate in the process of emergency service primarily due to the personal benefits that they can obtain from the participation in the emergency service process such as their safety. However, it should be noted that citizen participation in emergency service leads to better emergency service outcomes at the individual level and it eventually contributes to solving the problems in the community at the aggregate level (Fung, 2015).

Given the benefits of citizen co-production of public service, it is imperative to understand the motivations of citizen co-production of public service to promote it for achieving democratic values particularly in the administrative process such as effectiveness and efficiency of public service. Therefore, scholars in citizen co-production have drawn theories and empirical findings from political participation and economics literature and have found various factors associated with citizen co-production behaviors and willingness (Uzochukwu and Thomas, 2018; Voorberg et al., 2018; Van de Graaff, 2016; Parrado et al., 2013; Bovaird et al., 2016). While these studies have tremendously contributed to our understanding of the determinants and motivations of citizen co-production of public service, there have been also some limitations in these studies.

First, these studies have not considered public trust in specific issue agencies related to the types of public service. While public trust has been considered in co-production literature, scholars have mainly looked at more general political institutions such as federal, state and local government as other political science studies have done. However, it has been observed that trust in issue-specific agencies is more decisive than trust in general political institutions when it comes to

citizen's opinions and behaviors related to specific issues. Marschall (2004) argues that citizen co-production of specific public service cannot be solely explained by the factors explaining the variations in the general political participation of citizens. Therefore, in this dissertation, I seek to investigate the importance of public trust in issue-specific agencies in shaping citizen individual and collective co-production of emergency service.

Second, while scholars have found many variables associated with citizen co-production behaviors and willingness, scholars have not been able to answer the following question: which variables are the most decisive factors to shape citizen co-production behaviors and willingness? This may mainly results from the limitation of traditional statistical approaches. Correlations among variables affect the statistical significance in the statistical models. Scholars. generally check the multicollinearity issue by looking at the indexes such as Pearson's r coefficients or VIF scores. While the threshold for these indexes vary depending on the scholars and specific contexts, scholars consider that there is no multicollinearity issue if the Pearson's r or VIF is less than the threshold. However, relatively lower correlation does not mean that the variables in the model are independent as required for statistical analysis. Under this circumstance, it has been difficult to answer the decisiveness of factors in shaping citizen's opinions and behaviors. The decisiveness of factors is important in terms of theory building. Individual opinion, behaviors and willingness are rather complex therefore, one factor may not be able to explain the total variation in individual perceptions, behaviors and willingness. However, by understanding the relative decisiveness of factors, we can start examining the most decisive variable closely and think about the causal mechanisms between the decisive factor and the dependent variable. Given the absence of citizen co-production motivation theory, I argue that understanding

the decisiveness of factors may contribute to the development of the theory of citizen co-production.

To summarize, the primary purpose of this dissertation is to examine how public trust in issue-specific agencies affect citizens' individual and collective co-production of emergency service particularly in the context of tornadoes. Emergency service is a continuous process starting before, during and after emergency and disasters (Bullock, Haddow and Coppola, 2017). Given that, I seek to investigate citizen's co-production behaviors and willingness before, during and after emergencies, particularly tornadoes and how public trust, trust in emergency service agencies and trust in communities and other issue-specific factors shape their behaviors and willingness for co-production of emergency service. More specifically, in this dissertation, I ask specific research questions as follows:

1. How do public trust in local emergency service agencies shape citizen's individual co-production before tornadoes?

2. How decisive public trust in local emergency service agencies is in shaping citizens; individual co-production behaviors and willingness during tornadoes?

3. What is the relative decisiveness of social trust in explaining citizen's willingness for collective co-production of emergency service after tornadoes in collaboration with government and non-government led groups?

To answer these questions, I utilize both traditional statistical approaches and a relatively uncommon machine learning technique, random forest regressor. While traditional statistical approaches provide the coefficients of explanatory

variables to show the strength and the directions of variable effects, they do not allow us to understand the relative decisiveness of explanatory factors in explaining the variations in the dependent variable mainly due to multicollinearity issues. However, a random forest regressor calculates the relative decisiveness of factors without requiring strong parametric assumptions and high correlation issues among explanatory variables. In the meantime, a random forest regressor is also somewhat limited because it only indicates the decisiveness of factors; it does not provide the direction of variable effects. Therefore, in this dissertation, I utilize both statistical tools and machine learning techniques to explore how decisive public trust is in shaping citizens' behaviors and willingness for co-production of emergency service among many variables including basic demographic characteristics, political and social predispositions, and issue-specific factors.

In the following section, I first review the history of broader citizen participation in public administration. I then provide a review of citizen co-production including the definition, level of co-production. Based on the review of citizen co-production literature, I describe what citizen co-production means in the context of emergency service for tornadoes. Afterward, I review the motivational studies of citizen co-production and describe why public trust matters in citizen co-production behaviors and willingness. Additionally, I describe a random forest regressor as a primary method in this dissertation and explain how and why I utilize both traditional statistical approaches such as OLS, logistic and ordered probit regressions to answer the questions I ask in this dissertation. Finally, I conclude this section with the contribution of this dissertation and the outlines of this dissertation.

1.2 Citizen Participation in Public Administration

While there has been a recent resurgence of scholarly interests in citizen participation in public administration, particularly in the public service process, citizen participation is not at all a new concept. Citizen participation as a key process of a democratic society has been highlighted since the history of the United States started while citizen participation was extremely limited to a certain gender, economic class and race back then (Strange, 1972).

Citizen participation is generally defined as a process that incorporates citizen's demands, concerns, interests and values into government decision-making (Creighton, 2005; Cunningham, 1972). The fundamentals of citizen participation are well aligned with the values of founding fathers that the government should represent its people. Voting, as a right of citizens, is the most common and well-known mechanisms for citizen participation (Whitaker, 1980). However, throughout the history of citizen participation in public administration, citizens have participated in the political and administrative process via initiatives, public hearings, town hall meeting, and citizen advisory committees as well (Buss, Redburn and Guo, 2014; Banyan and Olympia, 2006; McComas and Derville, 2005).

Scholars have argued that citizen participation is an essential means to achieve core democratic values such as innovation, legitimacy, justice, and effectiveness of government actions (Olsen, 1982; Fung, 2006; Frederickson, 1996; Denhardt and Denhardt, 2015). More specifically, Fung (2015) argues that legitimacy is the strongest motivation for having more citizens participating in the political process. When citizens have opportunities to judge and influence the policies and

hold politicians accountable, they may be more likely to perceive the government as legitimate (Przeworski et al., 1999). Furthermore, by including more citizens, particularly under-privileged, have-not citizens (Arnstein, 1969), the power in the political and economic process can be redistributed and it will eventually give more opportunities for have-not citizens to be deliberately included in the future power distribution. Finally, citizen participation is imperative to improve the effectiveness to address public and social problems (Fung, 2006). Citizens who may be affected by the public policy to address social problems are the ones who suffer the most and they may have the best information and knowledge about the problematic situation and the solutions to address these problems. By drawing information, ideas, creativity from citizens, the government may address public and social problems more effectively (Loeffler and Bovaird, 2016; Fung, 2015). Given these benefits, scholars in public administration and political science more broadly have emphasized the role of citizens, particularly in the context of agenda-setting and decision-making process.

Through various citizen participation mechanisms, citizens have opportunities to provide input and influence political and administrative decision making related to policies, tax allocation, program operations and other general decision-making processes. While there are various types of citizen participation in the political and administrative decision-making process, Arstein (1969) argues that any mechanisms of citizen participation make sure to provide opportunities that citizens can substantively provide inputs in the decision-making process. In her canonical work of citizen participation, she provided eight mechanisms of citizen participation using a ladder metaphor. Her categorization includes manipulation, therapy, informing, consultation, placation, partnership, delegated power, and citizen control. At the lower steps of the ladder such as manipulation and

therapy, while citizens have the opportunity to participate in the decision-making process, they do not have substantive power to influence the decision-making process. However, at the highest steps of the latter such as citizen control and delegated power, citizens play important roles and have opportunities and power to meaningfully work with administrators in the process of decision making. Arstein (1996) maintains that the inclusion of have-not citizens, in turn, leads to more citizen participation among underprivileged groups in the future decision-making process.

There have been variations in the degree and forms of citizen participation throughout the history of citizen participation (Gawthrop, 1998). For instance, while the founding fathers of American emphasized the representative government, citizen participation at the beginning of history was somewhat limited by economic status, race, gender and education Strange. However, citizen participation has embraced broader scope of citizens and it became more popular since the federal government formally required more active citizen involvement in policy programs for federal grants-in-aid in the 1950s and 1960s (Day, 1997; Whitaker, 1980). In order to describe the changes in citizen participation in the United States over time, King (2015) provides a description of the history of citizen participation in the United States. In this description, he argues that there have been four eras of citizen participation in the United States: the founding, populist, progressive and the awakening from the American dream era (King, 2015).

First, in the founding era (birth to 1830s), while founding fathers supported representative government and sought to reflect the wills of citizens, the role of citizens was extremely restricted. Given the basic assumption that citizens were unqualified and uninterested in direct citizen participation, citizen participation

was limited by economic status, race, gender and education. During this period, the federal government was in charge of the decision-making process for a majority of public affairs.

King describes that the populist period started in the 1830s. During this period (the 1830s to 1890s), under President Jackson's presidency, decentralized decision-making started to be heavily highlighted and broader citizen participation and active public activities were encouraged. During this time, there were more opportunities provided for more ordinary citizens no matter what their demographics were. One of the citizen participation mechanisms operated during this time is the New England town hall-style of local governance. New England town hall meeting promotes citizen participation in local governance via allowing citizens to speak up their opinions regarding public affairs and to vote for laws and budgets (Bryan, 2010). While the populist period provided opportunities for direct citizen participation in the political and administrative process, the progressive movement era (the 1890s to 1950s) changed the emphasis on citizen participation. This era was heavily affected by the Woodrow Wilson's essay, "The study of Administration". In this essay, he highlights the professionalism and expertise of administrators. Instead of focusing on citizens' direct participation, the government during this era cared about public opinion and sought to hold themselves accountable to the citizens. During this era, technocrats were primarily in charge of any administrative process (Kearney and Sinha, 1988) and the proper role of citizens was to be aware and knowledgeable of public affairs and to ask the government for their efficiency and expertise.

Finally, King describes the awakening from the American dream period (the 1960s – 2000s). During the 1950s and 1960s, there was another change in citizen participation in the United States. Public distrust in government significantly

increased and the government started losing the perceived legitimacy of the administrative political process. Given that, citizen participation was considered an essential key to recover from the damages in public trust and to maintain a democratic society. Furthermore, there was an underlying belief that citizen participation might contribute to formulating more realistic and effective policies to address public and social problems (King, Feltey and Susel, 2015; Irvin and Stansbury, 2004). Additionally, this situation was coupled with the federal government requirements for citizen participation and involvement in the administrative process particularly for federal grants-in-aid programs (Day, 1997). Given that, local governments started having more public hearings and tried to include citizens in the administrative process. However, this is also the time where public administrators found that inclusion of citizens may be costly and inefficient particularly in the 1980s. While scholars and practitioners were somewhat skeptical about citizen participation in the administrative process, citizens were more actively looking for the opportunity for involvement in the administrative process. Furthermore, under the New Public Administration movement (Frederickson, 1980), scholars began to maintain the citizen-centered governance as a form of citizen participation in public administration (Barber, 2003; Frederickson, 1996; Gawthrop, 1998; Thomas, 1995).

Throughout the history of citizen participation, scholars in public administration have highlighted the role of citizens mostly in the context of the political and administrative decision- making and agenda-setting process. However, a recent body of scholarship denoted as citizen co-production, emphasizes the role of citizens in phases of public service. In citizen co-production literature, citizens do not simply provide inputs for administrative decision-making. Instead, as a co-producer of public service, citizens make substantive contributions to the

process of public service provision and delivery. In the next section, I review the citizen co-production literature and their arguments.

1.3 Citizen Co-production in Public Service Delivery

1.3.1 Definition of Citizen Co-production

Citizen co-production was initially introduced in the late 1970s and early 1980s as an alternative to the centralized bureaucracies in public service delivery (Ostrom, 1972). Under the New Public Management movement, scholars and practitioners focused on more various policy actors including public, private and non-governmental actors in public service and highlighted the role and responsibility of individual service users (Levine and Fisher, 1984). Scholars argue that service users, individual public, can reduce costs and improve the quantity and quality of public service (Alford, 2014). While it did not attract many audiences in the research community back then, scholarly interests in citizen co-production have been resurgent under the importance of collaborative and citizen-centered governance (Bingham, Leary and Nabatchi, 2005; Frederickson, 1996; Gawthrop and Waldo, 1984).

As scholars have recently started focusing more on citizen co-production, citizen co-production literature has been criticized due to its imprecision of definition. In terms of defining citizen co-production, there have been arguments and disagreement over several aspects of citizen co-production. First, in citizen co-production, there are two main actors: professional and regular producers and citizens as co-producers (Ostrom, 1996; Parks et al., 1981). Initially, professional

producers generally referred to government particularly at the local level. However, some scholars have expanded the types of regular and professional producers from local government to public agencies, professionals and service providers potentially in private and nongovernmental sectors (Alford, 2014; Bovaird, 2007). Scholars have also expanded the co-producers from citizens to clients, customers, service users, community members, volunteers and community organizations.

There have been also some arguments regarding the characteristics of citizen's behavior. While some scholars argue that co-production occurs when citizens voluntarily cooperate with the professional public service providers (Brudney and England, 1983; Whitaker, 1980), others maintain that citizens as co-producers often participate in co-production of public service partly compulsorily (Osborne and Strokosch, 2013; Alford, 2009). Furthermore, some scholars emphasize the direct personal relationship between regular public service providers (Brandsen and Honingh, 2016) when other scholars consider behavior changes by co-producers such as service users and citizens triggered by public policies as the relationship found in co-production of public service (Loeffler and Bovaird, 2016).

Finally, while citizen co-production was initially introduced to explain the involvement of citizens as co-producers of public service at the point of public service delivery (Ostrom, 1972; Alford, 2009), scholars in citizen co-production literature have applied the term, citizen co-production in other phases of the public service cycle such as public service decision making or evaluation phases (Bovaird, 2007; Sicilia et al., 2016). According to these scholars, they use the term of co-production as an umbrella term and citizens can contribute to different phases of public service by co-commissioning, co-designing, co-delivering and co-assessing public service (Nabatchi, Sancino and Sicilia, 2017; Brandsen and Honingh, 2016; Voorberg, Bekkers and Tummers, 2015).

To reduce the potential confusion, it should be noted that in this dissertation, citizen co-production is defined as the contribution of resources by citizens and public service providers in the process of public service delivery. Government, public, private or non-governmental groups, and agents may participate in the process of public service delivery as professional public service providers. In the process of public service delivery, citizens as co-producers may co-produce public service via contributing their knowledge, resources such as time, money and effort, ideas and creativity (Loeffler and Bovaird, 2016). Besides, citizens can contribute to the public service delivery process by directly or indirectly cooperating with public service providers in carrying out public service programs (Whitaker, 1980; Vanleene, Voets and Verschuere, 2018).

1.3.2 Levels of citizen co-production

Scholars have sought to create typologies of co-production. Brudney and England (1983) initially suggested three levels of co-production based on whether citizens individually or collectively participate in co-production and whether the benefits resulted from co-production are enjoyed individually or collectively. First, in individual co-production, citizens participate in co-production individually. Citizens often participate in individual co-production compulsorily (Osborne and Strokosch, 2013; Alford, 2009), however, they also co-produce public service voluntarily because they would be the consumers of this public service as well. Through individual co-production, citizens who co-produce public service obtain the benefits from this process. Common examples of individual co-production include clients working with health service providers (Clark and Fairlie, 2015; Jo and Nabatchi, 2019; Cepiku and Giordano, 2014).

In group co-production, a group of citizens participates in co-producing public service for their benefits. In group co-production, citizens collectively co-produce public service with public service providers and the benefits from the co-production process are shared by those who participate in this process. In collective co-production, citizens collectively participate in the co-production of public service as they do in group co-production. However, the difference between group co-production and collective co-production is that the benefits collectively produced via collective co-production process can be enjoyed by the entire community and the benefits are not limited to those who participate in the co-production process, but the entire community can share them (Brudney and England, 1983; Bovaird et al., 2016). A common example in collective co-production is citizen's participation in neighborhood watch programs. Citizens and community members participate in neighborhood watch programs to combat crime in their community and their participation benefits not only them but for the entire community by providing a safer environment of their community (Goldstein, 1977; Innes et al., 2011; Sabet, 2014).

While Brudney and England in 1983 initially suggested three levels of citizen co-production, some scholars consider group co-production as a part of collective co-production (Bovaird et al., 2015, 2016). Bovaird and his colleagues (2016) categorize citizen co-production into two-level, instead of three: individual and collective co-production. This categorization is based on two criteria. First, they consider whether individuals collectively or individually co-produce public service. They then consider whether individuals are collectively or individually benefited from the co-production of public service. While their approaches show that collective and individual co-production can be motivated by both self-interest or more general altruistic motivations, this categorization may imply that citizens

can enjoy the benefits from co-production only either individually or collectively

In this dissertation, I focus on two levels of citizen co-production: individual and collective co-production based on whether citizens individually or jointly take actions to contribute to public service delivery. However, I argue that the benefits from individual and collective co-productions can be shared both individually and collectively in a long-term. For instance, citizens may individually take certain actions to contribute to public service delivery for their personal interests. Through participating in individual co-production, citizens expect to enjoy some personal benefits such as better education attainment or better health outcome. However, I argue that individual co-production may produce better outcomes of public service for individuals and this eventually leads to solving public problems at the aggregate level because public problems are consisting of problems of multiple individuals. When we have more individual citizens who have fewer problems or enjoy better public service outcomes, this may eventually create a better community and society.

1.4 Citizen Co-production of Emergency Service

Following the previous arguments, in this dissertation, I define citizen co-production as the contribution of resources by citizens in the process of public service delivery. By contribution of resource I mean here citizen's knowledge, resources such as time, money and efforts, ideas and creativities as well as their cooperation with professional public service providers (Brudney and England, 1983; Loeffler and Bovaird, 2016; Whitaker, 1980). Citizens can individually or collectively co-

produce public service by providing their contribution to the process of public service delivery. The short-term benefits may be personal in citizens' individual co-production; however, I argue that personal benefits may be aggregated and eventually solve broader social issues. In this dissertation, I seek to investigate the motivations and determinants of citizen's individual and collective co-production of emergency service, particularly in the context of tornadoes. To do so, I first clarify what citizen individual and collective co-production of emergency service mean in the context of tornadoes.

Emergency service is provided throughout the four phases of emergency management. Four phases include mitigation, preparedness, response and recovery (Bullock, Haddow and Coppola, 2017; Mushkatel and Nigg, 1987). The mitigation phase includes all the activities to prevent emergencies and disasters. However, the complete prevention of natural hazards is not feasible, therefore, in terms of natural hazards, mitigation means the activities to prevent an emergency from becoming a disaster. During the preparedness phase, emergency service agencies develop emergency response plans and train professional first responders and other relevant actors according to the plans. It should be noted that there is a fuzzy distinction between mitigation and preparedness. Scholars and practitioners often use these two terms interchangeably. While both mitigation and preparedness phases start before emergencies and disasters, the preparedness phase assumes the occurrence of emergencies and disasters when the mitigation phase tries to reduce the probability of its occurrence. Response phases include all the activities to provide assistant to people and communities to minimize risks. Finally, in recovery phases, emergency service agencies support people and communities to return back to their normal life. Emergency service agencies often seek to respond to and recover from emergencies and disasters simultaneously

once disastrous events occur.

Under the consideration of these phases, there may be several ways that citizens individually and collectively co-produce emergency service before, during and after disasters. While scholars have looked at citizen co-production of emergency service (Mees et al., 2016; Stallings and Quarantelli, 1985), they have looked at the term of co-production as an umbrella term and considered co-commissioning, co-designing, co-delivery and co-evaluation of emergency service. However, it should be noted that in this dissertation, I only focus on co-delivery as co-production of public service.

One of the most common forms of individual co-production of emergency service is to provide disaster-related information (Díaz, Carroll and Aedo, 2016; Mees et al., 2016; Stallings and Quarantelli, 1985; Innes et al., 2011). For instance, the city of Norman emergency management office in Oklahoma tests tornado sirens each Saturday at noon. If the siren is not heard, it means that there is an issue with the siren system. Therefore, the residents of the city of Norman often contact their local emergency manager to inform that there was a failure of the siren test so that the emergency manager can make sure that the system works. Furthermore, citizens can provide possible dangers near their residence to their local emergency service agencies. This type of individual co-production may occur before, during, and after tornadoes and other disastrous events. This type of individual co-production may benefit both individuals who participate in this process and the entire community.

Another form of cooperation citizen's individual co-production is emergency preparedness at the household level (Stallings and Quarantelli, 1985). Local emergency service agencies such as local emergency management offices and other professional first responders provide guidelines for emergency prepared-

ness to minimize the risks associated with emergencies and disasters once they occur. Scholars in emergency management have shown that individual household level cooperation with emergency preparedness recommendations at the individual level can significantly reduce the negative outcomes such as mortality and property damages resulted from disastrous events(Diekman et al., 2007). This type of individual co-production may occur before tornadoes and other disastrous events.

Additionally, citizens can individually co-produce emergency service during tornadoes through cooperating with local emergency service agencies. When there is a tornado warning issued, citizens are recommended to take some protective action such as moving to a sheltered area. By cooperating with this recommendation during tornadoes, citizens can obtain some personal benefits such as their own safety and significantly contribute to emergency service outcomes at the aggregate level as well. Following evacuation orders during hurricanes and staying away from a certain area during flash floods based on the recommendations suggested by local emergency service agencies are other examples of citizens' individual co-production during disasters.

Citizens may also collectively co-produce of emergency service (Stallings and Quarantelli, 1985). For instance, in order to manage flood risks, governments in some countries have operated citizen groups named "flood leaders" in Belgium and Poland and "flood wardens" in England (Mees et al., 2016). Under these programs, citizens are first trained for emergencies and disasters and assist emergency service agencies during emergency events. In the United States, FEMA and local emergency management offices have operated government-led group named Community Emergency Response Team (CERT). Similar to flood leaders and flood wardens, citizens are trained as first responders for various disastrous

situations and assist emergency service agencies in the implementation and coordination of response and recovery activities during and after emergencies and disasters (Flint and Stevenson, 2010). Furthermore, citizens can volunteer for nongovernmental groups that seek to provide emergency service independently or in collaboration with governmental groups.

In this dissertation, I look at two individual co-production and one collective co-production of emergency service before, during, and after tornadoes. More specifically, I look at the motivations and determinants of citizens' cooperation with emergency preparedness recommendations before tornadoes in the second chapter. I then focus on citizen's cooperative behaviors and willingness during tornadoes. In this chapter, I investigate factors affecting citizens' decisions on taking protective action during tornadoes based on the information provided by emergency management authorities and their willingness for future action. Finally, in my fourth chapter, I look at citizens' collective co-production of emergency service by focusing on their willingness to participate in CERT as a form of collective co-production. Furthermore, I also look at their willingness to volunteer for nongovernment-led groups to respond to and recovery from tornadoes.

1.5 Determinants of Citizen Co-production

1.5.1 Public Trust in Issue-specific Agency and Citizen Co-production

In this dissertation, I posit that public trust is a key factor in shaping citizens' behaviors and willingness for co-production of public service. By public trust, I mean public trust in public service agencies and public trust in society denoted

as social capital. In this section, I describe the reasoning of this argument.

Scholars in public administration argue that public trust in government plays an important role in the interactions between citizens and government. They have argued that public trust in government may increase citizen's willingness to be compliant and cooperative with government policies and recommendations (Makkai and Braithwaite, 1994; Levi, 1998; Kim, 2005). While some argue that citizens' compliance of laws and regulations may be mainly driven by the fear of punishment (Whitaker, 1980), others claim that citizens may voluntarily accept most decisions and recommendations made by the government when they perceive greater trust in government (Kim, 2005). In other words, greater trust in government leads to greater citizen cooperation without any coercion (Levi and Stoker, 2000; Scholz and Lubell, 1998; Scholz and Pinney, 1995; Chanley, Rudolph and Rahn, 2000; Thomas, 1998; Ruscio, 1997).

Public administration scholars, political scientists more broadly, have primarily highlighted public trust in general political institutions such as the President, Congress, federal, state or local government to understand citizens' behaviors and attitudes toward government, government policies and recommendations (Cooper, Knotts and Brennan, 2008; Hetherington and Rudolph, 2008; Rahn and Rudolph, 2005). However, a body of scholarship in public administration has recently highlighted the need to investigate public trust in issue-specific agencies for several reasons (Robinson, Stoutenborough and Vedlitz, 2017; Robinson et al., 2012).

First, previous polls and existing studies have shown that citizens are capable of evaluating different levels of government and agencies differently (**?**Robinson, Stoutenborough and Vedlitz, 2017; Kettl, 2019). Furthermore, citizens evaluate the level of trust in government based on their specific policy expectations and

preferences (Bouckaert and Van de Walle, 2003; Christensen and Lægreid, 2005; Job, 2005; Ryzin, 2004; Yang and Holzer, 2006). According to this evidence, it is reasonable to assume that citizens evaluate the level of trust in issue-specific agencies based on the context-specific variables. Additionally, it follows intuitively to look at public trust in a specific agency to understand citizen's cooperative behaviors, willingness and perceptions towards specific policies. This is because, for example, public trust in the Department of Homeland Security or Federal Emergency Management Agency (FEMA) matters more than their trust in general political institutions when it comes to decisions regarding emergency preparedness for various disasters. In fact, it has been observed that citizens tend to cooperate with the police more when they perceive greater trust in the police department (Tyler, 2005). Tyler (2005) finds that greater trust in the police department leads citizens to report dangerous or suspicious activities in their community to the law enforcement agency.

Citizen co-production scholars have also emphasized public trust in government in citizen co-production behaviors and willingness(Fledderus, Brandsen and Honingh, 2014; Fledderus, 2015; Van de Graaff, 2016; Parrado et al., 2013) although these studies primarily look at how citizens' participation in the co-production process may affect their trust in government (Fledderus, Brandsen and Honingh, 2014; Fledderus, 2015; Kang and Van Ryzin, 2019). These studies argue that citizens' participation of co-production may lead to greater trust and legitimacy of government. Furthermore, while some studies have investigated how public trust may shape citizen's co-production behaviors and willingness, there have been some mixed findings on the effect of public trust (Van de Graaff, 2016; Parrado et al., 2013).

Despite the recognition of the importance of public trust, there have been

insufficient studies focusing on how public trust in government leads to citizens' co-production behaviors and willingness. In this dissertation, I argue that it is reasonable to expect that public trust in government plays a primary role in structuring citizens' behaviors and willingness to co-produce public service, especially when citizens' contributions can be made through their cooperation with the government. Therefore, in this dissertation, I seek to investigate the decisiveness of public trust in issue-specific agencies and their effects on citizen co-production of emergency service particularly in the context of tornadoes. By issue-specific agencies in the context of emergency service, I mean local emergency medical agency, law enforcement, fire department and local government in the context of emergency management.

1.5.2 Public Trust in Government and Citizen Co-production of Emergency Service

Scholars in emergency management have investigated the role of public trust in managing emergencies and crises. While they do not use the term of citizen co-production, they have primarily looked at citizens' contribution in emergency management by cooperating with emergency management authorities and emergency service agencies.

For instance, a study of the refugee crises in Turkey found that refugees' trust in government and legitimacy lead to their greater cooperation and compliance with the government policies of hosting country (Demiroz and Unlu, 2018). Furthermore, scholars have examined how public trust in federal, state, or local government is associated with individual cooperation with the government, particularly emergency preparedness recommendations for various emergencies such

as earthquakes, hurricanes, terrorist attacks, and other health-related situations (Murphy et al., 2009; Murphy, Greer and Wu, 2018; Basolo et al., 2009; Arlikatti, Lindell and Prater, 2007; Perry and Lindell, 1991; Terpstra, 2011). Most scholars have provided evidence that there is a positive association between public trust in government and citizens' cooperation with the government. These scholars have found that citizens are more likely to adopt emergency preparedness measures when they perceive higher trust in government (Paton, 2008; Longstaff and Yang, 2008; Murphy et al., 2009; Murphy, Greer and Wu, 2018; Ablah, Konda and Kelley, 2009)

However, there are also mixed findings regarding the effect of trust in government in the context of emergencies. For instance, Terpstra (2011) finds that citizens who have a higher level of trust in government are less likely to have a higher level of flood preparedness intentions (Terpstra, 2011). One potential explanation of this association is that citizens may not see the necessity of adopting preparedness measures if they believe that the government will take care of the potential emergencies for them (Murphy, Greer and Wu, 2018; Scolobig, De Marchi and Borga, 2012). In other words, citizens may pass on the full responsibility of preparing and responding to emergencies to the government when they perceive higher trust in government.

However, most evidence suggests that higher trust in government is positively associated with citizens' cooperation with the government across many other hazards; therefore, this relationship may also be present when examining preparedness for tornadoes. If citizens trust the government more, they will consider the risk estimates and risk mitigation policies of emergency service agencies more credible (Johnston et al., 1999). While previous studies investigating public trust in government and citizens' cooperation in emergency management have signif-

icantly contributed to the scholarship, they have mainly looked at public trust in general political institution, rather than emergency service agency. Therefore, following the previous argument, I expect that citizens may be more cooperative in the emergency service delivery process if they trust the government, particularly the emergency service agencies.

1.5.3 Social Capital and Citizen Co-production

As previously stated, I posit that social capital may be also a key factor in structure citizens' co-production behaviors and willingness, particularly at the collective level. Social capital generally refers to the "features of social organization such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit" (Putnam, 1995). Scholars have argued that social capital makes individual cooperation possible, therefore, it helps us to achieve certain ends in society (Fukuyama, 2000; Putnam, 1993; Coleman, 1988).

Ostrom (1996) argues that social capital is required to fulfill the promises of collective action. She argues that social capital measured by trustworthiness, network and institution can enhance the trust in society and this trust can achieve collective action and its benefits (Ostrom and Ahn, 2009). Given the strong social capital in society, people believe that others in society will do things for helping each other, therefore, it eventually leads to a stronger commitment to collective actions (Fukuyama, 2000; Voorberg, Bekkers and Tummers, 2015). Scholars in other disciplines have also found that social capital leads to individuals to participate in collective actions such as volunteering (Martikke et al., 2019). However, It should be noted that there is a reciprocal relationship between collective action and social capital. While social capital may encourage collective actions in

society, collective actions, in turn, helps developing more social capital as well as (Pestoff, 2012; Fox, 1997; Bovaird et al., 2016; **?**).

According to these arguments, it is reasonable or even necessary to consider the role of social capital in structuring collective co-production of public service among citizens. However, Voorberg and his colleagues (2015) have found that only 30 percent of studies focus on social capital in shaping citizens' co-production behaviors and willingness. Under this circumstance, in this chapter, I seek to understand, in addition to other factors, the decisiveness of social capital in shaping citizen co-production.

1.5.4 Other determinants of citizen co-production

While there have been insufficient quantitative studies, scholars in public administration have sought to understand the determinants and motivation of citizen co-production of public service (Parrado et al., 2013; Alonso et al., 2019; Bovaird et al., 2016, 2015). Scholars have primarily drawn theories and arguments from different bodies of literature in political science, public administration, economics, and psychology and found several variables associated with citizen co-production behaviors and willingness.

First of all, Scholars have shown that gender, age, education, household location are likely to influence citizen's co-production activities and their willingness (Sundeen, 1988; Alford and Yates, 2016; Egerton, 2002; Parrado et al., 2013; Bovaird et al., 2016, 2015; Alonso et al., 2019). For instance, studies have found that women are more associated with individual co-production in environmental areas (Parrado et al., 2013; Bovaird et al., 2016, 2015; Alonso et al., 2019). Furthermore, these studies have found that older people are more likely to par-

ticipate in individual co-production and other general civic activities (Parrado et al., 2013; Bovaird et al., 2016, 2015; Alonso et al., 2019). While scholars from other disciplines such as psychology have argued that well-educated people are more likely to be knowledgeable about environmental issues and take actions to address them, co-production studies in public administration have found that education does not make a big difference to individual behaviors and willingness to co-produce public service (Alford and Yates, 2016; Parrado et al., 2013). Additionally, scholars have found that people who live in an urban location are more negatively associated with co-production willingness particularly on environment issues (Parrado et al., 2013).

Income, race, home-ownership and whether they live with minor children have been investigated to understand citizens' behavior and willingness to co-produce public service. Scholars have argued that higher income will be more associated with citizen's participation in co-production. While the effect of race can vary depending on contexts (Uzochukwu and Thomas, 2018), most prior research has shown that racial minority population is less associated with co-production behaviors and willingness (Jakobsen and Andersen, 2013). Uzochukwu and Thomas (2018) argue that residents who have minor children will not be more involved in the co-production of public service following the arguments of citizen-initiated contacting theory. However, numerous studies have shown that households with minor children and other caretakers are more likely to be cooperative with government particularly in the context of disasters and emergency management (Murphy et al., 2009; Ablah, Konda and Kelley, 2009). This shows that these variables may vary depending on the context of a specific policy area.

Scholars have also looked at some psychological factors such as self-efficacy to understand citizen's co-production behaviors and willingness (Bandura, 2013;

Wise, Paton and Gegenhuber, 2012; Parrado et al., 2013; Bovaird et al., 2016, 2015; Uzochukwu and Thomas, 2018; Alonso et al., 2019). These studies have shown that when citizens believe that they can make a change, they are more likely to be associated with the co-production of public service. Furthermore, Uzochukwu and Thomas (2018) argue, based on citizen-initiated contacting theory, that when people perceive the need for new or improved public service increase, they are more likely to co-produce public service. Individual attitudes toward government and perceived service importance have been also investigated (Bovaird et al., 2016, 2015). While there have been mixed results, these studies have shown that a positive attitude towards government performance and their interaction with citizens may be positively associated with citizen's participation in individual co-production of public service.

1.6 Method

1.6.1 Limitations of Traditional Statistical Approaches

In numerous public administration and political science studies, scholars have primarily utilized traditional statistical approaches such as Ordinary Least Squares (OLS), logistic and ordered probit regressions to understand the correlations between explanatory variables and their dependent variable. For instance, Choi and Wehde (2019) utilize OLS regression analyses to see the relationship between how people define the earthquakes in Oklahoma affects their support for earthquake mitigation policy (Choi and Wehde, 2019). The analyses of OLS regression provide the coefficient of each explanatory variable and its significance. The size and direction of coefficients then indicate the effect of explanatory variables in

explaining the variations in the dependent variable. Furthermore, by comparing the size of coefficients, scholars may conclude which variables have more impact on the variations in the dependent variable.

While studies utilizing traditional statistical approaches have significantly contributed to our understanding of many relationships in public administration and political science more broadly, these results are somewhat limited. Traditional statistical approaches are often based on strong parametric assumptions: scholars assume that samples they use in their research are drawn from the population which has specific characteristics (Garson, 2012). For instance, in OLS regression, it is assumed that the relationship is linear (linearity assumption) and the data have a normal distribution (normality) to name a few (Berry, 1993). While logistic or ordered probit regressions do not require normality or linearity as OLS regression does, they still require some assumptions. However, unfortunately, these assumptions are often violated particularly in social science data. While some violations may not significantly affect the research, others may change the conclusions (Garson, 2012).

Furthermore, most parametric statistical models as one of the assumptions, require that explanatory variables in a model are not perfectly or highly correlated to each other. Scholars often use Pearson's r coefficient or Variation Inflation Factor (VIF) to detect high correlation issues (Garson, 2012). While the threshold for multicollinearity issue is somewhat arbitrary (Fotheringham and Oshan, 2016), the threshold of 5 for VIF is generally utilized (Garson, 2012). However, the problem here is that lower correlation does not mean that there is no correlation among explanatory variables. If explanatory variables are correlated to each other even at the lower level, it is difficult to understand the effects of variables and their significance. Given that, it is not helpful, or even inaccurate to discuss

the relative decisiveness and importance of variables among many in a model by comparing the coefficient sizes of explanatory variables although standardized coefficients may provide some insights.

Under this circumstance, I intend to utilize a relatively uncommon machine learning technique, random forest regressor. Random forest regressor (RFR) is an ensemble machine learning technique which may be utilized for efficient regression and classification tasks on large data sets Hastie et al. (2005). Furthermore, as a by-product, a random forest regressor allows us to calculate the relative decisiveness (importance) of explanatory variables without any strong parametric assumptions and correlation issues.

1.6.2 Random Forest Regressors and Decision Trees

Random forest regressors utilize multiple decision trees to predict the dependent variables. Therefore, to understand random forest regressors, it is important to understand the logic of decision trees. A decision tree is a branching method splitting a data set according to its various explanatory variables. Based on a node, each explanatory variable, a decision tree split the data set by measuring the effectiveness of the split. By the effectiveness of the split, it means impurity or variance reduction in the split data set. Variance reduction for a regression task can be defined as

$$H\left(Q_m\right) = \frac{1}{N_m} \sum_{i=0}^{N_m} \left(y_i - \overline{y}_m\right)^2, \tag{1.1}$$

with $\overline{y}_m$ is the mean of the dependent variable y_i given by

$$\overline{y}_m = \frac{1}{N_m} \sum_{i=0}^{N_m} y_i, \tag{1.2}$$

and where N_m is the number of data points at a particular node m. The set Q_m represents the data that resides at a node. The total impurity at this node may then be expressed as

$$G(Q_m, \theta) = \frac{n_{left}}{N_m} H\left(Q_{left}(\theta)\right) + \frac{n_{\text{right}}}{N_m} H\left(Q_{\text{right}}(\theta)\right), \tag{1.3}$$

where n_{left} and n_{right} correspond to the number of children data points in the left and right branches arising from the node m and

$$\begin{aligned} Q_{left}(\theta) &= (x, y) | x_j <= t_m, \\ Q_{right}(\theta) &= (x, y) | x_j > t_m \end{aligned} \tag{1.4}$$

are the left and right split data sets respectively. Note that the splitting of Q_m depends on a independent variable x_j and a threshold t_m at each node. Scholars generally choose the median value of variable as a threshold. The decision tree splits the data Q_m in a way that minimizes $G(Q_m, \theta)$ by choosing an optimal dimension j for the independent variable.

A decision tree splits the data set repeatedly for every node (corresponding to a different j) until certain criteria are met such as $N_m <= N_{\text{tol}}$ at which point the node is denoted a leaf. Researchers may decide the certain criteria for the analysis. A decision tree may stop branching if a certain maximum depth is reached. A new data point (i.e., an unseen sample) can then follow the branching trajectory (by tracking the order of splits by j and Equation 1.3 and placement

into left or right branches by t_m) and reach a leaf. In case a N_{tol} criteria is set, the prediction of the decision tree for a sample is the average prediction value of the dependent variables at this leaf.

RFRs utilize multiple decision trees by selecting random subsets of the total data for each tree to obtain a consensus on regression predictions. This leads to greater accuracy than the utilization of one decision tree solely which is prone to the phenomenon of 'overfitting', implying a lack of generalization of the model. Each tree utilizes a random subset of the data through sampling with replacement and may therefore obtain a completely different branching structure depending on the distribution of that particular data set. The generation of multiple decision trees as estimators also encourages generalization. RFRs are well-suited to the modeling of non-linear interactions between independent variables for which they considered more robust than linear regression methods. In addition to greater robustness in model building, RFRs also provide their users a metric of independent variable importance. Each decision tree therefore provides different estimates for impurity reduction for each variable for each tree. Average impurity reductions may then be obtained for the entire forest and used to rank the relative importance of variables. In other words, variables with the most average impurity reduction are classified as more important.

1.6.3 Limitations of Social Science Data and Random Forest Regressor

While scholars particularly in computer science community have heavily utilized random forest regressor with a big data set, it should be noted that social science data set scholars utilize in public administration and political science more

broadly are, not always however often, relatively small. Given that, it is reasonable to execute several validations of the results before making any conclusions. In order to do so, in this dissertation, I create 40 different random forests and 80 % of the data is utilized as a training set. Subsequently, for each tree, a hyper-parameter optimization is performed to determine the optimal depth for branching following the practice of computer science community. This optimization scans between a minimum branching depth of 4 to a maximum depth of 15 to determine when branching should be stopped to account for the lowest mean absolute test error. Note that the test error comes from the 20% of the total data set that is kept aside for each of the 40 assessments - commonly denoted *test data* in machine learning parlance.

The implementation of the RFR in this dissertation uses the well-known scikit-learn machine learning package for Python. I utilize 100 trees with each tree using all the independent variables and keep $N_{\text{tol}} = 1$. Variable rankings (obtained from the forest with the optimal depth) are then ranked according to their importance on this set. Finally, one is left with 40 sets of variable importances. I stack all the feature importance and display box plots which also show median, quartile, minimum, maximum and outlier values for the ranking a variable obtained. I can thus be more confident about the conclusions in this manner.

While random forest regressor allows us to explore the relative decisiveness of explanatory variables without any strong parametric assumptions and high correlation issues, it should be noted that these methods can only provide limited information: it does not provide correlation coefficients. Therefore, it may be possible to see which variable is the most decisive factor shaping the dependent variable, however, we cannot conclude whether this factor positively or negatively affects the dependent variable. Therefore, in this dissertation, I utilize

both random forest regressors and other traditional statistical tools to provide comprehensive information about the associations between motivational factors, particularly public trust in the issue-specific agency and social capital, and citizen co-production behaviors and willingness.

1.7 Chapter Summaries

In this dissertation, I look at the citizen's participation in the process of public service through the lens of citizen co-production. The primary purpose of this dissertation is to understand the determinants and motivations of citizens' individual and collective co-production of emergency service before, during and after tornadoes. This dissertation seeks to contribute to the scholarly endeavors to understand citizen co-production by emphasizing public trust as a primary factor, considering more issue-specific contexts and factors. Furthermore, by utilizing multiple methods and under-investigated public service areas, this dissertation seeks to take the first step to develop a theory of citizen co-production as a part of a broader research program. Additionally, through the lens of citizen co-production, I expect to provide different perspectives to emergency management practitioners regarding the role of citizens as a co-producer, not a simple service consumer who should obey the orders of emergency management authorities.

In Chapter two, I seek to investigate how public trust in issue-specific agencies, in conjunction with individual characteristics, affect citizens' individual co-production of emergency service. More specifically, I look at citizens' individual co-production before tornadoes, preparedness for tornadoes and how citizen's co-operation in the emergency service process is shaped by their trust in local emergency service agencies. Furthermore, I also examine the relative decisiveness of

public trust in local emergency service agencies among basic demographics, political and social dispositions and issue-specific factors. Using a unique survey, I find that public trust in local emergency service agencies, as a mediator, is positively associated with citizens' preparedness for tornadoes. Furthermore, public trust in local emergency service agencies seems to be one of the most decisive factors in structuring citizens' cooperation with local emergency service agencies in addition to social capital.

In Chapter three, I explore the decisiveness of various factors in shaping citizens' decisions on taking protective actions during tornadoes and willingness for future events as a form of co-production of emergency service at the individual level. By utilizing both random forest regressor and logistic regression model, I find that risk perception, trust in local emergency service agencies and social capital are the most decisive factors to shape citizens' behaviors and willingness to take protective actions during tornadoes. However, the logistic regression analyses provide somewhat nuanced effects of social capital on citizens' co-production behaviors and willingness.

While the first two empirical chapters focus on citizens' individual co-production behaviors and willingness before and during tornadoes, Chapter four investigates citizens' collective co-production willingness to co-produce emergency service after tornadoes in collaboration with government and nongovernment-led groups. This chapter finds that social capital is the most decisive factor to shape citizen's willingness to work with the government-led group, Community Emergency Response Team (CERT) and to volunteer for nongovernment-led groups to respond to and recover from tornadoes. The ordered probit regression analyses indicate that people with higher social capital are more willing to co-produce emergency services with government and non-governmental groups for their community.

Last, in Chapter five, I conclude with a summary of each empirical chapter. The concluding chapter also includes the theoretical and practical contributions of this dissertation. Furthermore, I provide direction for future research plans to extend the findings in this dissertation and to understand the effect and process of citizen co-production in the process of public service.

Abstract

How does public trust in issue-specific agencies, in conjunction with individual characteristics, affect citizens' co-production of public service? How decisive public trust is in shaping citizens' co-production behavior? In this chapter, I seek to answer these questions by investigating how public trust in local emergency service agencies affects citizens' co-production of emergency service in the context of tornadoes by utilizing a relatively uncommon machine learning technique in public administration, random forest regressor, and traditional statistical approach. I particularly focus on citizens' preparedness for tornadoes that are recommended by emergency service agencies as a form of individual co-production. Using a unique survey, I find that public trust in local emergency service agencies, as a mediator, is positively associated with citizens' preparedness for tornadoes. Furthermore, public trust in local emergency service agencies seems to be one of the most decisive and important factors in structuring citizens' cooperation with local emergency service agencies in addition to social capital. I end with a discussion of the implications and contributions of this study.

Keyworkds Citizen co-production, Emergency management, Tornado preparedness, Public trust in an issue-specific agency, Machine learning

Chapter 2

Public trust and Citizen Co-production: Individual co-production before tornadoes

2.1 Introduction

While scholars have used the term, citizen co-production in somewhat different ways (Nabatchi, Sancino and Sicilia, 2017), citizen co-production is often defined as the process that citizens, traditionally considered as public service consumers contribute to the public service provision and delivery via direct and indirect interaction with public service providers (Brudney, 1983). As co-producers of public service, citizens may contribute to the process of public service delivery by providing their knowledge, resources such as time, money and effort, ideas and creativity (Loeffler and Bovaird, 2016). Furthermore, citizens may cooperate with public service providers in carrying out public service programs (Whitaker, 1980; Vanleene, Voets and Verschuere, 2018; Brudney, 1987). Scholars have argued

that citizen co-production may not always involve a direct relationship between citizens and public service providers. For instance, citizen's behavioral changes by a new policy may be considered as co-production of public service (Loeffler and Bovaird, 2016). [1]. In this chapter, I particularly focus on citizen cooperation with the public service provider as a form of citizen co-production of public service delivery.

Citizen co-production was introduced in the late 1970s and early 1980s as an alternative to the centralized bureaucracies in public service delivery and provision (Ostrom, 1972). While it did not attract many audiences in the research community back then, scholarly interests in co-production have been resurgent under the importance of collaborative efforts among public, private, non-governmental actors as well as citizens and community members in the process of public service provision and delivery (Alford, 1998; Osborne, Radnor and Strokosch, 2016; Fung, 2015; Bingham, Leary and Nabatchi, 2005).

Under the resurgence of scholarly interests in citizen co-production, scholars have recently sought to investigate various factors driving citizens' behaviors and willingness and have found various factors explaining the variations in citizens' behaviors and willingness to co-produce public service (Parrado et al., 2013; Bovaird et al., 2016, 2015; Voorberg et al., 2018; Van de Graaff, 2016). These studies have found that basic demographic characteristics, individual attitudes toward government and public service and intrinsic and extrinsic motivations affect citizens' co-production behaviors and willingness (Wise, Paton and Gegenhuber, 2012; Sundeen, 1988; Talsma and Molenbroek, 2012; Bovaird and Loeffler,

[1]While using the term citizen here, I do not mean to only include individuals who possess the legal citizenship of the United States. I intend to mean more general public and community members who enjoy public service. However, I still choose to use the term of the citizen here to be consistent with existing literature

2008; Parrado et al., 2013; Bovaird et al., 2016, 2015; Pestoff, 2012; Alford, 2009; Marschall, 2004).

While these factors are important to understand the motivations and determinants of citizen co-production, I argue that public trust in an issue-specific agency may play an important role to shape citizen co-production behavior, particularly citizens' cooperation with public service providers. Public administration scholars have argued that public trust in government may explain many variations in their cooperative and compliant behaviors with government policies, orders, and recommendations (Kim, 2005; Chanley, Rudolph and Rahn, 2000; Scholz and Lubell, 1998; Scholz and Pinney, 1995; Hough et al., 2010). These scholars have shown that citizens are more cooperative with and compliant with the government when they perceive greater legitimacy and trust in government.

Furthermore, a recent body of scholarship has argued that public trust varies in different levels of government and agencies particularly depending on the specific issues they are dealing with (Robinson, Stoutenborough and Vedlitz, 2017; Robinson et al., 2013; Choi and Wehde, N.d.). Therefore, it is imperative to look at public trust in an issue-specific agency to understand their cooperation with the agency. For instance, Tyler (2005) finds that citizens are more likely to be cooperative with the police department when they perceive greater trust in the police department (Tyler, 2005). Following these arguments, I seek to examine how trust in issue-specific agencies may promote citizens' cooperation in the process of public service delivery as a form of citizen individual co-production, particularly in the context of emergency service.

Citizens' cooperation with local emergency service agencies, the primary emergency management actors, may mean several things particularly depending on the phases of emergency management (Basolo et al., 2009; Sadiq, Tharp and

Graham, 2016). [2] For instance, citizens may cooperate with emergency service providers by following evacuation orders during hurricanes or staying away from a certain area during flash floods based on the recommendations suggested by local emergency service agencies. Another form of cooperation is to follow emergency preparedness recommendations before disasters. Local emergency service agencies such as local emergency offices and other professional first responders provide guidelines for emergency preparedness to minimize the risks associated with emergencies and disasters. Scholars in emergency management have shown that individual cooperation before, during and after emergencies and disasters can significantly reduce the negative outcomes such as mortality and property damages resulted from disastrous events (Diekman et al., 2007). In this chapter, I particularly look at citizens' preparedness for tornadoes at the household level as a form of citizens' individual co-production of emergency service.

To that end, I ask how does public trust in local emergency service agencies, in conjunction with individual characteristics, explain citizens' cooperation with emergency service agencies to co-produce emergency service in the context of disasters, particularly tornadoes? I focus on public trust in local emergency service agencies including emergency medical services, law enforcement, fire department and local government in the context of emergency management and examine how it affects citizens' preparedness for tornadoes as citizens' cooperation.

Furthermore, I also ask how important and decisive public trust in local emergency service agencies is among many other factors to structure citizens' preparedness for tornadoes by utilizing a relatively uncommon machine learning technique, random forest regressor. While standardized coefficients of variables in

[2]There are four phases of emergency management: Emergency mitigation, preparedness, response, and recovery (Bullock, Haddow and Coppola, 2017)

a statistical model may indicate which variable has larger effect on the dependent variable, the result of this statistical model is somewhat limited due to high correlation issues and strong parametric assumptions. For instance, high correlation issues may inflate the standard errors of variables and it may consequently affect the statistical significance of variables. However, random forest regressor allows us to investigate the relative decisiveness of factors without strong parametric assumptions and multicollinearity issues. By utilizing both statistical approaches and random forest regressor, I expect to provide more accurate information regarding the direction and decisiveness of public trust in issue-specific agency in shaping citizens' preparedness for tornadoes as a form of individual co-production of emergency service.

In the following section, I first review previous studies of public trust in government and individual cooperative behaviors. I then explain the 2013 Severe Weather and Society survey data and utilize statistical analysis to investigate how public trust in local emergency service agencies, in conjunction with other factors, affects individual preparedness for tornadoes as a form of individual co-production in emergency service area. Besides, I utilize a random forest regressor to calculate the relative decisiveness of public trust in local emergency service agencies to see how important it is to structure citizens' preparedness for tornadoes. In this chapter, I find that public trust in emergency service agencies as a mediator is positively associated with citizens' co-production behavior in the context of emergency management. Furthermore, public trust in local emergency service agencies seems to be one of the most decisive and important factors in shaping individual preparedness for tornadoes. I end with a summary of the following chapters.

2.2 Literature Review

2.2.1 Citizen co-production and Motivations

Citizen co-production is not the first or only scholarship emphasizing the role of citizens and community members in public administration. Scholars have highlighted the role of citizens in the decision-making process, particularly concerning public budgeting (Irvin and Stansbury, 2004; Franklin, Ho and Ebdon, 2009; Arnstein, 1969; Filner, 2006; Thomas, 1995; Adams, 2004; Anessi-Pessina et al., 2016). Scholars have seriously taken the inputs that citizens can provide in the administrative decision-making process. However, the novelty in citizen co-production literature is that they consider citizens as co-producer of public service rather than a simple consumer particularly in the process of public service delivery (Brudney and England, 1983; Whitaker, 1980; Ostrom, 1996; Parks et al., 1981; Wybron and Paget, 2016).

Scholars have categorized citizen co-production into three levels: individual, group and collective co-production (Brudney and England, 1983; Nabatchi, Sancino and Sicilia, 2017). According to this categorization, while citizens individually participate in co-production for private benefits in individual co-production, collective co-production requires collective actions of citizens and the benefits resulted from co-production can be enjoyed by the entire community. It should be noted that citizens may participate in individual benefits, however, their participation leads to better public service outcomes and it eventually contributes to solve the social problems in community (Fung, 2015). Additionally, group co-production refers to where citizens participate in co-production collectively for benefits only shared by the participants in the co-production process. Some scholars have considered group co-production as a part of collective co-production due

to the difficulties to distinguish the boundaries of co-production benefits (Bovaird et al., 2016).

Under the resurgence of scholarly interests in citizen co-production, numerous studies in citizen co-production have investigated how citizens co-produce public service by cooperating with professional public service providers in many public service areas such as health, education, childcare, recycling, environmental and postal service (Jo and Nabatchi, 2019; Parks et al., 1981; Parrado et al., 2013; Alonso et al., 2019; Alford, 2009; Pestoff, 2006; Realpe and Wallace, 2010). Furthermore, scholars have investigated the effect of citizen co-production. It has been observed that citizen co-production may improve public service outcomes by boosting the efficiency and effectiveness of the public service delivery process to name a few (Osborne and Strokosch, 2013; Osborne, Radnor and Strokosch, 2016; Loeffler and Bovaird, 2016).

Furthermore, scholars have sought to investigate various factors driving citizens' behaviors and willingness and have found various factors explaining the variations in citizens' behaviors and willingness to co-produce public service (Parrado et al., 2013; Bovaird et al., 2016, 2015; Voorberg et al., 2018; Van de Graaff, 2016). Most studies have drawn theories and empirical findings from other literature in political science, psychology, sociology, and economics (Uzochukwu and Thomas, 2018; Bovaird et al., 2016; Marschall, 2004; Parrado et al., 2013). For instance, scholars have heavily focused on some factors previously investigated in political participation literature. These studies have found that basic demographic characteristics, individual attitudes toward government and public service and intrinsic and extrinsic motivations affect citizen co-production behaviors and willingness (Wise, Paton and Gegenhuber, 2012; Sundeen, 1988; Talsma and Molenbroek, 2012; Bovaird and Loeffler, 2008; Parrado et al., 2013;

Bovaird et al., 2016, 2015; Pestoff, 2012; Alford, 2009; Marschall, 2004). However, Marschall (2004) argues that political participation and other general factors cannot entirely explain citizen co-production of specific local public service and goods (Marschall, 2004). Factors specific to certain public service and goods should be more seriously considered. To understand citizen co-production of emergency service, it is imperative to consider more issue-specific factors. Scholars have argued that issue-specific factors are correlates of individual attitudes, opinions and behaviors related to certain issues (Robinson, Stoutenborough and Vedlitz, 2017; Choi and Wehde, 2019).

2.2.2 Trust in government and Citizen cooperation in the context of Emergencies

Scholars in public administration argue that public trust in government plays an important role in increasing the compliance and cooperation of individuals with government policies and recommendations (Makkai and Braithwaite, 1994; Levi, 1998; Kim, 2005). Some argue that citizens may be compliant simply because they are afraid of getting punished if they do not follow laws and regulations (Whitaker, 1980). However, others claim that public trust in government increases the likelihood that citizens will voluntarily accept most decisions made by the government (Kim, 2005). In other words, citizens are more cooperative with government decisions that are not mandated by laws without any coercion if they have greater trust in government (Levi and Stoker, 2000; Scholz and Lubell, 1998; Scholz and Pinney, 1995; Chanley, Rudolph and Rahn, 2000; Thomas, 1998; Ruscio, 1997).

Understanding the effects of public trust is an important for scholars of emer-

gencies and disasters. While scholars have heavily focused on how disastrous events may affect political trust and satisfaction of individuals (Brändström, Kuipers and Daléus, 2008; Albrecht, 2017; Han et al., 2017), they have also investigated the role of public trust in managing emergencies and crises. For instance, a study of the refugee crises in Turkey found that refugees' government trust and legitimacy lead to greater cooperation and compliance of refugees with government policies of hosting country (Demiroz and Unlu, 2018). Furthermore, scholars have examined how public trust in federal, state, or local government is associated with individual cooperation with the government, particularly emergency preparedness recommendations for various emergencies such as earthquakes, hurricanes, terrorist attacks, and other health-related situations (Murphy et al., 2009; Murphy, Greer and Wu, 2018; Basolo et al., 2009; Arlikatti, Lindell and Prater, 2007; Perry and Lindell, 1991; Terpstra, 2011). Most scholars have provided evidence that there is a positive association between public trust in government and citizens' cooperation with the government. These scholars have found that citizens are more likely to adopt emergency preparedness measures when they perceive higher trust in government (Paton, 2008; Longstaff and Yang, 2008; Murphy et al., 2009; Murphy, Greer and Wu, 2018; Ablah, Konda and Kelley, 2009)

However, there are also mixed findings regarding the effect of trust in government in the context of emergencies. For instance, Terpstra (2011) finds that citizens who have a higher level of trust in government are less likely to have a higher level of flood preparedness intentions (Terpstra, 2011). One potential explanation of this association is that citizens may not see the necessity of adopting preparedness measures if they believe that the government will take care of the potential emergencies for them (Murphy, Greer and Wu, 2018; Scolobig,

De Marchi and Borga, 2012). In other words, citizens may pass on the full responsibility of preparing and responding to emergencies to the government when they perceive higher trust in government.

However, most evidence suggests that higher trust in government is positively associated with individual emergency preparedness across many other hazards; therefore, this relationship may also be present when examining preparedness for tornadoes. As stated, local government and other emergency service agencies have promoted emergency preparedness at the household level to minimize potential risks associated with disasters. If individuals trust the government more, they will consider the risk estimates and risk mitigation policies of emergency service agencies more credible (Johnston et al., 1999). Therefore, it is reasonable to expect that citizens may be more prepared for emergencies if they trust the government and their recommendations and policies more. Furthermore, other previous studies have shown no dampening effect of public trust in government on citizens' preparedness behaviors (Basolo et al., 2009; DeYoung and Peters, 2016).

Scholars in co-production literature have also recognized the importance of public trust in government in citizen co-production behaviors and willingness (Fledderus, Brandsen and Honingh, 2014; Fledderus, 2015; Van de Graaff, 2016; Parrado et al., 2013). However, these studies have mainly focused on how co-production can lead citizens to perceive greater trust in government (Fledderus, Brandsen and Honingh, 2014; Fledderus, 2015; Kang and Van Ryzin, 2019). Furthermore, there have been some mixed findings on the effect of public trust (Van de Graaff, 2016; Parrado et al., 2013).

2.2.3 Citizen cooperation and Trust in an issue-specific agency

In public administration and political science more broadly, scholars have highlighted public trust in general political institutions such as the President, Congress, federal, state, or local government to understand individual behaviors and attitudes towards government orders and recommendations (Cooper, Knotts and Brennan, 2008; Hetherington and Rudolph, 2008; Rahn and Rudolph, 2005). However, a body of scholarship in public administration has recently highlighted the need to investigate public trust in issue-specific government agencies for several reasons (Robinson, Stoutenborough and Vedlitz, 2017; Robinson et al., 2012). First, previous studies have found that context-specific variables matter in the formation of public trust in government. According to existing studies, citizens evaluate the level of trust in government based on their specific policy expectations and/or preferences (Bouckaert and Van de Walle, 2003; Christensen and Lægreid, 2005; Job, 2005; Ryzin, 2004; Yang and Holzer, 2006). Furthermore, previous polls and studies have shown that citizens are capable of evaluating different government agencies differently (**?**Robinson, Stoutenborough and Vedlitz, 2017; Kettl, 2019). Additionally, it follows intuitively to look at trust in a specific agency to understand individual cooperative behaviors or perceptions towards specific policies. This is because, for example, individual trust in the Department of Health and Human service most likely matters more than their trust in general political institutions when it comes to decisions regarding vaccination. For instance, Tyler Tyler (2005) finds that individuals are more likely to be cooperative with the police, operationalized as reporting dangerous or suspicious activities in their community when they perceive greater trust in the police

department.

Following these arguments, instead of highlighting public trust in general political institutions, I seek to investigate public trust in issue-specific agencies and their effects on citizen cooperation in the context of emergency service. I particularly consider emergency medical agency, law enforcement, fire department and local government in the context of emergency management as issue-specific agencies.

2.2.4 Trust in local emergency service agencies as a mediator

Though I argue that public trust in emergency service agencies is an important factor in shaping citizen preparedness for tornadoes, individual behaviors are complex with many potential explanatory factors. Previous studies have found that several major predisposition characteristics primarily affect individual behaviors for emergency preparedness.

The first set of variables is individual demographic characteristics. Research in emergency management has documented the important contingent effect of a large variety of demographic variables that are related to individual emergency preparedness. Previous studies have shown that age (Heller et al., 2005; Ablah, Konda and Kelley, 2009; Lindell and Perry, 2000), gender (Murphy et al., 2009; Blessman et al., 2007; Eisenman et al., 2006; Robinson, Pudlo and Wehde, 2019), education (Russell, Goltz and Bourque, 1995; Fothergill and Peek, 2004), income (Edwards, 1993; Ablah, Konda and Kelley, 2009), location (Wehde, Pudlo and Robinson, 2019), and race/ethnicity (Torabi and Seo, 2004; Brodie et al., 2006; Eisenman et al., 2006; Redlener et al., 2008; Peacock, Morrow and Gladwin, 1997;

Eisenman et al., 2006) capture important individual differences that structure individual emergency preparedness and response. Additionally, individuals who have children at their residence tend to be more prepared for disasters (Edwards, 1993; Russell, Goltz and Bourque, 1995; Baker and Cormier, 2013).

The second set of variables is issue-specific characteristics. These variables generally include individuals' perceived risk, previous experience and knowledge regarding specific disasters of individuals to name a few (Robinson, Stoutenborough and Vedlitz, 2017). Individual perceived risks of specific disasters are a significant predictor affecting individual emergency preparedness and other risk-mitigating behaviors (Miceli, Sotgiu and Settanni, 2008; Paton, 2008; Murphy et al., 2009; Palm et al., 1990; Miceli, Sotgiu and Settanni, 2008; Lai, Chib and Ling, 2018; Funk, Salathé and Jansen, 2010). These studies have shown that when people perceive higher risks associated with potentially disastrous events, they tend to prepare for these events more. However, other studies in this area have found that risk perception is not significantly associated with individual risk-mitigating behaviors (Russell, Goltz and Bourque, 1995; Jackson, 1981; Mileti and Darlington, 1997). Some scholars argue that the mixed results are derived from different measurement strategies across these various studies (Miceli, Sotgiu and Settanni, 2008). Previous studies have also found that people tend to take action for risk mitigation and emergency preparedness more when they are knowledgeable about risks they face (Jaeger et al., 1993; Leiserowitz, 2006; Bord, Fisher and O'Connor, 1998). For instance, O'Connor and his colleagues (O'Connor, Bord and Fisher, 1999), find that people take greater efforts to reduce the burning of fossil fuels when they are more knowledgeable about global warming issues. Furthermore, it has been observed that those who have previously experienced disasters tend to prepare for emergencies more (Mulilis, Duval and Rogers, 2003;

Norris, Smith and Kaniasty, 1999).

Additionally, political and social dispositions are often investigated to explain individuals' cooperative behaviors with government authorities to prepare for, respond to and recover from emergencies. Political and social dispositions are generally measured as a social capital, political ideology, party identification or attitudes toward government. These serve as underlying predispositions and filters through which individuals process their decisions related to policy (Taber and Lodge, 2006; Rudolph and Evans, 2005). Despite numerous studies looking at various political disposition variables such as political ideology and party identification as predictors of individual mitigation attitude or support for risk mitigation policies (Reckhow, Grossmann and Evans, 2015; Mumpower et al., 2013; Mumpower, Liu and Vedlitz, 2016; Stoutenborough, Sturgess and Vedlitz, 2013), there have been insufficient studies looking at these variables of political dispositions to understand the actual behavior of emergency preparedness of individuals, except a few (Ablah, Konda and Kelley, 2009; Perry and Lindell, 1991; Murphy, Greer and Wu, 2018; Basolo et al., 2009; Arlikatti, Lindell and Prater, 2007; van der Weerd et al., 2011).

Instead of treating trust in local emergency service agencies as another explanatory variable in addition to these sets of variables, this article argues that trust in local emergency service agencies plays a role as a mediator between three sets of individual predisposition variables and individual emergency preparedness. This is because trust in the issue-specific agency is also a function of these same categories of explanatory factors (Robinson, Stoutenborough and Vedlitz, 2017; Liu, Robinson and Vedlitz, 2017; Choi and Wehde, 2019). In a recent study, Robinson and colleagues (2017) review a broad range of existing studies and conclude that individual trust in an issue-specific agency is primarily constructed by

these sets of explanatory factors including demographic characteristics, political dispositions and issue-specific variables. Therefore, I reasonably expect that trust in local emergency service agencies is structured by demographic characteristics, political and social predispositions and issue-specific characteristics while trust in emergency management authorities itself is also a determinant or explanatory factor of individual emergency preparedness. Following these arguments previously described, I arrive at two research expectations as follows:

Expectation 1: Trust in local emergency service agency is structured by demographic characteristics, political and social predispositions, and issue-specific factors.

Expectation 2: Trust in local emergency service agency will be positively associated with citizens' preparedness for tornadoes.

Given the importance of public trust in shaping their cooperative behaviors, I expect that among many other factors, trust in local emergency service agencies is one of the most decisive and important factors in shaping levels of citizen preparedness for tornadoes. I seek to test this expectation by utilizing a random forest regressor which calculates the relative decisiveness and importance of factors without strong parametric assumptions and multicollinearity issues.

Expectation 3: Trust in local emergency service agency is one of the most decisive and important factors in shaping citizens' preparedness for tornadoes among many factors.

2.3 Data and Measurements

To test these expectations, I draw on data from the 2013 Severe Weather and Society survey. This survey measures the perceptions, opinions and preferences of Americans regarding concerning severe weather and public policy. A total of 3,976 people in the United States participated in this online survey between May 8th and June 27th. The participants were recruited from SurveySpot Internet panel. In this chapter, I rely on 3,598 observations for analyses. The average completion time was approximately 29 minutes. Respondents have recruited from tornado-prone states including Alabama, Arkansas, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Mississippi, Missouri, North Carolina, Ohio, Oklahoma, South Carolina, Tennessee, and Texas. These states are commonly known as "Tornado Alley" because they consistently experience a high frequency of tornadoes each year. The study included an oversample of individuals from rural areas to avoid the urban clustering commonly associated with internet-based surveys. The survey includes a set of questions regarding natural disaster issues, perceived risk, trust in various levels of government and agencies, respondents' knowledge about tornadoes and basic demographic characteristics

The dependent variable in this study is citizen cooperation with local emergency service agencies. To measure this, I operationalize this concept as *citizens' tornado preparedness*. The respondents were asked to select items they currently have available at their residence in case of emergencies. These items recommended by local emergency service agencies include 1) a disaster response plan for them and their family, 2) an emergency preparedness kit containing first-aid supplies, flashlights, batteries, etc, 3) supplies of water and food, 4) generators to provide electricity, 5) designated place to provide the most shelter from tornadoes

within their house, and 6) specially constructed room or other facilities on your property designed to provide shelter from tornadoes. Using this survey question, I create a measure of citizen preparedness for tornadoes (0 = "not prepared at all" to 6 = "fully prepared").

As a dependent and a mediating variable, I include *trust in local emergency service agencies (Trust in Local ESA)*. I focus on citizens' confidence in the emergency medical agency, law enforcement, fire department and local government in the context of emergency management to measure their trust. First, the respondents were asked to the rate the following statement to report their trust: On a scale from zero to ten, where zero means not at all confident and ten means completely confident, how confident are your that emergency medical providers (EMT), fire department, state and local police, sheriff, or other law enforcement agencies will meet your immediate emergency needs if you experience a natural disaster? Furthermore, each respondent was also asked to rate the statement of "how much of the time do you trust your county and local governments to do what is right for you and your fellow residents in your local area?". This scale ranges from zero which represents none of the time to ten which represents all of the time. While this question is asked in a more general sense, given the nature and context of the survey, I confidently argue that this measure captures public confidence in local government during disasters. Based on these questionnaires, I create a *trust in emergency service agencies* by calculating the average scores of each question (0= "not at all confident" to 10= " completely confident") [3]

As explanatory variables, I first include several important demographic variables which have been discussed previously in citizen co-production and emer-

[3] I tested internal consistency of four survey questions regarding trust in emergency medical providers, fire department, law enforcement and local government in the context of emergency management before creating this index variable and the Cronbach's alpha was 0.79, which is acceptable (DeVellis, 2016)

gency management literature. I include *male* (0 = "female", 1 = "male"), *age* (respondent's actual age), *education* (1 = "elementary or some high school", 7 = " doctorate of any type"), *White* (1= "White", 0= "others"), and *income* (1= "less than $50,000", 4= "$150,000 or more"). Furthermore, I also include *children* (number of children residing with the respondent 0 = "none" to 4= "four or more"), *home_ownership* (0= "do not pay rent or pay rent", 1= "own primary residence") and *rural*, the household location (0= "urban or suburban", 1= "rural").

I also include several political and social disposition variables. First, I include *trust in federal government* as a political disposition variable. The respondents were asked to rate how much of the time they trust the federal government to do what is right for the American people (0 = "none of the time" to 10 = "all of the time"). Additionally, respondents were asked to report their *political ideology* (1 = "strongly liberal" to 7 = " strongly conservative"). Last, they were also asked to self-identify their *party affiliation* (Republican, Independent, or Democrats). Based on this article created dummy variables for Republican. As social disposition variables, I include *efficacy* and *social capital* variables. To measure efficacy, I used the survey question which initially intended to measure fatalistic characteristics of individuals (0 = "lower efficacy", 10 = " higher efficacy"). Respondents were also asked to rate 6 statements to measure the social capital of them. Social capital has been highlighted in citizen co-production literature (Ostrom, 1996) while public trust literature often ignores it. Based on these ratings, this article created a variable of social capital (1 = "lower social capital" 7 = "higher social capital").

Last, I include some items to measure issue-specific variables related to tornadoes such as perceived risk, knowledge about disasters and previous tornado

experience to measure tornado and emergency service specific variables. First, I include *risk perception of tornadoes*. The respondents were asked to rate how much risk they think tornadoes impose to them and their family (From 0 = "no risk" to 10 = "extreme risk"). *Knowledge on tornadoes* is also included. The respondents were asked to answer six questions regarding common myths about tornadoes. These statements were either true or false; each question was re-coded where 1 = correct and 0 = incorrect. Based on these recorded questions, I create a scale of individual knowledge (0 = "not knowledgeable at all" to 6 = "fully knowledgeable"). In order to measure disaster experience, I include two ordinal variables: *damage experience* and *tornado experience*. To measure *damage experience*, the respondents were asked to answer how many tornadoes they have personally seen while they were active (1= "none" to 4 = "more than five"). Additionally, the respondent was asked if they or their members of family, neighbors, friends or associates ever experienced property damage, personal injury, or loss of life from a tornado (0 = "No" to 4= "Yes for them personally, for family, for neighbors, for close friends or associates"). By including these two ordinal variables to measure individual experience with tornadoes, I expect to have a more accurate understanding of the role of disaster experience.

Using these measures and variables, I specify a series of Ordinary Least Squares (OLS) regression models as well as a random forest regressor. For OLS regression models, I standardized all continuous variables by dividing by two standard deviation. The standardization of variables by two standard deviation allows us to have more comparability of continuous and binary variables on roughly the same scale (Gelman, 2008). Furthermore, I expect to see the relative importance of variables by investigating the standardized coefficients of variables and compare them to the results of random forest regressor as a way of validat-

ing the results. In the following section, I first assess the effect of predisposition variables on public trust in local emergency service agencies. I then examine if public trust in local emergency service agencies influences citizens' preparedness for tornadoes as a form of citizen co-production in the process of emergency service delivery. Finally, by utilizing a random forest regressor model, I investigate the relative decisiveness and importance of public trust in local emergency service agencies. Summary statistics are in Table 2.1 below.

Table 2.1: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Max
Dependent variables					
Tornado preparedness	3,598	1.720	1.454	0	6
Trust in LocalESA	3,598	7.085	1.753	0	10
Trust in EMT	3,598	7.940	2.067	0	10
Trust in Fire Dept.	3,598	8.006	2.083	0	10
Trust in Cops	3,598	7.503	2.309	0	10
Trust in Local Govt.	3,598	4.890	2.457	0	10
Demographics					
Rural	3,598	0.281	0.450	0	1
Home ownership	3,598	0.534	0.499	0	1
Age	3,598	45.267	16.393	18	99
Education	3,598	3.309	1.253	1	7
Male	3,598	0.471	0.499	0	1
Children	3,598	0.512	0.911	0	4
White	3,598	0.786	0.410	0	1
Income	3,598	1.521	0.740	1	4
Disaster specific variables					
Risk perception	3,598	5.342	2.258	0	10
Tornado experience	3,598	1.742	0.851	1	4
Damage.experience	3,598	0.621	0.978	0	4
Knowledge on tornado	3,598	3.631	1.244	0	6
Political and social dispositions					
Efficacy	3,598	5.591	3.019	0	10
Social capital	3,598	3.742	0.882	1	7
Trust in fed	3,598	3.436	2.566	0	10
Republican	3,598	0.279	0.449	0	1
Political ideology	3,598	4.180	1.582	1	7

2.4 Results

2.4.1 Determinants of Trust in local emergency service agency

In this section, I first examine the determinants of public trust in local emergency service agencies. I explore how public trust in local emergency service agencies are structured by characteristics including demographics, social and political dispositions, and issue-specific variables. The measures public trust in local emergency service agencies in this study is ten-point scales; therefore, I use ordinary least squares (OLS) regression models to assess the determinants of trust in local emergency service agency. These models are presented in Table 2.2. This model presented heteroskedasticity, therefore, I report robust standard errors. Additionally, I checked for multicollinearity using the VIF statistic; all were below 10. The coefficients of variables in this model are standardized by dividing by two standard deviation.

The results indicate that many predisposition variables are correlated with public trust in local emergency service agencies. First, demographics seem to help explain public trust in local emergency service agencies in the context of emergency management. For instance, the results show that income and race are positively associated with public trust in local emergency service agencies. White Americans who make higher income are more likely to trust local emergency service agencies. Furthermore, the results also indicate that older people are more likely to trust the local emergency service agency. However, the results also show that several demographic characteristics such as household location and education, are negatively associated with public trust in local emergency

service agencies. People living in rural areas and are less likely to trust local emergency service agencies than those living in urban or suburban areas. The effects of home ownership, gender and children residing with respondents are not statistically significant.

The results show that a majority of political and social disposition variables are significantly and positively associated with public trust in local emergency service agencies. Republicans are more likely to trust local emergency service agencies. Furthermore, higher social capital, efficacy and greater trust in the federal government are also significantly and positively associated with individual trust in local emergency service agencies.

Finally, a couple of disaster-specific factors seem to be significantly associated with public trust in local emergency service agencies. The results find that risk perception of tornadoes is strongly and positively associated with trust in local emergency service agencies. While tornado experience and knowledge on tornado are not significantly associated with trust in local emergency service agencies, people trust local government more when they previously experienced damages from tornadoes.

2.4.2 Trust in local emergency service agencies and Citizen cooperation

In this chapter, I measured citizens' preparedness for tornadoes, a form of citizen co-production in emergency service by counting the number of items citizens prepared for tornadoes. The measurement of this variable is 7-point discrete scales; therefore, I use ordinary least squares (OLS) regression models to assess the determinants of citizens' preparedness for tornadoes. This model is presented in Table

Table 2.2: Standardized coefficients for determinants of trust in local emergency service agencies

	Dependent variable:
	Trust in Local Emergency Service Agencies
Demographics	
Rural	-0.432^{***} (0.062)
Home ownership	-0.029 (0.062)
Age	0.424^{***} (0.063)
Education	-0.110^{*} (0.059)
Male	-0.014 (0.056)
Children	-0.030 (0.057)
White	0.243^{***} (0.072)
Income	0.120^{**} (0.060)
Disaster specific variables	
Tornado experience	-0.036 (0.059)
Damage experience	0.113^{*} (0.059)
Knowledge on tornado	-0.032 (0.055)
Risk perception	0.188^{***} (0.058)
Political and social dispositions	
Efficacy	0.200^{***} (0.056)
Social capital	0.495^{***} (0.057)
Trust in fed	0.978^{***} (0.060)
Republican	0.154^{**} (0.071)
Political ideology	0.084 (0.065)
Constant	7.085^{***} (0.027)
Observations	3,598
R^2	0.133
Adjusted R^2	0.129
Residual Std. Error	1.636 (df = 3580)
F Statistic	32.371^{***} (df = 17; 3580)
Note:	*p<0.1; **p<0.05; ***p<0.01

2.3. This model presented heteroskedasticity, therefore, I report robust standard errors. Additionally, I checked for multicollinearity using the VIF statistic; all were below 10. The coefficients of variables in this model are standardized by dividing by two standard deviation.

First, Table 2.3 shows that several demographic characteristics are significantly associated with citizens' preparedness for tornadoes as a form of individual co-production in emergency management. The results indicate that those who own their house and live in rural areas are more likely to prepare for tornadoes. Furthermore, people who earn a higher income and have children are more likely to prepare for tornadoes. Education is positively associated with citizens' preparedness for tornadoes. Citizens who are highly educated and have children under 18 residing in their household are more likely to prepare for tornadoes.

Several political and social disposition variables also seem to be associated with citizens' preparedness for tornadoes. For instance, when people have higher efficacy, they are more likely to prepare for tornadoes. Furthermore, the social capital variable is also positively associated with individual preparedness for tornadoes. This is interesting that social capital, trust in society and their communities, matters even when it comes to individual co-production, in which individual participates for their interests and benefits. However, trust in federal government and party identification seem to be negatively associated with preparedness for tornadoes. The results show that people who trust the federal government more and people identifying themselves as Republicans are less likely to prepare for tornadoes.

Table 2.3 also shows that a couple of disaster specific factors are significantly associated with individual preparedness for tornadoes as a form of individual co-production. While, surprisingly, risk perception and knowledge on tornadoes do

not seem to affect citizens' preparedness for tornadoes, people who previously experienced tornadoes and damages from tornadoes are more likely to prepare for tornadoes. In this chapter, I primarily claim that public trust in local emergency service agencies structures citizens' preparedness for tornadoes as a form of individual co-production in the context of emergency management. Table 2.3 indicates that this expectation is supported. The result shows that public trust in local emergency service agencies is positively associated with citizens' preparedness for tornadoes even after controlling for other factors.

As previously stated, I standardized the coefficients of variables by dividing by two standard deviations. By standardizing them, I can see which variable is more important than others. According to the size of coefficients of all the variables in the model, trust in local emergency service agencies has the second largest effect on citizens' preparedness for tornadoes followed by damage experience. Thus, I may conclude that trust in local emergency service agencies plays an important role to shape citizens preparedness for tornadoes. When people trust local emergency service agencies including emergency medical personnel, fire department, law enforcement and local government in the context of emergency management more, they are more likely to co-produce emergency service before tornadoes by cooperating with emergency preparedness recommendations.

2.4.3 Relative decisiveness of Trust in local emergency service agency

In this chapter, I claimed that public trust in local emergency service agencies, in conjunction with individual characteristics, influences citizens' preparedness for tornadoes as a form of individual co-production. By utilizing ordinary least

Table 2.3: Standardized coefficients for determinants of tornado preparedness

	Dependent variable:
	Tornado preparedness
Trust in Local emergency service agencies	0.376^{***} (0.048)
Demographics	
Rural	0.141^{***} (0.051)
Home ownership	0.228^{***} (0.051)
Age	0.039 (0.052)
Education	0.148^{***} (0.048)
Male	-0.003 (0.046)
Children	0.196^{***} (0.047)
White	0.044 (0.059)
Income	0.225^{***} (0.049)
Disaster specific variables	
Tornado experience	0.324^{***} (0.048)
Damage experience	0.446^{***} (0.048)
Knowledge tornado	0.006 (0.045)
Risk Perception	0.048 (0.047)
Political and social dispositions	
Efficacy	0.301^{***} (0.045)
Social capital	0.361^{***} (0.047)
Trust in federal	-0.248^{***} (0.051)
Republican	-0.115^{**} (0.058)
Political ideology	0.009 (0.053)
Constant	1.720^{***} (0.022)
Observations	3,598
R^2	0.160
Adjusted R^2	0.156
Residual Std. Error	1.336 (df = 3579)
F Statistic	37.906^{***} (df = 18; 3579)
Note:	*p<0.1; **p<0.05; ***p<0.01

squares regressions models, I found that public trust in local emergency service agencies is positively associated with individual preparedness for tornadoes in addition to other individual factors. Based on the size of standardized coefficients, I also found that trust in local emergency service agencies has the second largest effect on preparedness for tornado. However, this result is somewhat limited due to strong parametric assumptions of OLS models and correlation issues among variables. Therefore, in this section, I additionally conduct a random forest regressor and investigate the relative decisiveness of public trust in emergency service agencies in shaping individual preparedness for tornadoes to see how important and decisive public trust in local emergency service agencies is among many other factors.

To answer the question, I calculated modal rankings of variable decisiveness concerning individual preparedness for tornadoes. Figure 2.1 presents the results. Box-plots for each explanatory variable are presented to provide more detailed information about the variance of variable decisiveness. I remind that a higher modal value implies *lower* ranking and consequently lower importance in our formulation. For example, the first place is best while higher rankings are less decisive. Also, I provide the percentages in relative decisiveness of each explanatory variable in Figure 2.2. While random forest regressors do not provide quantitative interpretation with these percentages in relative decisiveness, it helps us identify the clusters of decisive factors among all explanatory variables.

Considering both Figure 2.1 and Figure 2.2, social capital and public trust in local emergency service agencies seem to be the most decisive factors to structure citizens' preparedness for tornadoes. Figure 2.2 particularly shows that social capital and public trust in local emergency service agencies are the most commonly decisive factors by a notable margin (approximately 0. and 0.10 in

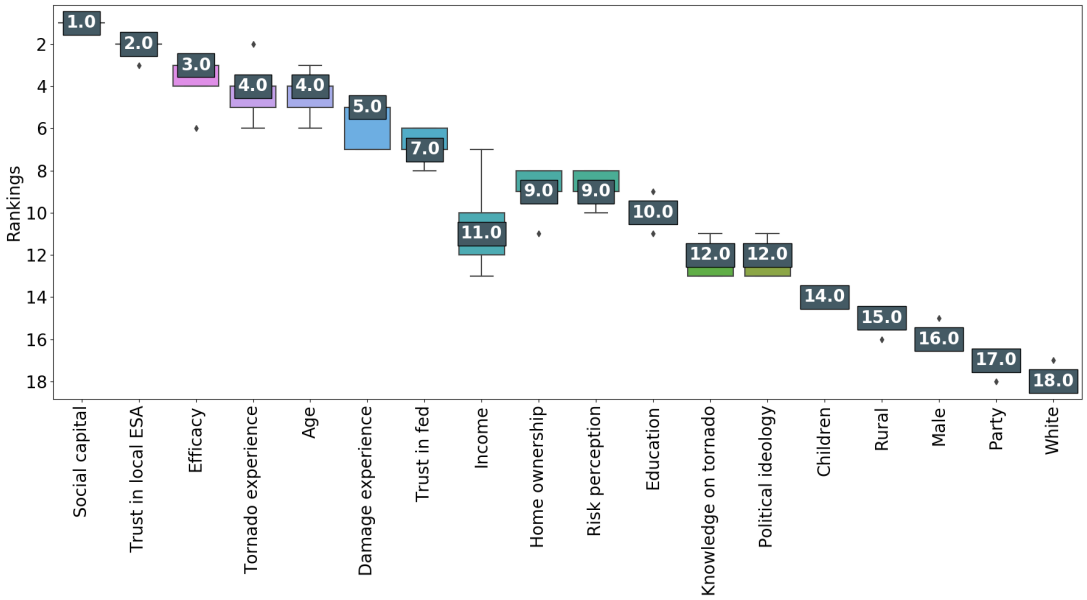

Figure 2.1: Relative Decisiveness of Independent Variables

relative decisiveness respectively). It should be highlighted that trust in issue specific agencies seems to be more important than generalized trust, trust in federal government. In addition, it has been observed that efficacy and tornado experience are relatively more decisive than other variables. The importance of tornado experience may show the possibility of learning from the personal history related to tornadoes.

One of the interesting findings here is that most of the basic demographic characteristics are similarly decisive at a low level except home ownership and income. While co-production and emergency management literature has highlighted the basic demographic characteristics such as gender, race, household location, and education to explain the variations in individual cooperative behaviors, the results show that they may be associated with differences in preparedness but are not decisive factors in predicting levels of preparedness in the analysis.

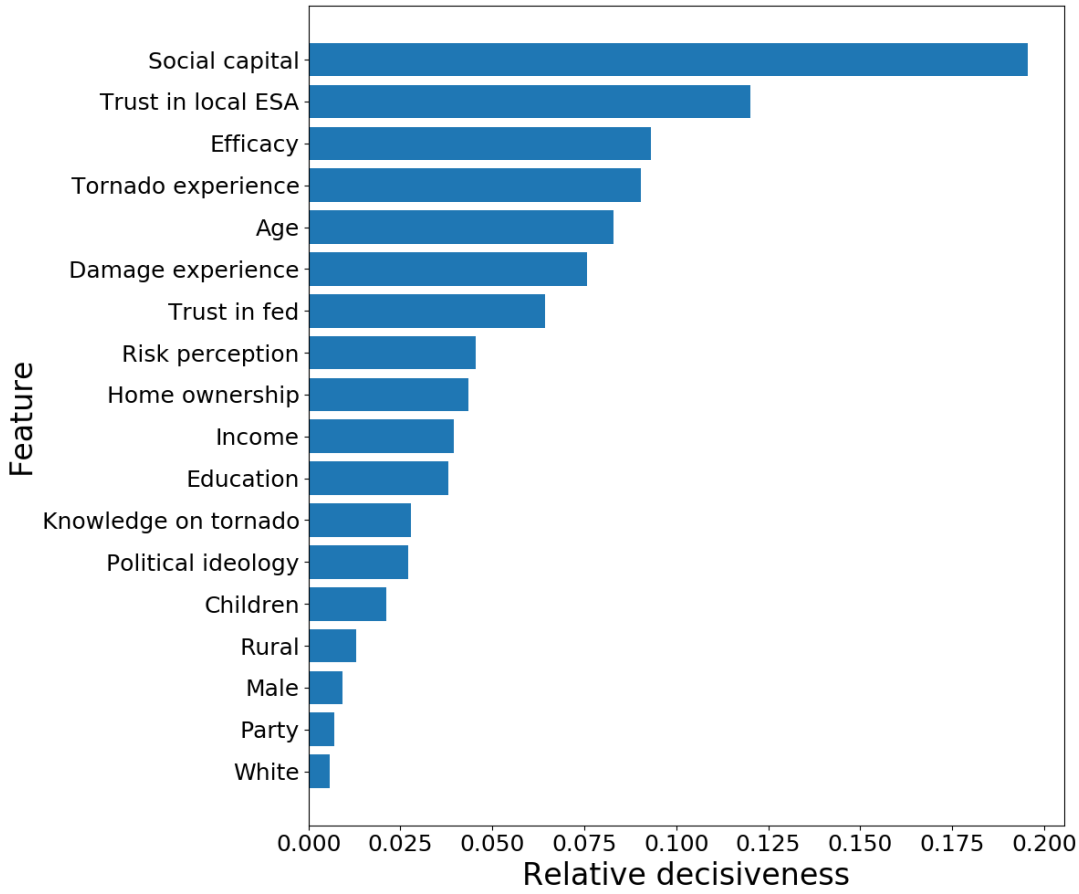

Figure 2.2: Relative Decisiveness of Independent Variables

2.5 Discussion

In this chapter, I sought to understand the role of public trust in an issue-specific agency in shaping citizens' cooperation with public service providers as a form of individual co-production particularly in the context of emergency service. Therefore, I investigated how public trust in local emergency service agencies affects citizens preparedness for tornadoes as a form of individual co-production of emergency service. Scholars have previously shown that citizens' preparedness for disastrous events significantly contributes to the reduction of negative outcomes of emergencies and disasters in emergency management.

The analyses in this chapter first suggest that public trust in local emergency service agencies is structured by individual predisposition characteristics. This result supports previous research claiming that public trust in an agency is a function of demographic characteristics, political dispositions and issue-specific variables (Robinson, Stoutenborough and Vedlitz, 2017; Liu, Robinson and Vedlitz, 2017). Also, the findings show that citizens perceive trust in local emergency service agencies plays a significant role in their cooperation with local emergency service agencies. More specifically, when people believe that local emergency service agencies will provide effective assistance to people and their community in the case of a natural disaster, they tend to prepare for emergencies more. The standardized coefficients of variables in the OLS regression model show that trust in local emergency service imposes the second largest effect (0.376) on citizens' tornado preparedness after damage experience (0.446).

The random forest regressor model supports the evidence I found in OLS regression model, particularly around the role of trust in local emergency service agencies. The results of random forest regressor indicates that trust in local emergency service agencies is the second most decisive factor among others after social capital. While scholars have previously focused on the effect of trust in general federal government, this result shows that trust in issue specific agencies should be more highlighted to understand citizen co-production in the context of specific public service delivery.

While the random forest regressor and OLS regression models provided similar results regarding the role of trust in local emergency service agencies, it should be noted that they also show somewhat different conclusion regarding, particularly social capital and damage experienced. The standardized coefficients of OLS regression model indicate that damage experience has the largest effect on

citizens' preparedness for tornadoes. While social capital is positively and significantly associated with preparedness for tornadoes, the OLS regression analysis show that its effect is relatively smaller than other variables such as trust in local emergency service agencies and damage experience. The further investigation should be required to understand the gap of the results between random forest regressor and traditional statistical approaches.

While this chapter provides some intriguing evidence regarding citizen co-operation and their trust in an issue-specific agency, these findings should be understood within the limitations. First, in this article, I created a scale to measure citizens preparedness for tornadoes. As previously mentioned, those who prepare more items as recommended by emergency service agencies had higher scores on this emergency preparedness scale. However, this measurement does not consider the fact that preparing each item takes different levels of effort, time, and resources. For example, stockpiling water for three days is much easier than preparing a shelter for disasters. For future research, measuring citizens' preparedness for disaster should consider ways of measuring effort. One solution may be to weigh these different items according to their relative difficulties. Another way may be to directly ask people how much effort they have put into being prepared for emergencies, as opposed to specific actions. Second, emergency service is a unique public service area. Therefore, it should be careful to make arguments about the effect of public trust in citizens' cooperation in other public service areas. Furthermore, the results provided in this chapter may be specific to citizens' co-production particularly in the process of emergency service. In order to produce more generalizable knowledge regarding the determinants and motivations of citizen co-production, it should be required to utilizing the same set of variables and methods in other public service areas as well.

Despite the limitation, this chapter provides implications to emergency management practitioners and scholars in emergency management and co-production literature. First, this result shows that emergency service agency should improve their reputation among their constituents for better emergency management given the relative importance of trust in local emergency service agencies. Second, this chapter suggests considering more issue-specific factors when seeking to understand citizens' co-production behaviors and willingness in addition to more general dispositions.

In this chapter, I mainly focus on citizens' individual co-production of emergency service before tornadoes. In the next chapter, I seek to understand citizen cooperation as a form of individual co-production during tornadoes.

Empirical Chapter 2. Abstract

Scholars have argued that citizens as public service co-producers can contribute to the provision and delivery of public service by providing their knowledge, resources such as time and efforts, ideas and creativity as well as by cooperating with professional public service providers. Under the resurgence of scholarly interests in citizen co-production, scholars have recently attempted to identify the variables most closely associated with citizens' contributions and their willingness in various public service areas. Therefore, we now have much more knowledge regarding these factors and their association with citizens' co-production behaviors and willingness. However, it has not been sufficiently discussed how decisive many of these factors are in shaping citizen co-production behaviors and willingness. In this chapter, I seek to examine what factors, among the many examined in public administration and emergency management, are most central to structure citizen co-production behaviors and willingness particularly in the context of emergency service. To that end, I investigate the decisiveness of factors in shaping citizens' decisions on taking protective action during tornadoes and willingness for future events as a form of co-production of emergency service by utilizing a relatively uncommon machine learning technique in public administration and emergency management literature. Using unique survey data, I find that in the case of citizens' cooperative behaviors and willingness during tornadoes, the most decisive

variables are related to risk perception, trust in local emergency service agencies, age and social capital. However, logistic regression analyses conducted to complement the results of random forest regressor provide somewhat contradicting findings particularly around the effect of social capital. The findings of this chapter contribute to scholarly endeavors to understand citizens co-production behaviors and willingness and provide practical implications for emergency management practitioners.

Keywords Citizen co-production, Emergency management, Machine learning, random forest regression, Protective action for tornadoes

Chapter 3

What Matters the Most? Individual Co-production during Tornadoes

3.1 Introduction

While public administration scholars have mostly focused on citizen participation in decision making and agenda setting process, a body of scholarship, denoted as citizen co-production has emphasized the role of citizens in the process of public service delivery. Citizen co-production has been defined in many different ways among scholars (Nabatchi, Sancino and Sicilia, 2017). In this chapter, I define citizen co-production is the process that citizens contribute to the public service delivery process by cooperating with public service providers. While citizens may cooperate with public service providers through direct interactions, I argue that direct interactions are not necessarily required (Loeffler and Bovaird, 2016). Citizens may cooperate with government policy and recommendations to co-

produce public service without direct relationships.

Scholars have argued that citizens may individually and collectively participate in the process of public service co-production. Individual citizen co-production may be often driven by self-interests and private benefits (**?**). However, citizen co-production driven by self-interests may produce better outcomes of public service and this eventually leads to solving public problems in the aggregate level (Fung, 2015). Scholars have argued that citizen co-production may improve efficiency, effectiveness and innovation of public service delivery and provision to name a few (Osborne and Strokosch, 2013; Ostrom, 1996; Whitaker, 1980; Brudney and England, 1983). [1].

Given the resurgence of scholarly interests in citizen co-production, scholars have recently investigated how and why citizens individually co-produce public service by cooperating with public service providers in many areas such as health, education, childcare, recycling, environmental and postal services (Jo and Nabatchi, 2019; Parks et al., 1981; **?**; Alonso et al., 2019; **?**; Pestoff, 2006). Scholars in citizen co-production have found various determinants and motivations to shape citizen's cooperative behaviors and willingness by utilizing case studies and traditional statistical techniques (Jakobsen and Andersen, 2013; Parrado et al., 2013; Bovaird et al., 2016, 2015).

Therefore, we now have much knowledge about the determinants and motivations of citizen's cooperative behaviors and willingness. However, the dominant statistical approach and other qualitative approaches have not been able to answer an important question: what factors, among the many tested in the previous studies, are the most decisive to drive citizens' cooperative behavior and willing-

[1] Again, while using the term citizen here to be consistent with existing literature, I do not mean to only include individuals who possess the legal citizenship of the United States. I intend to mean more general public and community members who enjoy public service.

ness to co-produce public service? I seek to identify the decisiveness of various factors motivating citizen's behavior and willingness to co-produce public service by utilizing a random forest regressor. Besides, given the limited information radon forest regressor analyses can provide, to see the effect directions of variables, I also conduct standardized logistic regression analyses to see how the most decisive factors affect citizens cooperative behaviors and willingness [2].

To that end, among may public service areas, I seek to examine citizens' cooperation as a form of individual co-production particularly in the context of emergency service. While emergency service agencies at the local, state and federal level are the key actors in the process of emergency service delivery, it has been observed that the government cannot solely steer the management of emergencies and their associated risks (Mees et al., 2016; Leroy and Arts, 2006). While various actors such as nonprofit and for-profit organizations play imperative roles, the role of citizens has been heavily highlighted in the process of emergency service provision and delivery. Previous disasters and their consequences have shown that citizens' contributions before, during and after emergencies and disasters can make a significant difference in outcomes of emergency services such as mortality and property damage (Diekman et al., 2007; Keim, 2008; Paton, 2008).

One way of citizens co-producing emergency service is by cooperating with the recommendations and orders of local emergency service agencies such as local emergency management offices, emergency medical personnel, firefighters and law enforcement, primary emergency management actors in the context of emergency service. As stated in a previous chapter, citizens can follow emergency preparedness recommendations suggested by local emergency service agencies

[2] While random forest regressor allows us to calculate the relative decisiveness of factors in shaping the dependent variables, it does not provide the direction of effects. By utilizing standardized logistic regression, I expect to understand the directions of decisive factors. Furthermore, given that standardized logistic regressions provide standardized coefficients, this result may validate the relative decisiveness of factors analyzed by a random forest regressor

before emergencies and disasters. Furthermore, citizens can also evacuate their homes or take other protective actions following the orders and recommendations of emergency service agencies during emergencies. Citizens may take protective actions purely due to their interests. However, citizens' cooperation during emergencies can eventually contribute to the outcomes of emergency service not only for themselves but also for the community as a whole(Fung, 2015).

In this chapter, I look at citizens' previous cooperative behaviors (take protective actions during tornadoes) and willingness to take protective actions during tornadoes in the future as a form of citizens' individual co-production. When a tornado warning is issued, citizens are recommended to find and move to a safe sheltered place. By doing so, citizens can protect themselves and reduce the burdens of local emergency service agencies, therefore, eventually contribute to the emergency service outcomes at the aggregate level. However, it is not always the case that citizens cooperate with these recommendations of emergency service agencies during tornadoes even for their safety. Therefore, in this chapter, I seek to investigate the decisiveness of many determinants and motivations and how these determinants affect citizen cooperation during tornadoes.

In the following sections, I first review previous studies regarding the motivations of citizen cooperative behaviors and willingness from co-production and emergency management literature to decide the set of variables I include in the analyses. I then utilize a unique survey, the 2013 Severe Weather and Society Survey and conduct both random forest regressors and logistic regression analyses. While providing some evidence supporting the results of previous studies, the results highlight public trust in local government in the context of emergency management and social capital as motivators of citizen's co-production behavior and willingness in the context of emergency service. I find that when citizens

trust their local government to address emergencies and disasters well, they are more likely and willing to take protective actions during tornadoes. Furthermore, social capital seems to be positively associated with citizens' cooperative behaviors and willingness. However, two methods, random forest regressor, and logistic regression show somewhat nuanced evidence. I conclude this chapter with some implications for the theoretical development of citizen's co-production as well as emergency service practitioners.

3.2 Literature Review

While some scholars argue that citizens individually co-produce public service due to its compulsory characteristics of types of public service (Alford, 2009, 2002; Osborne, Radnor and Strokosch, 2016), they also voluntarily decide to get involved in the process of co-production of public service (Nabatchi, Sancino and Sicilia, 2017; Parks et al., 1981; Pestoff, 2006). Citizens frequently participate in the co-production of public service individually because of self-interests and personal benefits (Roberts, 2004; Brudney and England, 1983). However, citizen co-production driven by self-interests may produce better outcomes of public service and this eventually leads to solving public problems in the aggregate level (Fung, 2015).

While some individually co-produce public service for their self-interests or broader benefits to their community, why do others decide not to participate in the process of co-producing public service? In the context of emergency service, more specifically, why do citizens not cooperate with emergency service agencies during the time of emergencies and disasters? In this section, I first review motivation studies in citizen co-production literature.

3.2.1 Determinants of Citizen Co-production

Under the resurgence of scholarly interests in citizen co-production, there have been numerous studies investigating the determinants and motivators of citizen's behaviors and willingness to co-produce public service. While a majority of citizen co-production studies have utilized case studies (for instance, see (Alford, 2009) and (Van Eijk and Steen, 2016)), some studies have utilized quantitative methods such as traditional statistical techniques and experiments. By drawing theories and empirical findings from different disciplines such as political science, psychology, and economics to name a few, these studies have sought to understand citizen's co-production motivations and determinants in several public service areas such as education, health, and environment (Uzochukwu and Thomas, 2018; Voorberg et al., 2018; Van de Graaff, 2016; Parrado et al., 2013; Bovaird et al., 2016, 2015).

First of all, scholars have found that several socio-demographic characteristics explain the variations in citizen participation in the co-production of public service. Scholars have shown that gender, age, education, household location are likely to influence citizen's co-production activities and their willingness (Sundeen, 1988; Alford and Yates, 2016; Egerton, 2002; Parrado et al., 2013; Bovaird et al., 2016, 2015; Alonso et al., 2019). For instance, studies have found that women are more associated with individual co-production in environmental areas (Parrado et al., 2013; Bovaird et al., 2016, 2015; Alonso et al., 2019). Furthermore, these studies have found that older people are more likely to participate in individual co-production and other general civic activities (Parrado et al., 2013; Bovaird et al., 2016, 2015; Alonso et al., 2019). While scholars from other disciplines such as psychology have argued that well-educated people are more likely to

be knowledgeable about environmental issues and take actions to address them, co-production studies in public administration have empirically found that education does not make a big difference to individual behaviors and willingness to co-produce public service (Alford and Yates, 2016; Parrado et al., 2013). Additionally, scholars have found that people who live in an urban location are more negatively associated with co-production willingness particularly on environment issues (Parrado et al., 2013).

Income, race, home-ownership and whether they live with minor children have been investigated to understand citizens' behavior and willingness to co-produce public service. Scholars have argued and tested that higher income will be more associated with citizen's participation in co-production. While the effect of race can vary depending on contexts (Uzochukwu and Thomas, 2018), most prior research has shown that racial minority population is less associated with co-production behaviors and willingness (Jakobsen and Andersen, 2013). Uzochukwu and Thomas (2018) argue that residents who have minor children will not be more involved in the co-production of public service following the arguments of citizen-initiated contacting theory. However, numerous studies have shown that households with minor children and other caretakers are more likely to be cooperative with government particularly in the context of disasters and emergency management (Murphy et al., 2009; Ablah, Konda and Kelley, 2009). This shows that these variables may vary depending on the context of a specific policy area.

Scholars have also looked at some psychological factors such as self-efficacy to understand citizen's co-production behaviors and willingness (Bandura, 2013; Wise, Paton and Gegenhuber, 2012; Parrado et al., 2013; Bovaird et al., 2016, 2015; Uzochukwu and Thomas, 2018; Alonso et al., 2019). These studies have

shown that when citizens believe that they can make a change, they are more likely to be associated with the co-production of public service. Furthermore, Uzochukwu and Thomas (2018) argue that when people perceive the need for new or improved public service increase, they are more likely to co-produce public service. Individual attitudes toward government and perceived service importance have been also investigated (Bovaird et al., 2016, 2015). While there have been mixed results, these studies have shown that a positive attitude towards government performance and their interaction with citizens may be positively associated with citizen's participation in individual co-production of public service.

3.2.2 Citizen Co-production in Emergency Management

As stated, these studies mainly borrow theoretical and empirical findings and arguments from other disciplines. For instance, scholars have heavily focused on some factors previously investigated in political participation literature. However, Marschall (2004) argues that political participation and other general factors cannot entirely explain citizens' co-production of specific local public services and goods (Marschall, 2004). Factors specific to certain public service and goods should be more seriously considered. Therefore, to understand citizens' co-production of emergency service, it is imperative to consider more issue-specific factors. Scholars have argued that issue-specific factors are correlates of individual attitudes, opinions and behaviors related to certain issues (Robinson, Stoutenborough and Vedlitz, 2017; Choi and Wehde, 2019).

Given that, I also review emergency management literature particularly focusing on the motivations and determinants of individual decisions on taking protective actions during disasters such as evacuating their homes during hur-

ricanes, moving to sheltered places during tornadoes and other risk-mitigating behaviors. By reviewing this body of literature in addition to co-production studies, I expect to include a more comprehensive set of variables to understand citizen co-production particularly in the context of emergency service.

First of all, emergency management scholars have found that hazard experience is positively associated with citizens' protective actions during disasters (Mileti and Sorensen, 1990; Silver and Andrey, 2014; Bubeck, Botzen and Aerts, 2012; Siegrist and Gutscher, 2006). For instance, scholars have found that previous experience of hurricanes significantly leads citizens to cooperate with evacuation orders (Brommer and Senkbeil, 2010; Demuth et al., 2016). Furthermore, it has been observed that personal experience with previous disasters leads people to respond to current and future tornado warnings (Hodler, 1982; Simmons and Stutter, 2007). However, some scholars also find that the effect of experience is not statistically significant in shaping citizens' protective action during tornadoes (Nagele and Trainor, 2012).

Additionally, tornado warning receptions and citizen's knowledge regarding tornado warning play important roles in structuring citizens' protective action during disasters (Krocak et al., 2020; Drabek, 2012; Lindell and Perry, 2012; Mileti and Sorensen, 1990). If people do not receive tornado warnings or do not understand warnings or other relevant information, it is obvious that they are less likely to take protective actions (Balluz et al., 2000; Blanchard-Boehm and Cook, 2004). Similar to the findings in citizen co-production literature, self-efficacy is also positively associated with citizen cooperation during disasters (Bubeck et al., 2013; Grothmann and Reusswig, 2006). Sims and Baumann argue that people with higher personal efficacy are more likely to respond to a warning by taking protective actions (Sims and Baumann, 1972). However, scholars have also argued

that efficacy beliefs are mediated by information-seeking behavior, therefore, they only indirectly affect citizens' protective actions (Mileti and Fitzpatrick, 1992; Kievik and Gutteling, 2011). Risk perception has been also heavily highlighted to explain citizen's protective actions and their willingness for future disasters (Kox and Thieken, 2017; Baker, 1991; Dash and Gladwin, 2007).

Similar to citizen co-production literature, emergency management scholars have also investigated the effect of basic demographic characteristics such as gender, home-ownership, race, age, education and income (Dixon et al., 2017; Balluz et al., 2000; Blanchard-Boehm and Cook, 2004; Biernacki et al., 2008; Grothmann and Reusswig, 2006; Silver and Andrey, 2014). For instance, it has been observed that females are more likely to respond to warning messages, therefore, they either evacuate the house or shelter in safe locations (Fothergill, 1996; Comstock and Mallonee, 2005). Furthermore, highly educated people are more likely to respond to a warning message during disasters than less-educated citizens (Balluz et al., 2000; Liu et al., 1996). However, there have been also mixed findings. Some scholars have found null or very weak effects of these demographic characteristics in predicting citizens' protective actions and their willingness to respond to disastrous events (Baker, 1991; Martín, Cutter and Li, 2020; Nagele and Trainor, 2012). Finally, trust in government and social capital have seemed to structure citizens' protective actions and willingness (Fothergill, 1996; Sadri, Ukkusuri and Gladwin, 2017; Johnson and Slovic, 1995).

3.3 Data and Measurement

To investigate the relative decisiveness of various factors shaping individual protective action during tornadoes and their willingness for future events, I draw on

data from the 2013 Severe Weather and Society survey. This survey measures the perceptions, opinions and preferences of Americans regarding concerning severe weather and public policy. A total of 3,976 people in the United States participated in this online survey between May 8th and June 27th. These respondents were recruited from tornado-prone states including Alabama, Arkansas, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Mississippi, Missouri, North Carolina, Ohio, Oklahoma, South Carolina, Tennessee, and Texas. These states are commonly known as "Tornado Alley" because they consistently experience a high frequency of tornadoes each year. The study included an oversample of individuals from rural areas to avoid the urban clustering commonly associated with internet-based surveys.

However, I rely on subsets of observations for analyses. As previously stated, citizens need to learn that a tornado warning is issued before deciding whether or not to take protective action. Therefore, to investigate citizen's protective action during the previous tornado, I only focus on 1189 people who answered that they heard tornado warnings (see Table 3.1) [3]. This survey measures the perceptions, opinions and preferences of Americans regarding natural disaster issues, particularly tornadoes, perceived risks, trust in various levels of government and agencies, knowledge about tornadoes, political dispositions and other basic demographic characteristics.

The first dependent variable in this study is *protective action*. This variable indicates whether citizens previously took protective actions during tornadoes. To measure this variable, each respondent was asked if they took some kind of protective action in response to the tornado warning when they learned the tornado warning was issued. If a respondent who answered that he or she did not

[3]For citizens co-production willingness, I include a larger set of data (see Table 3.2

Table 3.1: Summary statistics for protective action as a dependent variable

Statistic	N	Mean	St. Dev.	Min	Max
Dependent variable					
Protective action	1,189	0.614	0.487	0	1
Demographics					
Rural	1,189	0.820	1.338	0	3
Home ownership	1,189	1.597	1.497	0	3
Age	1,189	44.249	15.946	18	86
Education	1,189	3.274	1.228	1	7
Male	1,189	0.481	0.500	0	1
Children	1,189	0.556	0.914	0	4
White	1,189	0.791	0.406	0	1
Income	1,189	1.550	0.762	1	4
Disaster specific variables					
Knowledge on tornado	1,189	0.820	0.384	0	1
knowledge on tornado1	1,189	3.669	1.229	0	6
Risk perception	1,189	5.800	2.118	0	10
Salience	1,189	3.807	1.997	0	8
Tornado experience	1,189	1.865	0.900	1	4
Damage experience	1,189	0.761	1.049	0	4
Trust in local emergency service agencies (ESA)	1,189	7.231	1.680	0	10
Trust in EMT	1,189	8.080	1.940	0	10
Trust in Fire Dept.	1,189	8.171	1.966	0	10
Trust in Cops	1,189	7.627	2.229	0	10
Trust in local govt.	1,189	5.045	2.499	0	10
Political and social dispositions					
Efficacy	1,189	5.604	3.052	0	10
social.capital	1,189	3.779	0.911	1	7
Trust in federal	1,189	3.513	2.619	0	10
Republican	1,189	0.285	0.452	0	1
Political ideology	1,189	4.177	1.585	1	7

Table 3.2: Summary statistics for willingness to take protective action as a dependent variable

Statistic	N	Mean	St. Dev.	Min	Max
Dependent variable					
Willing for protective action	1,838	0.900	0.300	0	1
Demographics					
Rural	1,838	0.276	0.447	0	1
Home ownership	1,838	0.532	0.499	0	1
Age	1,838	45.139	16.239	18	99
Education	1,838	3.312	1.257	1	7
Male	1,838	0.479	0.500	0	1
Children	1,838	0.501	0.882	0	4
White	1,838	0.787	0.409	0	1
Income	1,838	1.538	0.757	1	4
Disaster specific variables					
Knowledge on warning	1,838	0.819	0.385	0	1
knowledge on tornado	1,838	3.610	1.258	0	6
Tornado experience	1,838	1.760	0.860	1	4
Damage experience	1,838	0.609	0.957	0	4
Risk perception	1,838	5.389	2.229	0	10
Salience	1,838	3.467	2.009	0	8
Trust in local emergency service agencies(ESA)	1,838	7.121	1.730	0	10
Trust in EMT	1,838	7.979	2.041	0	10
Trust in Fire Dept.	1,838	8.036	2.061	0	10
Trust in Cops	1,838	7.515	2.263	0	10
Trust in local govt.	1,838	4.955	2.449	0	10
Political and social dispositions					
Efficacy	1,838	5.546	3.007	0	10
Social capital	1,838	3.755	0.890	1	7
Trust in federal	1,838	3.525	2.609	0	10
Republican	1,838	0.286	0.452	0	1
Political ideology	1,838	4.158	1.586	1	7

take any action, the respondent was coded as 0 ("no action taken"). In contrast, the respondent who answered that he or she took some kind of action in response to the tornado warning was coded as 1 ("some actions taken"). The second dependent variable is *willingness for protective action* during future tornadoes. To measure this variable, each respondent was asked if they would take some actions in response to future tornado warnings. If a respondent who answered that he or she would not take any protective action, the respondent was coded as 0 ("not willing to take"). In contrast, the respondent who answered that he or she would take some kind of action in response to the future tornado warning was coded as 1 ("willing to take").

This study includes several important demographic variables following the previous literature both in emergency management and public administration. This article includes *mender* (0=" female", 1="male"), *age* (respondent's actual age), *education* (variable ranging from 1 to 7 where 1 represents "elementary or some high school" and 7 indicates "doctorate"), *white* (race, dummy variable for White), and income (variable ranging from 1 to 4 where 1 represents "less than $ 50,000" and 4 indicates "$ 150,000 or more"). This article also includes *home-ownership* of individuals (0="do not live in their own property", 1= "live in their own property instead of renting house") and *children*, the number of children individuals live with in their household (0= "None" to 4 = "four or more"). Additionally, I include *rural*, individual household location (0="urban or suburban", 1="rural").

This study includes variables to measure disaster-specific factors regarding tornadoes such as *salience* of tornadoes in their community and previous tornado experience. To measure salience, each respondent was asked to answer how much their residence experience killer tornadoes that cause human deaths (1 =

"low number of killer tornadoes" 8 = "highest number of killer tornadoes"). To measure disaster experience, I included two ordinal variables: *damage experience* and *tornado experience*. To measure *tornado experience*, the respondents were asked to answer how many tornadoes they have personally seen while they were active (1= "none" to 4 = "more than five"). Additionally,to measure *damage experience* the respondent was asked if they or their members of family, neighbors, friends or associates ever experienced property damage, personal injury, or loss of life from a tornado (0 = "no" to 4= "yes for them personally, for family, for neighbors, for close friends or associates"). To measure *risk perception*, each respondent was asked to rate how much risk they think tornadoes impose to them and their family (from 0 = "no risk" to 10 = "extreme risk"). I also include individual knowledge regarding tornadoes (*knowledge on tornado*). The respondents were asked to answer six questions regarding common myths about tornadoes. These statements were either true or false; each question was re-coded where 1 = correct and 0 = incorrect. Based on these re-coded questions, we create a scale of individual knowledge (0 = "not knowledgeable at all" to 6 = "fully knowledgeable"). Furthermore, I also include a *knowledge on tornado warning* variable. The survey provided statements about tornado watch and tornado warning and asked respondents whether the statement explains either tornado watch or tornado warning. If the respondent answered correctly, they are coded as 1= "knowledgeable about tornado warning" otherwise 0 = "not knowledgeable about a tornado warning". Finally, as a disaster specific variable, I create a *trust in local emergency service* variable. I include this variable to measure individual trust in local actors providing emergency services such as local emergency management office, emergency medical personnel, firefighters and law enforcement. Each respondent was asked to answer how confident they are that

local government in the context of emergency management, emergency medical providers, fire departments and law enforcement agencies will meet their immediate emergency needs if they experience a natural disaster. I calculate the average score based on respondents' confidence for four local actors providing emergency service (0 = "not at all confident", 10 = "completely confident").

As a last set of variables, I include several political and social disposition variables. This set first includes *trust in federal government* variable. To measure this variable, each respondent was asked to answer how much they trust federal government to do what is right for the American people (0 =" not at all confident", 10="extremely confident"). Additionally, respondents were also asked to rate 6 statements to measure *social capital* of them. Based on these ratings, this article created a variable of social capital (1 = "lower social capital" 7 = "higher social capital"). To measure *self-efficacy*, the survey asked respondents to rate the statement which examines the fatalistic characteristics of individuals (0 = "lowest self-efficacy" 10 = "highest self-efficacy"). I included political ideology and party identification variables. For political ideology, respondents were asked to report their *political ideology* (1 = "strongly liberal" to 7 = " strongly conservative"). Based on self-identified party identification of respondents, I created a dummy variable for Republican (1= "Republican" 0= "Democrats, Independents and others"). Summary statistics are in Table 3.1 and Table 3.2 above.

3.4 Results

3.4.1 Random Forest Regression Results for Individual Co-production during Tornadoes

First, to investigate the relative decisiveness of variables to shape individual co-production during tornadoes, I conducted random forest regressors. In this analysis, I utilized the subset of data set including people who have previously heard tornado warnings in their residence. In this section, I first calculated modal rankings of variable decisiveness for individual previous co-production during tornadoes and their willingness for future co-production (see Figure 3.1 and Figure 3.3 respectively). More specifically, I look at the factors structuring individual previous cooperative action during a tornado (moved to the sheltered area during tornadoes) and their willingness to take protective actions during tornadoes in the future (willing to move to the sheltered area). Furthermore, I also provide the percentages in relative decisiveness of each explanatory variable in Figure 3.2 and Figure 3.3. While random forest regressors do not provide quantitative interpretation with these percentages in relative decisiveness, it helps us identify the clusters of decisive factors among all explanatory variables.

First, considering both Figure 3.1 and Figure 3.2, risk perception is the most decisive factor in structure individual co-production during tornadoes. Figure 3.2 particularly shows that risk perception is the most decisive factor by a notable margin (approximately 0.2 in relative decisiveness). Following the risk perception variable, the result shows that social capital and trust in local emergency service agencies are also one of the most decisive factors leading to citizens' decision on taking protective action during tornadoes by a notable margin (approximately

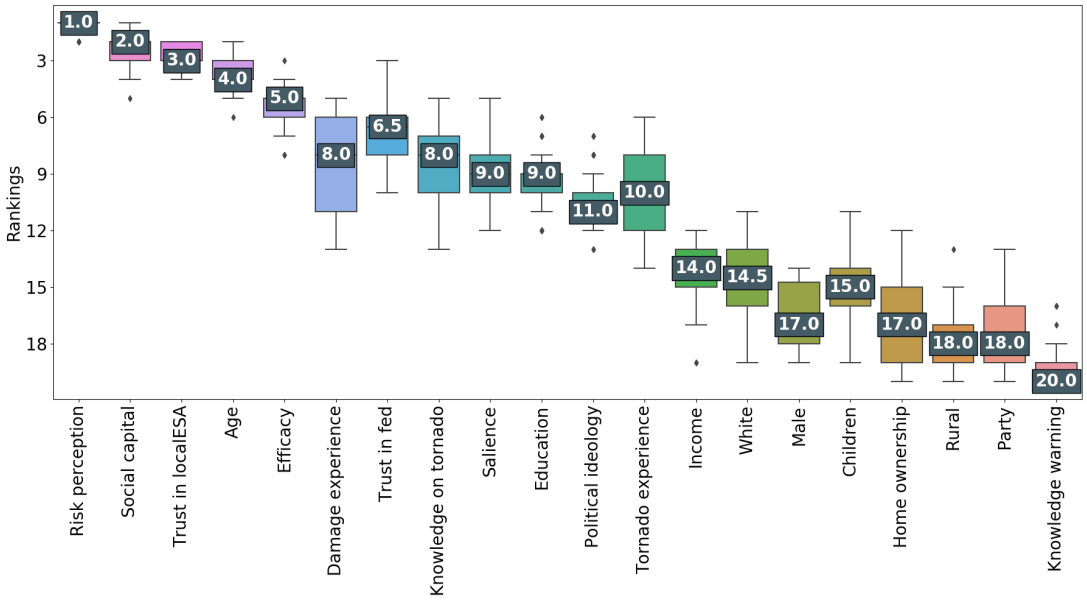

Figure 3.1: Modal rankings for relative decisiveness for previous protective action during tornadoes

0.135 and 0.11 in relative decisiveness respectively).

Similar to the previous chapter, the result shows that a majority of demographic variables are relatively decisive at the lower level except age. Trust in federal government as well as self-efficacy are also among the decisive factors in shaping individual co-production during tornadoes. Interestingly, it is trust in local emergency service agencies that is more decisive rather than trust in the federal government. This may suggest more attention to what it is about trust in local actors that makes it more salient to co-production decisions than more-distant (but, often in other situations, more salient and familiar) political characteristics like party identification.

The third set of variables, issue salience, tornado knowledge, ideology, education, damage experience and tornado experience seem to be similarly decisive at a lower level. At the lowest end, the results suggest that a majority of basic demographic factors such as the number of children, income, gender, race, party,

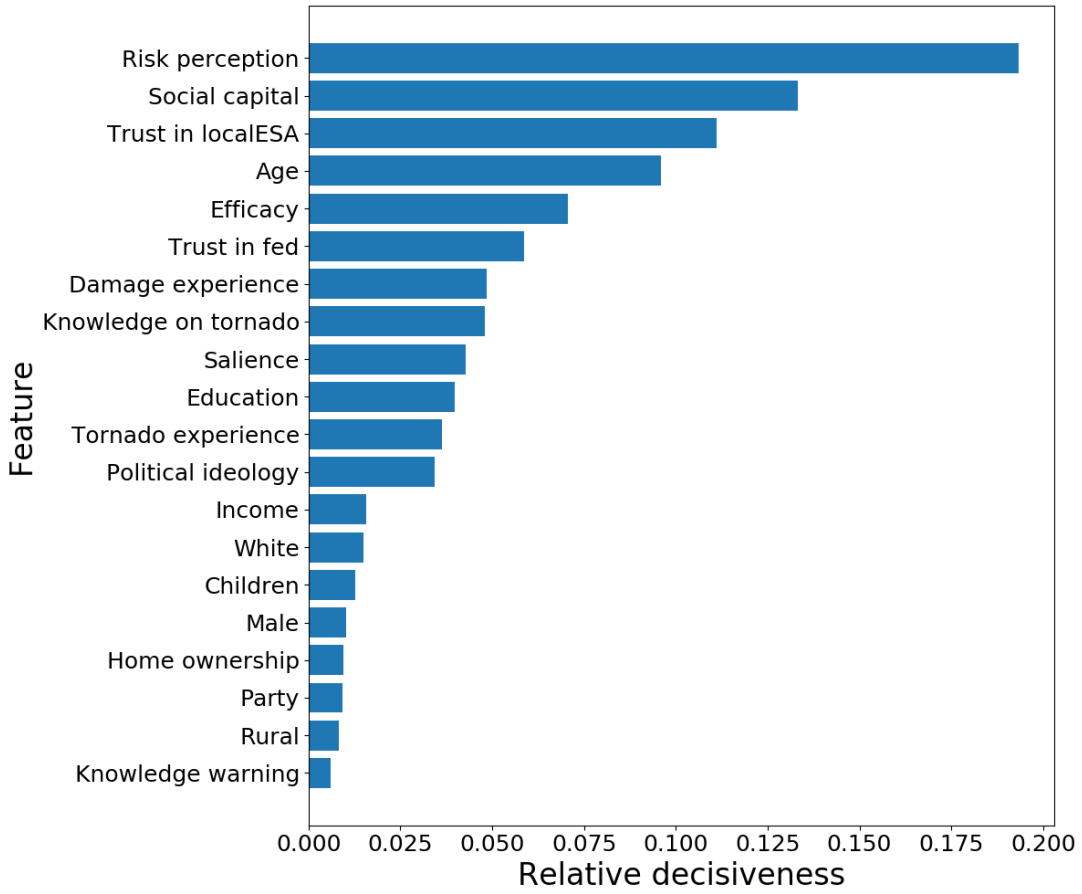

Figure 3.2: Relative decisiveness of previous protective action during tornadoes

household location, and home-ownership as well as knowledge regarding tornado warning may be associated with differences in preparedness but is not a decisive factor in predicting individual co-production during tornadoes in this analysis. While previous studies have argued that knowledge regarding tornado warning may be important for citizens to decide whether they take protective actions or not during emergencies and disaster, the analysis of random forest regressor shows that knowledge regarding tornado warning is the least decisive factor in shaping citizens' decisions on taking protective actions during tornadoes.

It should be noted that these results do not show the directions of the effect

of these variables. For instance, while we can say that public trust in local emergency service agencies plays an important role in individual co-production during tornadoes, we cannot conclude that trust in local emergency service agencies either positively or negatively affect individual co-production during tornadoes.

3.4.2 Random Forest Regression Results for Willingness for Co-production during Tornadoes

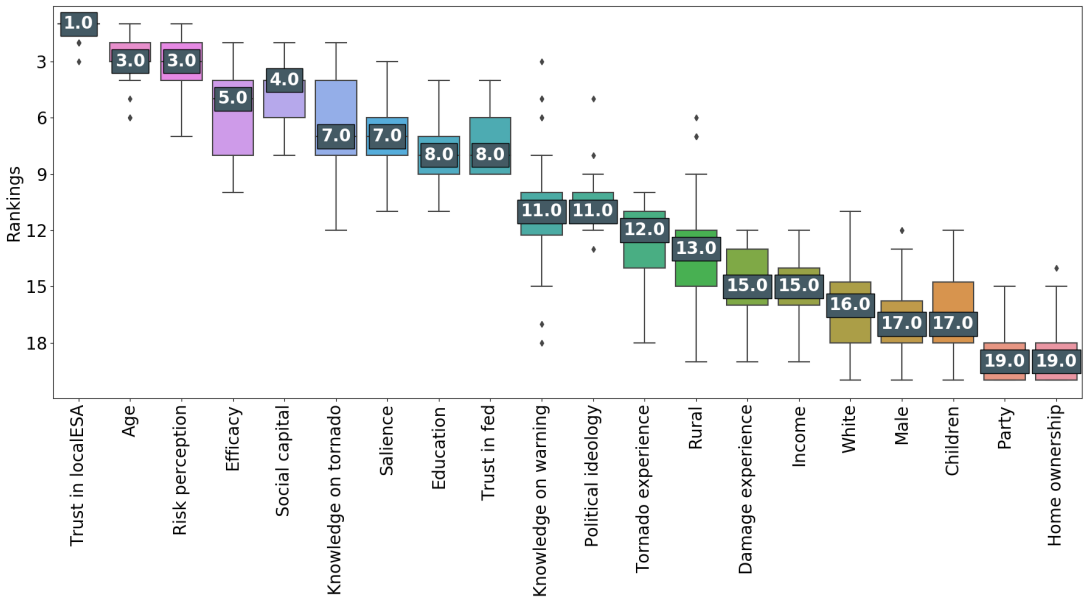

Figure 3.3: Modal rankings of relative decisiveness for willingness for taking protective actions during tornadoes

Secondly, I also utilized random forest regressor to explore the relative decisiveness of factors in shaping citizens' willingness to take protective actions during tornadoes. The results of this analysis seem to be somewhat similar to the results of individual co-production during tornadoes. when I consider both Figure 3.3 and Figure 3.4, trust in local emergency service agency is the most decisive factor to structure individual co-production during tornadoes. Figure

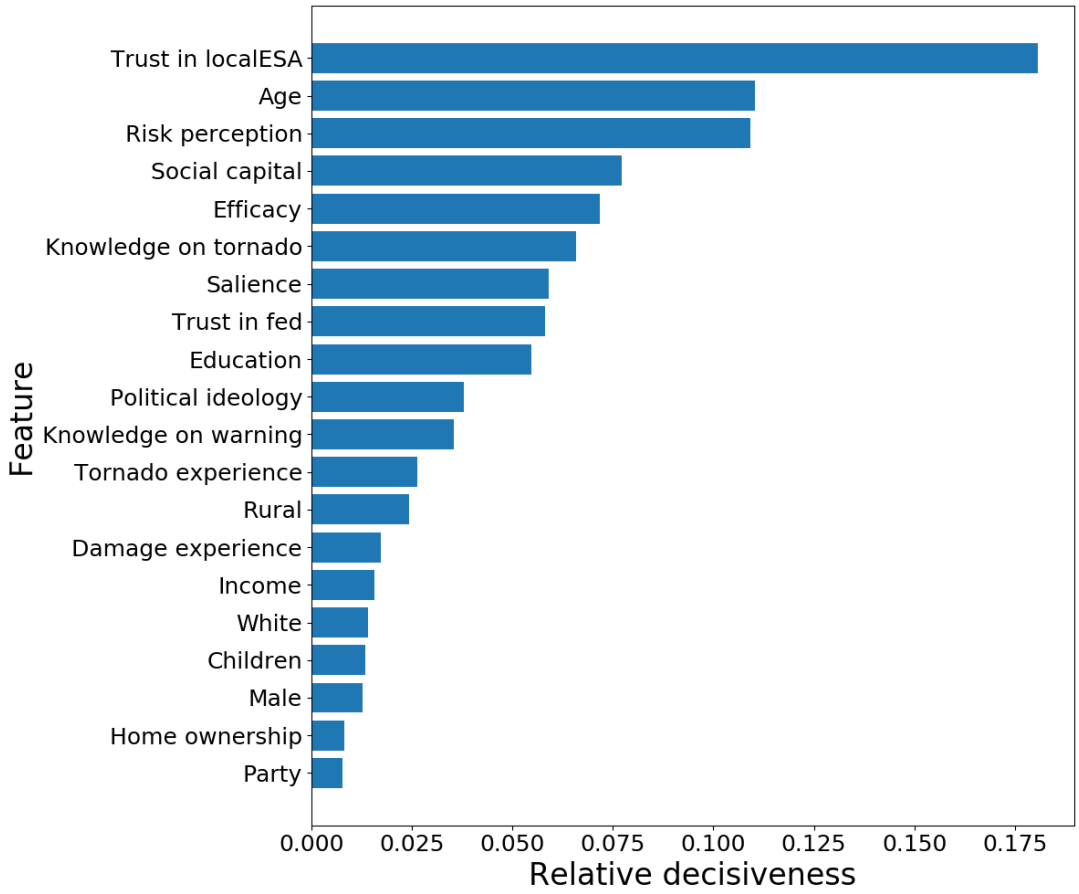

Figure 3.4: Relative decisiveness of willingness for taking protective actions during tornadoes

3.4 particularly shows that trust in local emergency service is the most decisive factor by a notable margin (approximately 0.175 in relative decisiveness). Similar to previous analyses, the result shows that trust in issue-specific agencies is much more decisive to shape citizens' willingness to co-produce than trust in general federal government.

Age and risk perception are also one of the most decisive factors leading to individual co-production during tornadoes. The relative decisiveness of age and risk perception are slightly more than 0.1. Age and risk perception were also more decisive than others in structuring citizens' previous protective actions dur-

ing tornadoes. The next set of variables are social capital, efficacy, salience, trust in federal, education and knowledge on tornado. Similar to the previous findings, a majority of basic demographic characteristics are less decisive than other variables, particularly disaster specific factors in shaping citizens willingness to take protective actions during tornadoes. Surprisingly, both tornado and damage experience do not seem to play much significant roles in shaping citizens willingness to take protective actions.

While I describe that x variable is more decisive than z variable, it should be noted that the analysis of random forest regressor do not let us know how much x is more decisive in comparison to z. Furthermore, given that I utilized multiple forests and calculates modal rankings and mean relative decisiveness of variables, while I may be able to say that one group of variables (such as age and risk perception) is definitely more decisive than the other group of variables (such as white, children and male), I cannot make a quantitative comparison between variables in a group: for instance, I cannot conclude that age is more decisive than risk perception. It should be noted that the analysis of random forest regressor should be understand in a more qualitative way rather than quantitatively.

3.4.3 Logistic regression results for citizens; protective actions during tornadoes

As previously stated, one of the limitations of the random forest regressor is that the results do not provide the directions of the relationship between the dependent variable and explanatory variables and the size of effects as well. Therefore, in this section, I take traditional statistical approaches to understand the directions of decisive factors in shaping citizens' protective actions during tornadoes.

The measurement of citizens' protective action during tornadoes is binary (if they took protective action or not during a tornado). Thus, I use standardized logistic regression to assess the determinants of individual co-production during tornadoes. A standardized logistic regression standardizes coefficients by dividing by two standard deviations and this provides more interpretable results (Gelman, 2008). Furthermore, by standardizing coefficients, it allows us to explore the relative size of coefficients of variables, which may validate or rebut the results produced by random forest regressor modelings.

Table 3.3 shows that individual co-production during tornadoes is associated with several predispositions. First, the result shows that age is negatively and significantly associated with citizens' previous protective actions during tornadoes. However, it has been also observed that Whites are more likely to take protective actions during tornadoes. While only two demographic characteristics show statistically significant associations, many of issue-specific factors and political and social dispositions seem to be associated with individual co-production during tornadoes. The results show that when people perceive higher risk associated with tornadoes, they are more likely to take protective actions during tornadoes. The standardized of coefficient for risk perception is 0.736 and it seems to have the largest effects on citizens' previous protective actions. This result supports the evidence of the random forest regression model conducted previously. The random forest regressor in the previous section showed that risk perception is the most decisive factor to shape citizens' previous protective actions during tornadoes.

While knowledge on tornado warning does not seem to be significant, knowledge on tornado is positively associated with citizens' previous protective actions during tornadoes. This indicates that when people are more knowledgeable about

Table 3.3: Standardized logistic regression for protective action during tornadoes

	Dependent variable:
	Protective action
Demographics	
Rural	−0.068 (0.049)
Home ownership	0.016 (0.049)
Age	−0.299** (0.149)
Education	0.082 (0.138)
Male	0.028 (0.131)
Children	0.141 (0.136)
White	0.407** (0.167)
Income	−0.048 (0.140)
Disaster specific variables	
Knowledge on warning	0.101 (0.165)
Knowledge on tornado	0.262** (0.129)
Risk perception	0.736*** (0.163)
Salience	−0.082 (0.164)
Tornado.experience	0.216 (0.139)
Damage.experience	0.253* (0.140)
Trust in local emergency service agencies	0.342** (0.134)
Political and social dispositions	
Efficacy	0.319** (0.129)
Social capital	0.524*** (0.135)
Trust in federal	0.277* (0.150)
Republican	0.007 (0.165)
Political ideology	−0.027 (0.152)
Constant	0.516*** (0.063)
Observations	1,189
Log Likelihood	−733.917
Akaike Inf. Crit.	1,509.834
Note:	*p<0.1; **p<0.05; ***p<0.01

the characteristics of tornadoes and things to do during tornadoes, they are more likely to take protective actions during tornadoes. Previously, the random forest regressor analysis showed that damage experience is relatively decisive at the lower level while tornado experience is relatively more decisive than others. However, the standardized logistic regression model indicates that damage experience is positively associated with citizens' previous protective actions during tornadoes while tornado experience does not explain the variations in the dependent variable.

Trust in local emergency service agencies is also positively correlated to citizens' protective actions as well as trust in federal government. It has been consistently observed that trust in local emergency service agencies affects citizens' co-production behaviors more than trust in federal government. The standardized coefficient of trust in local emergency service agencies is 0.342 and it seems to be the 4th most important variable in shaping citizens previous protective actions during tornadoes. Finally, the results indicate that social capital and efficacy seem to positively affect citizens' protective actions during tornadoes. However, other political dispositions such as party identification and political ideology do not seem to be statistically significant.

The standardized logistic regression analysis mostly support the evidence of the random forest regressor conducted in the previous section. Both models indicate that risk perception, social capital and trust in local emergency service agencies have larger effects on citizens' protective actions during tornadoes. However, they have also showed somewhat nuanced findings. For instance, while race variable (White) seems to be the third most important variable in the standardized logistic regression model, the random forest regressor analysis shows that race variable is only decisive at the lowest level. Furthermore, the results around

tornado experience and damage experience in both models are also different.

3.4.4 Logistic regression results for willingness to take protective action during tornadoes

I use a binary measure of individual willingness for co-production during tornadoes (if they would take protective action during a tornado in the future). Therefore, I use standardized logistic regression to investigate the directions of factors. The random forest regressor model in the previous section shows that trust in local emergency service agencies is the most decisive and important factor to structure citizens' willingness to take protective actions during future tornadoes. In addition, age and risk perception seem to be also one of the most decisive factors. However most of demographic variables such as household location and income are relatively decisive only at the lowest level.

In consistent with the previous analysis, the standardized logistic regression model shows that age is significantly associated with citizens' willingness to take protective actions during tornadoes. Table 3.4 indicates that older people are more willing to take protective actions if there is a tornado warning issued in the future. Other than age variable, it has been observed that household location is negatively associated with citizens' willingness. This shows that people living in rural area are less willing to take protective actions during tornadoes.

None of political and social disposition variables seems to be statistically significant except efficacy. The result shows that when people perceive higher self-efficacy, they are more willing to take protective actions during tornadoes. While the random forest regressor analysis indicates that social capital and trust in federal government are relative important than many other variables, Table

3.4 indicates that they are not statistically significant in structuring citizens' willingness for protective actions during tornadoes.

Finally, Table 3.4 indicates that several disaster specific factors are associated with individual willingness for co-production during tornadoes. When people are knowledgeable regarding tornadoes and perceive higher risks associated with tornadoes, they are more willing to take protective actions during tornadoes. However, surprisingly, when people believe that they face more killer tornadoes in their communities, they are much less willing to take protective actions during tornadoes. The coefficient of trust in local emergency service agencies is 0.412 and this shows that trust in local emergency service agencies affects citizens' willingness to take protective actions during tornadoes more than any other variables except salience variable.

3.5 Discussion

First, this chapter seeks to examine the relative decisiveness of factors in shaping individual co-production and their willingness for co-production during tornadoes by utilizing a relatively uncommon machine learning technique- random forest regressor. In particular, I focused on whether citizens took protective actions by moving to a sheltered area during tornadoes and if they are willing to do the same action in future tornado situations as a form of individual co-production of emergency service. I found the similar patterns of relative decisiveness of explanatory factors in shaping individual co-production and their willingness during tornadoes. Random forest regressor analyses show that public trust in local emergency service agencies, age, social capital and risk perception are the most decisive factors in shaping individual co-production during tornadoes. The re-

Table 3.4: Standardized logistic regression for willingness for protective actions during tornadoes

	Dependent variable:
	Willingness for protective action
Demographics	
Rural	-0.320^{*} (0.177)
Home ownership	-0.210 (0.181)
Age	0.378^{**} (0.185)
Education	-0.043 (0.172)
Male	-0.228 (0.162)
Children	0.259 (0.179)
White	0.191 (0.204)
Income	0.238 (0.186)
Disaster specific variables	
Knowledge on warning	-0.235 (0.154)
Knowledge on tornado	0.264^{*} (0.159)
Risk perception	0.364^{*} (0.207)
Salience	-0.496^{**} (0.209)
Tornado experience	0.149 (0.177)
Damage experience	0.185 (0.184)
Trust in local emergency service agencies	0.412^{***} (0.157)
Political and social dispositions	
Efficacy	0.335^{**} (0.162)
Social capital	-0.033 (0.164)
Trust in federal	0.093 (0.183)
Republican	0.041 (0.214)
Democrats	0.123 (0.200)
Political ideology	0.106 (0.189)
Constant	2.305^{***} (0.084)
Observations	1,867
Log Likelihood	-583.482
Akaike Inf. Crit.	1,210.964
Note:	*p<0.1; **p<0.05; ***p<0.01

sult also shows that public trust in local emergency service agencies, age, social capital and risk perception are the most important factors structuring individual willingness for co-production during tornadoes. While emergency management scholars have heavily focused on demographic factors such as gender and race, the analyses here indicate that most of the demographic characteristics and some of the political disposition such as party identification and political ideology may be associated with differences in individual cooperation with emergency service agencies and their willingness for future cooperation but are not decisive factors in predicting individual cooperative behaviors during tornadoes.

In addition to random forest regression analyses, I took traditional statistical approaches and conducted logistic regression analyses to examines the effect of these decisive factors in shaping individual co-production and their willingness for future cooperation during tornadoes. This is because, while random forest regressor provides interesting information regarding the role of factors, it does not provide the directions of factors in shaping the dependent variables. According to the logistic regression analyses in this chapter, when people trust local emergency service agencies more, they are more likely and willing to take protective actions during tornadoes. Furthermore, when people perceive higher risks associated with tornadoes, they are more likely and willing to take protective actions during tornadoes. Finally, older people and people perceive higher social capital are more likely to take protective actions during tornadoes. However, the result shows that people are less willing to take protective actions during tornadoes when they perceive higher social capital.

One interesting finding here is that random forest regressor and logistic regression analyses have shown a contrasting result. For instance, random forest regressor analyses show that social capital is one of the most decisive factors

in shaping individual willingness for co-production during tornadoes. However, the results of logistic analyses show that the size of social capital coefficient is very small and it is not significantly associated with individual willingness for co-production during tornadoes. This contrasting result suggests further investigation in the logistic regression analysis using different methods such as Bayesian logistic regression to understand the uncertainty of this model.

The results here have important implications for understanding what factors are the most decisive in shaping individual co-production during tornadoes. First, Previous studies in public administration, particularly co-production literature have heavily focused on more general political dispositions such as trust in the federal government. However, the analyses here show that trust in issue-specific agencies is a more important factor in shaping individual co-production and willingness for co-production during tornadoes. Furthermore, the results of random forest regressor highlight the importance of social capital. While scholars have emphasized the role of social capital in citizen's collective co-production (Ostrom, 1972; Ostrom and Ahn, 2009; Bovaird, 2007), there has not been much literature focusing on the role of social capital in shaping individual co-production behaviors and willingness (Voorberg, Bekkers and Tummers, 2015). The results of this chapter suggest to consider social capital more seriously to understand individual co-production behaviors and willingness. Finally, this chapter also shows that issue-specific factors may be more important than general demographic characteristics. While scholars have looked at some issue-specific factors such as service importance or issue salience, they have focused on more general factors. This analysis indicates that individual co-production of specific public service may be more associated with specific characteristics of those service and service areas. This provides implications for scholars regarding their model buildings.

In the next chapter, I intend to examine the motivations and determinants of collective co-production. To that end, I look at various factors in shaping individual willingness to participate in collective co-production during and after tornadoes.

Chapter 4. Abstract

While scholars have criticized co-production literature mainly due to its limited ability to produce systematic and generalizable research, one of the meaningful and consistent findings in co-production literature is that the level of individual co-production is substantially higher than collective co-production. Scholars have found that citizens are more likely and more willing to participate in co-production activity when the action required in the co-production process is relatively easy and carried out individually, rather than collectively. However, it has been argued that much of the potential benefits from co-production are more likely to occur from collective activities than individual co-production of public service. Therefore, in this chapter, I seek to reveal how scholars and practitioners can promote citizens' willingness to co-produce public service. To that end, I investigate the relative decisiveness of various factors, previously examined, in shaping citizens' willingness to collectively co-produce emergency service particularly in the context of tornadoes. In this chapter, I argue that social capital is the key to structure citizens' willingness to collectively co-produce emergency service. Utilizing a unique public survey, I conduct a random forest regressor, a machine learning technique to calculate the relative decisiveness of factors in shaping citizens' willingness for collective co-production. Furthermore, I conduct an standardized ordered probit regression to examine the directions of the effects

of the most decisive factors. The results of analyses indicate that social capital is the most decisive factor to shape citizens' willingness to co-produce emergency service in the context of tornadoes via both government and nongovernment-led organizations

Keywords Citizen co-production, Collective co-production, Emergency management, Machine learning, random forest regression, CERT

Chapter 4

Decisiveness of Social Capital in Collective Co-production in Emergency management

4.1 Introduction

Co-production scholars have argued that citizens as public service co-producers may contribute to the process of public service provision and delivery (Brudney, 1983; Ostrom, 1972). In this process, citizens can co-produce public service via contributing their knowledge, resources such as time, money and effort, compliance and cooperation, ideas and creativity (Loeffler and Bovaird, 2016). Professional public service providers are often government agencies particularly at the local level, however, other actors such as non-profit, non-government and for-profit organizations may play a role as professional public service providers (Nabatchi, Sancino and Sicilia, 2017).

Scholars have often categorized citizen co-production into three levels: indi-

vidual, group and collective co-production (Brudney and England, 1983; Nabatchi, Sancino and Sicilia, 2017). According to this categorization, while citizens individually participate in co-production for private benefits in individual co-production, collective co-production requires collective actions of citizens and the benefits resulted from co-production can be enjoyed by the entire community. It should be noted that citizens may participate in individual benefits, however, their participation leads to better public service outcomes and it eventually contributes to solving the social problems in community (Fung, 2015). Additionally, group co-production refers to where citizens participate in co-production collectively for benefits only shared by the participants in the co-production process. Some scholars have considered group co-production as a part of collective co-production due to the difficulties to distinguish the boundaries of co-production benefits (Bovaird et al., 2016).

While scholars have criticized co-production literature mainly due to its limited ability to produce systematic and generalizable research (Jo and Nabatchi, 2016; Brandsen and Honingh, 2016), one of the meaningful and consistent findings in co-production literature is that level of individual co-production is substantially higher than collective co-production (Bovaird et al., 2016; Löffler et al., 2008; Parrado et al., 2013). Scholars have found that citizens are more likely and more willing to participate in co-production activity when the action required in the co-production process is relatively easy and carried out individually, rather than collectively (Löffler et al., 2008; Parrado et al., 2013; Bovaird et al., 2016; Alford and Yates, 2016).

However, it has been also argued that much of the potential benefits from co-production are more likely to occur from collective activities than individual co-production of public service (Pestoff, 2012; Bovaird et al., 2016). Therefore,

it is imperative to understand the determinants and motivations of collective co-production and seek to promote it in public service delivery. However, a majority of citizen co-production studies, particularly using quantitative methods have heavily focused on individual co-production and its determinants and motivators Parrado et al. (2013); Uzochukwu and Thomas (2018); Voorberg et al. (2018). Therefore, in this chapter, I seek to investigate the determinants and motivations of citizens' willingness to participate in collective co-production of emergency service, among many public services, particularly in the context of tornadoes.

Citizens may contribute to emergency service provision and delivery for several ways, First, at the individual level, citizens may provide information about emergencies and damages near their residence and other related situations regarding emergency service to their local emergency managers (Stallings and Quarantelli, 1985; Díaz, Carroll and Aedo, 2016). Furthermore, citizens may also contribute to emergency service provision by taking certain actions based on recommendations and orders of emergency service agencies during disasters. At the collective level, citizens may contribute to emergency service provision by joining government and non-government-led groups such as Community Emergency Response Team (CERT). CERT operated by FEMA and local governments train citizens as first responders to respond to emergencies before the professional service providers (e.g. emergency medical personnel, police officers and firefighters in addition to emergency managers) arrive at the venue of emergencies. After the completion of this program, citizens are expected to help themselves, their family and their neighbors during and after disasters. Furthermore, CERT provides citizens opportunities for working with emergency managers and first responders in the events of emergencies and disasters. Through this program, depending on the jurisdictions, citizens are trained to assist professional first responders in the

course of emergency response by doing various activities such as collecting data, transporting necessary items, safely evacuating people in the events of disasters and emergencies. Furthermore, citizens can co-produce emergency service by working with non-governmental groups as public service providers. Citizens can volunteer for these groups and work with them to respond to and recover from emergencies and disasters (Mees et al., 2016; Stallings and Quarantelli, 1985). In this chapter, I seek to understand why and why not citizens are willing to participate in these government and nongovernment-led groups collectively for better emergency service outcomes.

To the best of my knowledge, there have been very few studies empirically investigating determinants and motivations of citizen collective co-production behaviors and willingness by utilizing quantitative methods in public administration (Bovaird et al., 2016, 2015). Furthermore, scholars in emergency management have also mainly focused on either individual or household behaviors in the course of emergency management (Murphy, Greer and Wu, 2018; Ablah, Konda and Kelley, 2009; Choi and Wehde, N.d.). Additionally, while looking at citizen collective co-production, scholars have simply extrapolated the determinants and motivations of individual co-production such as basic demographics and attitudes and see how those factors affect citizen's collective co-production behaviors and willingness (Bovaird et al., 2016, 2015). In these studies, scholars have mainly focused on basic socio-demographic factors and citizens' attitudes toward government and public service in their community.

Given the lack of empirical and theoretical research on determinants and motivations of collective co-production, following these previous studies, I also intend to include and examine the factors previously investigated to understand individual co-production behaviors and willingness to co-produce public service.

However, in addition to them, I argue that social capital should be highlighted to explain the variations in citizen collective co-production behaviors and willingness.

Social capital refers to the "network, norms, and social trust that facilitate coordination and cooperation for mutual benefits" (Putnam, 2001). In the canonical work in co-production literature, Ostrom (1996) argues that social capital plays a critical role in collective actions. She argues that social capital enhances the trust in society and trust may in turn achieve collective actions and its benefits (Ostrom and Ahn, 2009; Bovaird et al., 2016). According to this argument, social capital may be a key factor to lead citizens to participate in collective co-production. While scholars have recognized the importance of social capital to fully understand citizen co-production, there has been insufficient studies taking social capital into their quantitative models (Voorberg, Bekkers and Tummers, 2015). Therefore, I include social capital as a key factor in addition to other variables and see the importance of it in structuring citizens' willingness to co-produce emergency service in the context of tornadoes.

To summarize, I investigate how decisive various factors are in shaping citizens' willingness to participate in CERT and other nongovernment-led groups to co-produce emergency service by utilizing a random forest regressor. Random forest regressor is an ensemble machine learning technique that allows us to calculate the relative decisiveness of variables without requiring strong parametric assumptions and issues related to high correlation among explanatory variables. By utilizing a random forest regressor, I expect to examine the relative importance and decisiveness of social capital among many variables previously discussed in co-production literature in shaping citizens' willingness to co-produce emergency service. Additionally, I also conduct ordered probit regressions to see the direc-

tion of variable effects given the limited information random forest regressor can provide.

In the following section, I first review previous studies regarding determinants and motivations of citizen co-production. Given the lack of existing studies, I draw empirical studies mostly from individual co-production literature. Furthermore, I demonstrate why I intend to consider social capital as a key factor in this chapter. I then explain a data set, a public survey conducted via Amazon's Mechanical Turk (MTURK). This survey asks questions about citizen's willingness to co-produce emergency service in collaboration with government and non-governmental actors, their attitudes towards government and public service, demographic characteristics and some issue-specific factors. In this chapter, while the level of citizens' willingness to collectively co-produce emergency with the government (via CERT) is slightly but significantly higher than their willingness to collectively co-produce with non-government groups, I found that social capital among many other factors is the most decisive factor to structure citizen's willingness to co-produce emergency service in the context of tornadoes in collaboration with both government and non-governmental public service providers. I end with a discussion of the implications, limitations, and contributions of this study.

4.2 Literature Review

4.2.1 Citizen co-production and its effects in public service delivery

In the late 1970s and the early 1980s, Ostrom and other public administration scholars introduced the concept of co-production to the field of public administration as an alternative to the predominance of centralized bureaucracies in public administration (Ostrom, 1972). It did not attract much attention in the 1990s, however, scholarly interests in co-production have been resurgent under the importance of collaborative efforts among public, private, non-governmental actors as well as citizens and community members (Alford, 1998; Osborne et al., 2010; Osborne, Radnor and Strokosch, 2016; Bryson, Crosby and Bloomberg, 2014).

Co-production has become a broad umbrella term for all kinds of citizen's involvement in any stages of public service and scholars used it interchangeably in literature (Nabatchi, Sancino and Sicilia, 2017; Verschuere, Brandsen and Pestoff, 2012; Osborne and Strokosch, 2013). For instance, some scholars have used the term of co-production to describe citizen's involvement in the policy design stage when others use co-production for citizen's involvement in public service delivery. Recently, scholars have also tried to distinguish co-production from co-construction, co-policy planning or co-prioritization and co-creation to reduce the confusion (Voorberg, Bekkers and Tummers, 2015; Verschuere, Brandsen and Pestoff, 2012; Brandsen and Pestoff, 2006). Under this circumstance, in this chapter, I remind that I particularly focus on co-production in the stage of public service delivery, rather than in policy design and policy evaluation to reduce possible confusion.

While scholars have defined co-production in many different ways, citizen co-production is typically defined as the contribution of resources by citizens as public service consumers and service providers in the process of public service delivery (Brudney, 1983). Public service providers are often government, particularly at the local level, however, other actors such as non-governmental organizations can be co-producers of public service (Nabatchi, Sancino and Sicilia, 2017). In the process of public service delivery, citizens can co-produce public service via contributing their knowledge, resources such as time, money and effort, ideas and creativity (Loeffler and Bovaird, 2016). Besides, citizens can contribute to the public service delivery process by cooperating with public service providers in carrying out public service programs (Whitaker, 1980; Vanleene, Voets and Verschuere, 2018). Scholars argue that citizen's voluntary participation and their cooperative actions contribute to public service provision and delivery (Nabatchi, Sancino and Sicilia, 2017; Parks et al., 1981; Pestoff, 2006). However, some scholars also argue that citizens' compliance is also a contribution that citizens can make in the process of public service delivery (Alford, 2002; Osborne, Radnor and Strokosch, 2016).

4.2.2 Three levels of citizen co-production

Scholars have sought to create typologies of co-production. Brudney and England (1983) initially suggested three levels of co-production based on whether citizens individually or collectively participate in co-production and whether the benefits resulted from co-production are enjoyed individually or collectively. First, in individual co-production, citizens participate in co-production individually. Citizens often participate in individual co-production compulsorily (Osborne and

Strokosch, 2013; Alford, 2009), however, they also co-produce public service voluntarily because they would be the consumers of this public service as well. Through individual co-production, citizens who co-produce public service obtain the benefits from this process. Common examples of individual co-production include clients working with health service providers (Clark and Fairlie, 2015; Jo and Nabatchi, 2019; Cepiku and Giordano, 2014). Community members preparing for emergencies and taking protective actions during tornadoes by following recommendations suggested by emergency service providers are cases of individual co-production in the context of emergency management.

In group co-production, a group of citizens participates in co-producing public service for their benefits. In group co-production, citizens collectively co-produce public service with public service providers and the benefits from the co-production process are shared by those who participate in this process. Citizens collectively participate in the co-production of public service as they do in group co-production. However, the difference between group co-production and collective co-production is that the benefits collectively produced via collective co-production process can be enjoyed by the entire community. The benefits are not limited to those who participate in the co-production process, but the entire community can share them (Brudney and England, 1983; Bovaird et al., 2016). A common example in collective co-production is citizen's participation in neighborhood watch programs. Citizens and community members participate in neighborhood watch programs to combat crime in their community and their participation benefits not only them but for the entire community by providing a safer environment of their community (Goldstein, 1977; Innes et al., 2011; Sabet, 2014). While Brudney and England in 1983 initially suggested three levels of citizen co-production, some scholars consider group co-production as a part of

collective co-production (Bovaird et al., 2015, 2016). This is mainly because it is often hard to examine if the benefits from collective co-production are solely shared by those who participate in this process.

Scholars have found that the level of individual co-production is significantly higher than the level of collective co-production. It has been observed that citizens are more likely to participate in co-production activity when the action required in co-production is relatively easy and carried out individually (Löffler et al., 2008; Parrado et al., 2013; Bovaird et al., 2016). Furthermore, Bovaird and his colleagues have also found that the motivations and determinants of collective co-production of citizens are somewhat different from those of individual co-production.

While citizens tend to participate in individual co-production of public service more, scholars have found that the potential benefits from co-production are more likely to come from collective activities than individual-level activities (Pestoff, 2012; Bovaird et al., 2016, 2015). Under this circumstance, it is important to understand the motivations and determinants of collective co-production, therefore, we can promote collective co-production of public service for better policy outcomes.

4.2.3 Motivations of citizen co-production

Why do citizens initially decide to get involved in the process of co-production of public service? Scholars have recently investigated the motivators of citizen's behaviors and willingness to co-produce public service drawing theories and arguments from different bodies of literature in political science, public administration and economics (Uzochukwu and Thomas, 2018; Voorberg et al., 2018;

Van de Graaff, 2016). Given the lack of literature examining the determinants and motivations of citizens' collective co-production behaviors and willingness, in this section, I review the individual level co-production motivation studies.

First of all, scholars have found that several socio-demographic characteristics explain the variations in citizen participation in the co-production of public service. Scholars have shown that gender, age, education, household location are likely to influence citizen's co-production activities and their willingness (Sundeen, 1988; Alford and Yates, 2016; Egerton, 2002; Parrado et al., 2013; Bovaird et al., 2016, 2015; Alonso et al., 2019). For instance, studies have found that women are more associated with individual co-production in environmental areas (Parrado et al., 2013; Bovaird et al., 2016, 2015; Alonso et al., 2019). Furthermore, these studies have found that older people are more likely to participate in individual co-production and other general civic activities (Parrado et al., 2013; Bovaird et al., 2016, 2015; Alonso et al., 2019). While scholars from other disciplines such as psychology have argued that well-educated people are more likely to be knowledgeable about environmental issues and take actions to address them, co-production studies in public administration have found that education does not make a big difference to individual behaviors and willingness to co-produce public service (Alford and Yates, 2016; Parrado et al., 2013). Additionally, scholars have found that people who live in an urban location are more negatively associated with co-production willingness particularly on environment issues (Parrado et al., 2013).

Income, race, home-ownership and whether they live with minor children have been investigated to understand citizens' behavior and willingness to co-produce public service. Scholars have argued and tested that higher income will be more associated with citizen's participation in co-production. While the

effect of race can vary depending on contexts (Uzochukwu and Thomas, 2018), most prior research has shown that racial minority population is less associated with co-production behaviors and willingness (Jakobsen and Andersen, 2013). Uzochukwu and Thomas (2018) argue that residents who have minor children will not be more involved in the co-production of public service following the arguments of citizen-initiated contacting theory. However, numerous studies have shown that households with minor children and other caretakers are more likely to be cooperative with government particularly in the context of disasters and emergency management (Murphy et al., 2009; Ablah, Konda and Kelley, 2009). This shows that these variables may vary depending on the context of a specific policy area.

Scholars have also looked at some psychological factors such as self-efficacy to understand citizen's co-production behaviors and willingness (Bandura, 2013; Wise, Paton and Gegenhuber, 2012; Parrado et al., 2013; Bovaird et al., 2016, 2015; Uzochukwu and Thomas, 2018; Alonso et al., 2019). These studies have shown that when citizens believe that they can make a change, they are more likely to be associated with the co-production of public service. Furthermore, Uzochukwu and Thomas (2018) argue, based on citizen-initiated contacting theory, that when people perceive the need for new or improved public service increase, they are more likely to co-produce public service. Individual attitudes toward government and perceived service importance have been also investigated (Bovaird et al., 2016, 2015). While there have been mixed results, these studies have shown that a positive attitude towards government performance and their interaction with citizens may be positively associated with citizen's participation in individual co-production of public service.

In addition to these factors in co-production literature, I argue that issue-

specific variables should be more seriously considered when it comes to the motivators and determinants of citizen participation in the co-production of a specific public service. Scholars have argued that issue-specific factors are correlates of individual attitudes, opinions and behaviors related to certain issues (Robinson, Stoutenborough and Vedlitz, 2017; Choi and Wehde, 2019). For instance, it is reasonable to expect that citizens will be more involved in the co-production of emergency services when they have previous experience with emergencies. Scholars in emergency management literature have shown that citizens are more likely to prepare for emergencies when they previously experience disasters such as earthquakes, hurricanes and tornadoes (Murphy, Greer and Wu, 2018). Furthermore, when citizens perceive certain issues riskier and dangerous, they may be more likely to contribute to addressing those issues (Murphy, Greer and Wu, 2018; Maestas et al., 2018). Therefore, I argue that several issue-specific variables regarding a certain public service should be included in co-production studies.

4.2.4 Citizen collective co-production and Social Capital

While previous studies have significantly contributed to our understanding of motivations and determinants of citizen co-production, these studies are somewhat limited in the sense that they primarily look at the motivations and determinants of citizens' co-production. There have been insufficient studies investigating why citizens collectively participate in the co-production process of public service and their willingness for future co-production. While sets of variables previously investigated to understand individual co-production may play important roles in explaining the variations in collective co-production among citizens, factors more specific to collective actions may be included to understand citizen collective

co-production.

In this chapter, I argue that social capital may be a key factor in structure citizen collective co-production behaviors and willingness. Social capital often refers to the "networks, norms, and social trust that facilitate coordination and cooperation for mutual benefits" (Putnam, 1995). Scholars have argued that social capital can facilitate individual or collective actions (Coleman, 1988). Ostrom (1996) argues that social capital is required to fulfill the promises of collective action. She argues that social capital measured by trustworthiness, network and institution can enhance the trust in society and this trust can achieve collective action and its benefits (Ostrom and Ahn, 2009). Scholars in other disciplines have also found that social capital leads to individuals to participate in collective actions such as volunteering (Martikke et al., 2019). However, It should be noted that there is a reciprocal relationship between collective action and social capital. While social capital may encourage collective actions in society, collective actions, in turn, helps developing more social capital as well as (Pestoff, 2012; Fox, 1997; Bovaird et al., 2016). According to these arguments, it is reasonable or even necessary to consider the role of social capital in structuring collective co-production of public service among citizens. However, Voorberg and his colleagues (2014) have found that only 30 percent of studies focus on social capital in shaping citizens' co-production behaviors and willingness. Under this circumstance, in this chapter, I seek to understand, in addition to other factors, the decisiveness of social capital in shaping individual collective co-production.

4.3 Data and Measurement

4.3.1 Survey design

To investigate the determinants and motivations of citizen collective co-production of emergency service, I designed and conducted a public survey. Respondents were invited to participate in this survey between September 3 and December 11, 2019. In this chapter, I look at collective co-production of emergency service in the context of tornadoes, therefore, I restricted the sample based on geographic location and only those who live in a tornado-prone region, commonly known as Tornado Alleys were allowed to participate. A total of 500 participants living in tornado-prone areas from Alabama, Arkansas, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Mississippi, Missouri, North Carolina, Ohio, Oklahoma, South Carolina, Tennessee, and Texas were recruited for this survey. This survey measures the perceptions, opinions and behaviors of Americans regarding their willingness to collective co-produce emergency service, natural disaster issues, particularly tornadoes, perceived risks, trust in emergency management authorities, social capital, political dispositions and other basic demographic characteristics. By utilizing this data, I seek to understand what factors primarily shape community members' collective co-production of emergency service in the context of tornadoes.

For this survey, I recruited survey participants via Amazon's Mechanical Turk (MTurk). Among scholars, it has been discussed that MTurk data is not fully demographically representative when it compares to a demographic representation sample of the United States. In fact, as Table 4.1 shows, my respondents are more white, male, have more education and are more politically liberal than what would be expected in the average population in the United States. Therefore, it

must be noted that the generalizability of this is limited.

Table 4.1: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Max
Dependent variables					
Willingness_CERT	445	3.243	1.107	1	5
Willing_Volunteering	445	3.025	1.182	1	5
Willingness_Collective	445	3.321	0.950	1	5
Demographics					
Rural	445	0.218	0.413	0	1
Age	445	36.310	10.897	18	78
High.school	445	0.991	0.094	0	1
College	445	0.638	0.481	0	1
Graduate	445	0.173	0.379	0	1
Female	445	0.454	0.498	0	1
Children	445	0.454	0.498	0	1
White	445	0.764	0.425	0	1
Income	445	3.524	1.592	1	7
Employment	445	0.894	0.308	0	1
Home ownership	445	0.474	0.500	0	1
Disaster specific variables					
Personal experience with tornadoes	445	0.616	0.487	0	1
Community experience with tornadoes	445	0.636	0.482	0	1
Risk perception	445	4.800	2.238	0	10
Salience	445	3.519	1.808	1	8
Emergency service importance	445	7.422	2.470	0	10
Trust in local	445	6.987	2.288	0	10
Political and social dispositions					
Social capital	445	4.202	0.972	2	7
Trust in federal	445	5.715	2.640	0	10
Efficacy	445	5.526	2.592	1	10
Republican	445	0.317	0.466	0	1
Democrat	445	0.425	0.495	0	1
Political ideology	445	3.667	1.881	1	7

4.3.2 Measurement

To understand citizens' motivation for collective co-production in emergency service delivery, I include three dependent variables. First, the willingness to participate in the Community Emergency Response Team (CERT) was included. Each respondent was asked how much they are willing to participate in the Community Emergency Response Team (CERT) which educates community members about disaster preparedness and trains them to play a role as first responders for their family and neighbors before professionals arrive at the venue of emergencies (1="not at all", 5 ="a great deal") to measure this variable. The second dependent variable is "willingness to volunteer for organized groups". To measure this variable, each respondent was asked how much they are willing to become a member of nongovernmental organized groups to help with addressing emergencies (1="not at all", 5 "a great deal"). Both of these activities are types of collective co-production of emergency service, however, the emergency service providers community members work with vary. For instance, community members collectively co-produce emergency service with nongovernmental organized groups by volunteering for those groups while community members work with local emergency management authority via CERT. Finally, I create a "willingness for collective co-production" variable. This is an index variable calculated based on two measurements "willingness to volunteer for nongovernmental organized groups" and "willingness to participate in Community Emergency Response Team (CERT)". I seek to investigate the motivations of overall collective co-production willingness by including this dependent variable in this chapter. Based on these three dependent variables, I conduct three analyses respectively.

This study includes several important demographic variables following the

previous literature both in emergency management and public administration. This article includes gender (1=“ female”, 0=” male”), age (respondent’s actual age), education (dummy variable for high school, college and graduate education), race (dummy variable for White), and income (variable ranging from 1 to 4 where 1 represents “less than $ 25,000” and 7 indicates “$ 150,000 or more”). This article also includes home-ownership of individuals (0=” do not live in their property”, 1= “live in their property instead of renting a house”), the number of children individuals live with (0= “none” to 4 = “four or more”) and rural, individual household location (0=“urban or suburban”, 1=“rural”). Finally, I include employment status (0= “not employed”, 1= “part-time” and 2=“full time”).

In this chapter, I include variables to measure issue-specific factors such as service importance, risk perception, issue salience and disaster experience. To measure service importance, each respondent was asked to answer how important they think emergency service is at their residence (from 0= “not at all important” to 10=“extremely important”). For risk perception, I asked respondents to answer the question of “Using a scale from zero to ten, how do you rate the overall risk to you and your family from tornadoes? (from 0= “no risk” to 10=“extreme risk”). Additionally, to measure the perceived salience of tornadoes, respondents were asked to answer the question of “ Assuming zone - 0 experiences the lowest number of ”killer tornadoes” and zone-8 experiences the highest number of ”killer tornadoes”, in which zone do you think your primary residence is located (from 1=“no killer tornadoes” to 8=“highest number of killer tornadoes”). Finally, I include two variables to measure disaster experience. First, the respondents were asked to answer if they have had personal experience with tornado damages in their residence (damage experience 1= “personally experienced tornado

damages", 0 = " no personal experience). Also, I asked respondents if tornadoes have ever hit their community since they started living in your community (community experience 1= "Yes", 0 = "no"). I expect to measure both experiences of tornadoes and experience of tornado damages which are different from each other. Finally, to measure self-efficacy in the context of disasters, I ask respondents two questions about their perceived efficacy during and after emergencies. Each respondent was asked how much of a difference they believe that they can make if they go out to help their neighbors during and after emergencies (from 0="no difference" to 10= " extreme difference"). Based on these two questions, I calculated the average scores of these two variables and created an average efficacy variable.

I, finally, include several measures of political and social predispositions. First, I included political ideology and party identification variables. Respondents were asked to report their political ideology (1 = "strongly liberal" to 7 = " strongly conservative") and party identification (Republican, Independent, or Democrats). Based on this I created dummy variables for Republicans and Democrats. Also, I include public trust in the federal government variable. To measure this variable, each respondent was asked to answer how confident they are that FEMA, the federal agency for emergency management, will provide effective assistance to you and your community if you experience a natural disaster (0 =" not at all confident", 10="completely confident"). Additionally, I create public trust in local government variable. I include this variable to measure individual trust in the local emergency management office. Each respondent was asked to answer how confident they are that the local emergency management office will address emergencies such as tornadoes for your community (from 0= "not at all confident" to "completely confident"). Finally, respondents were also asked to rate 6

statements to measure the social capital of them. Based on these ratings, this article created a variable of social capital (1 = "lower social capital" 7 = "higher social capital").

4.4 Results

4.4.1 Results of random forest regressor models

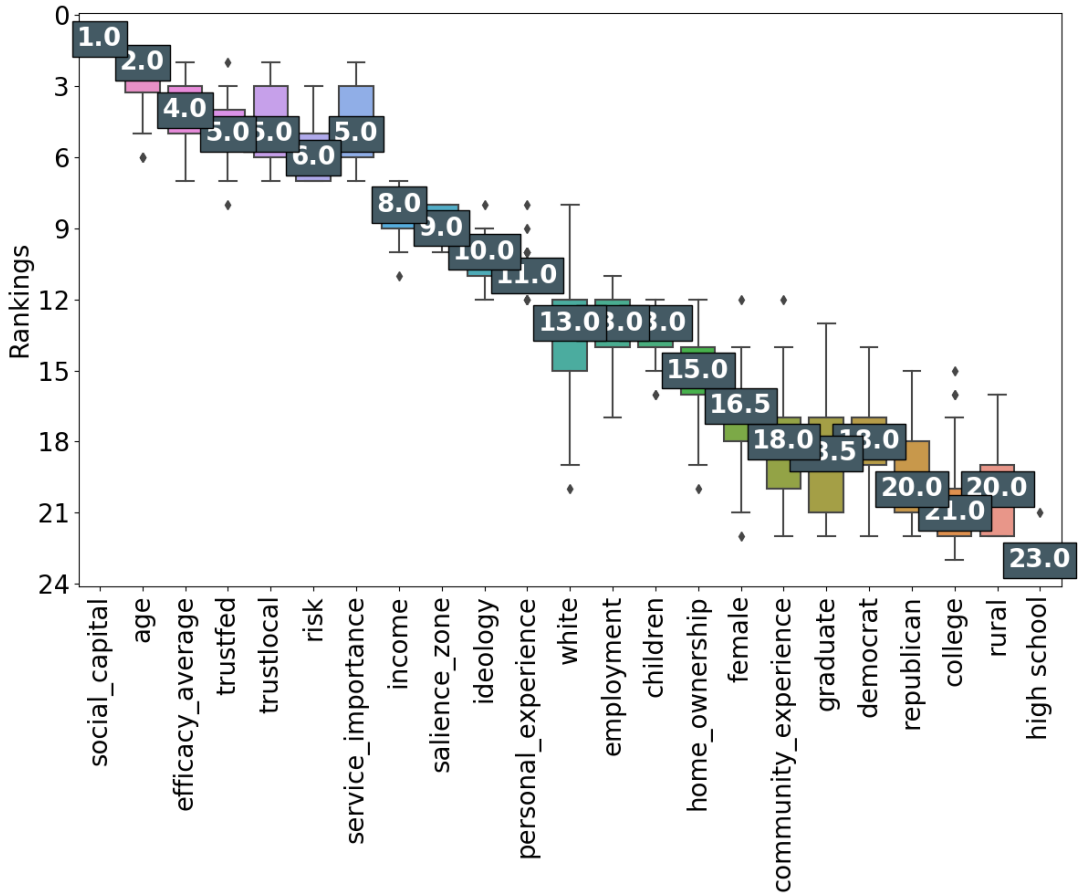

Figure 4.1: Modal rankings of relative decisiveness for willingness to participate in CERT

In this chapter, I first look at two dependent variables: one, citizens' willingness for collective co-production via CERT and the other, citizens' willingness for

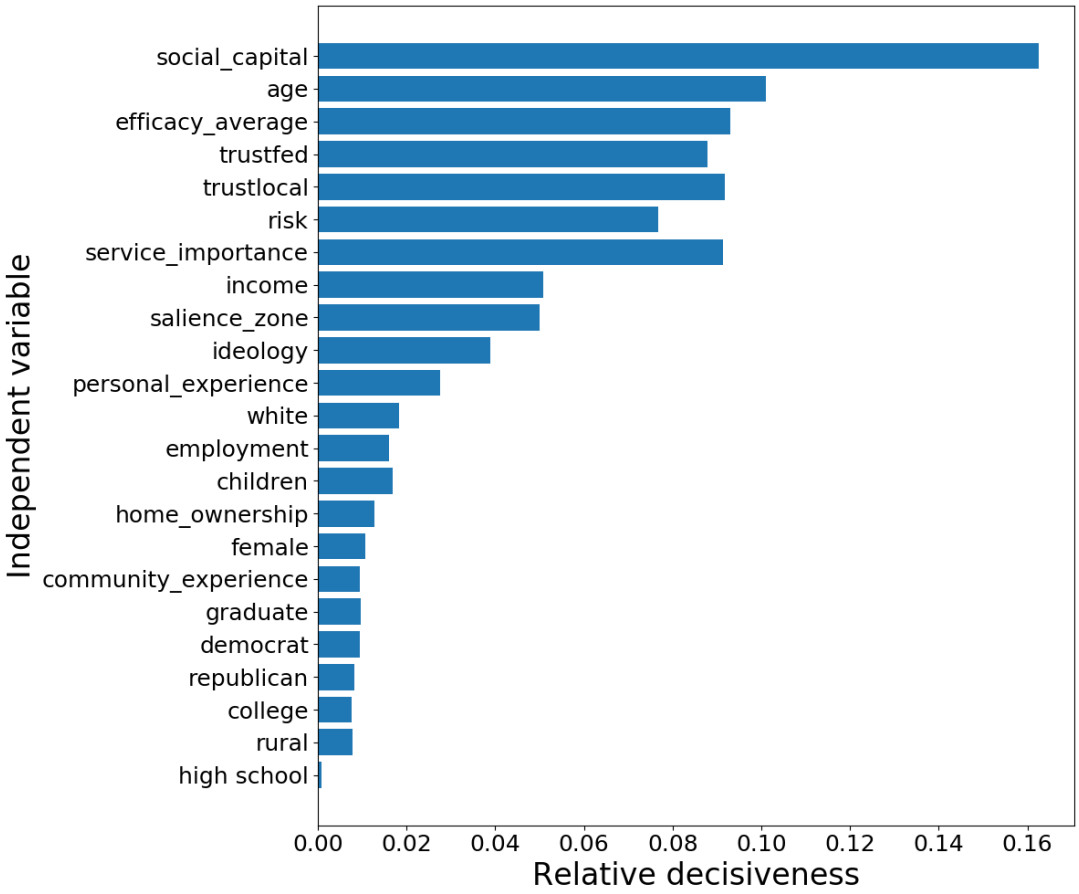

Figure 4.2: Relative decisiveness of variables for willingness to participate in CERT

co-production through volunteering for nongovernmental organized groups in the context of tornadoes. Additionally, I created a general collective co-production willingness by creating an index based on these two dependent variables. Based on these three dependent variables, I conducted random forest regressions [1]. In this analysis, I first calculated modal rankings of variable decisiveness concerning individual willingness for co-production via CERT and volunteering as well as the willingness to general co-production in the context of tornadoes (see Figure 4.1, Figure 4.3, Figure 4.5 respectively). Furthermore, I also provide the per-

[1] The Cronbach's alpha is 0.83 between willingness to participate in CERT and to volunteer variables

centages in relative decisiveness of each explanatory variable in Figure 4.2 Figure 4.4 and Figure 4.6. While random forest regressors do not provide quantitative interpretation with these percentages in relative decisiveness, it helps us identify the clusters of decisive factors among all explanatory variables.

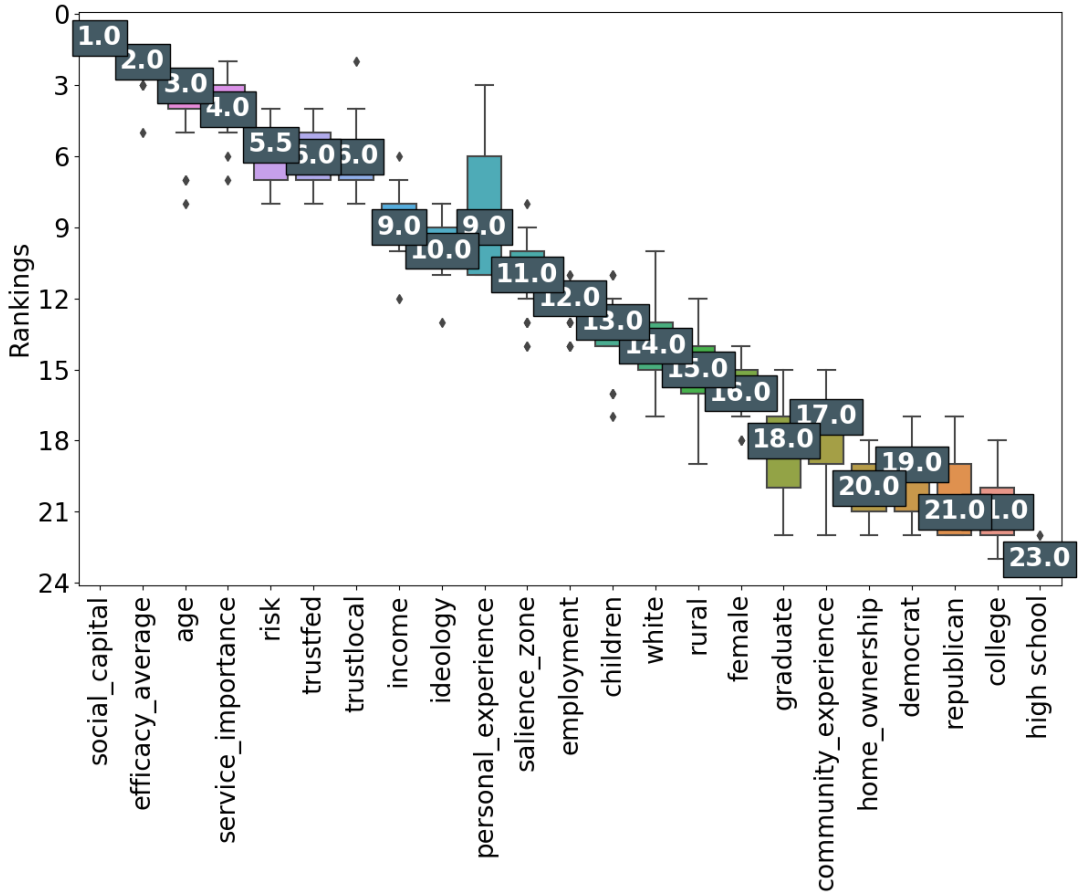

Figure 4.3: Modal rankings of relative decisiveness for willingness to volunteer

First, when I consider both Figure 4.1 and Figure 4.2, social capital seems to be the most decisive factor in the structure of citizens' willingness for collective co-production via CERT. Figure 4.2 particularly shows that social capital is the most decisive factor by a notable margin (approximately 0.16 in relative decisiveness). Age, efficacy and service importance and trust in local government are

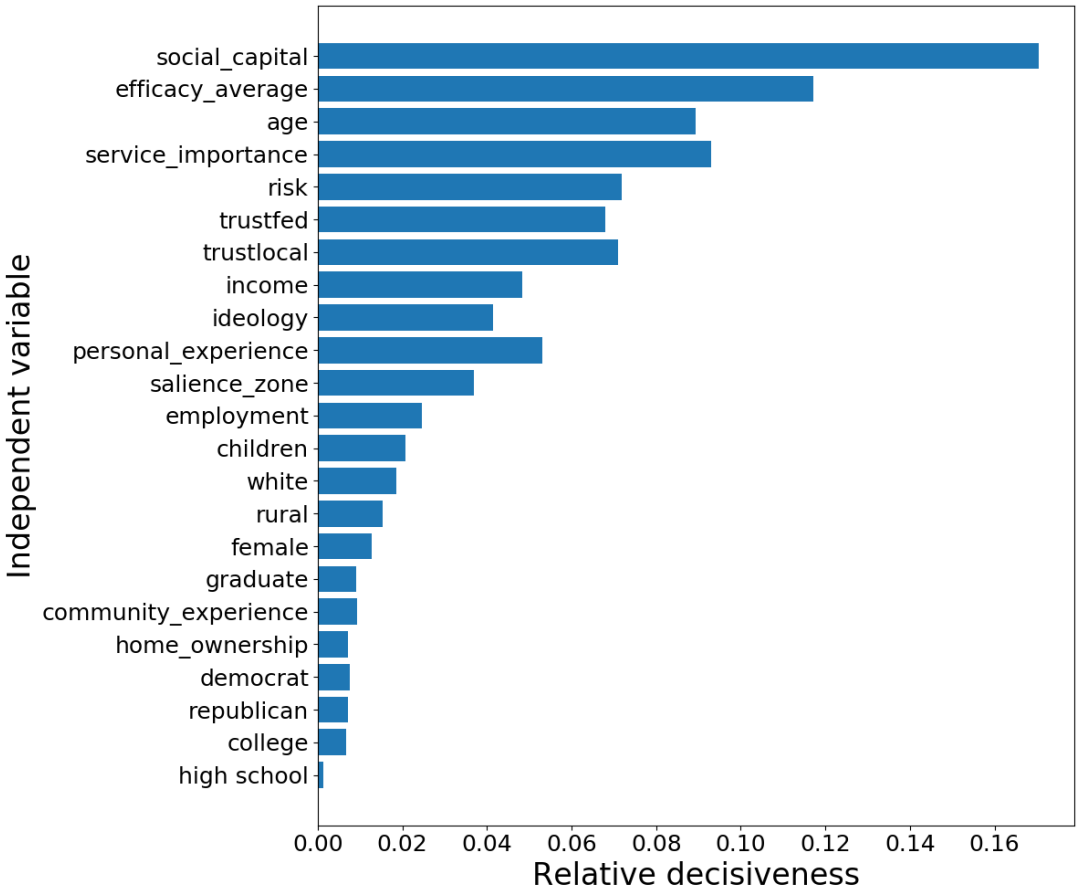

Figure 4.4: Relative decisiveness of variables for willingness to volunteer

also one of the most decisive factors leading to citizens' willingness for collective co-production via CERT in the context of tornadoes. Figure 4.2 shows that there four variables are relatively important by approximately 0.1 in relative decisiveness. Trust in the federal government and risk perception also play important roles in structuring citizens' willingness for collective co-production via CERT. However, similar to the previous result, trust in federal government is less decisive than trust in local government in the context of emergency service.

Income level, issue salience, political ideology and personal experience regarding tornadoes seem to be similarly decisive at a lower level. While demographic

variables have been highlighted in both citizen co-production and emergency management literature, similar to what I have found in previous sections, most of the demographic characteristics may be associated with differences in preparedness but is not a decisive factor in predicting citizens willingness for collective co-production via CERT.

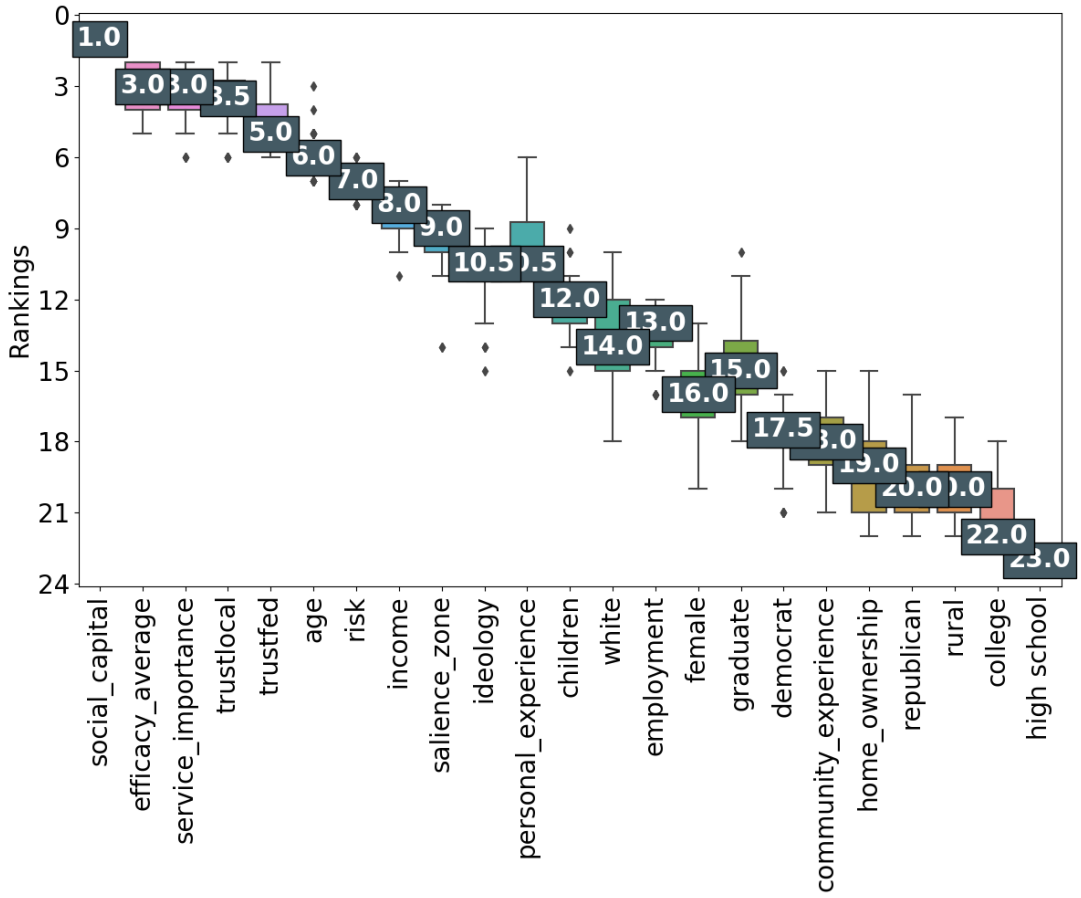

Figure 4.5: Modal rankings of relative decisiveness for collective co-production

Second, I look at both Figure 4.3 and Figure 4.4 to investigate the relative decisiveness of factors in shaping citizens' willingness for collective co-production via volunteering in the context of tornadoes. The result indicates that, similar to willingness for participating in CERT, social capital is the most decisive factor

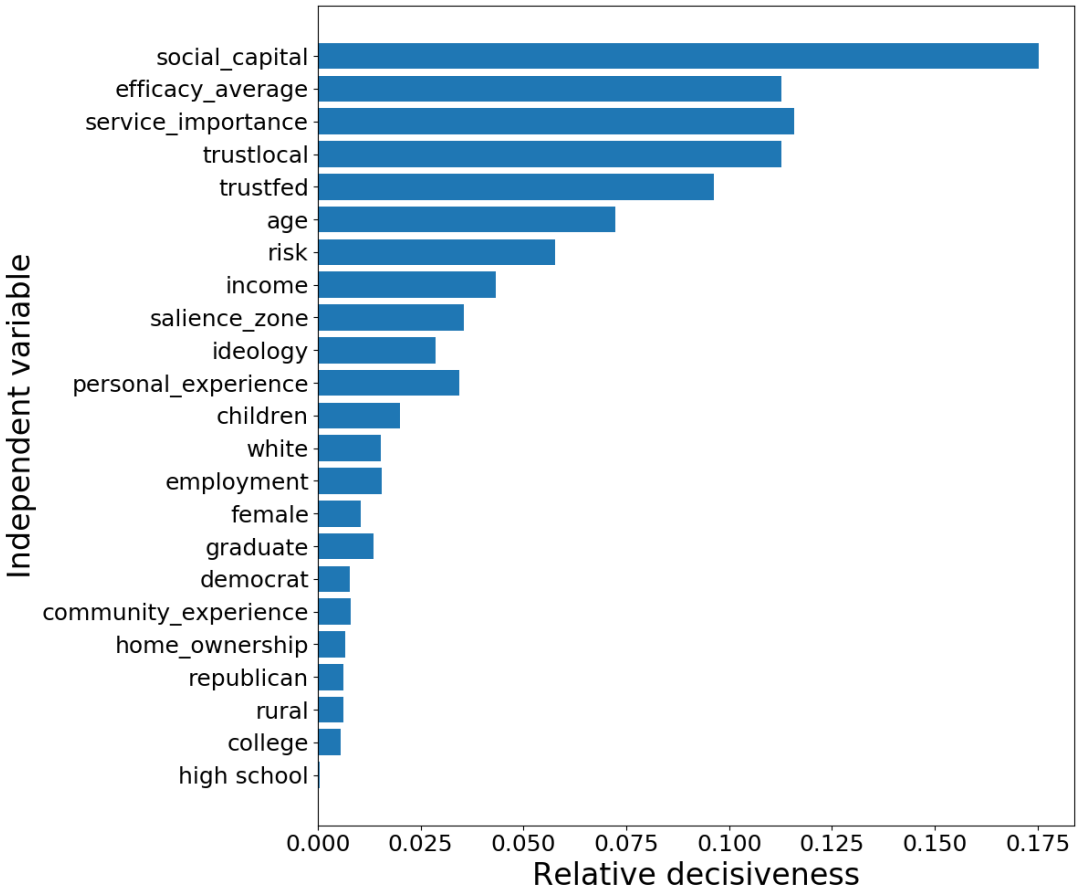

Figure 4.6: Relative decisiveness of variables for collective co-production

in structuring citizens' willingness to volunteer for non-governmental groups in respond to and recover from tornadoes. Figure 4.4 particularly shows that social capital is the most decisive factor by a notable margin (approximately 0.16 in relative decisiveness). Furthermore, self-efficacy is also one of the most decisive factors leading to citizens' willingness for collective co-production via volunteering for nongovernmental organized groups in the context of tornadoes. Self-efficacy is relatively important by approximately 0.12 in relative decisiveness. Next, service importance, trust in local and federal governments also play important roles in structuring citizens' willingness for collective co-production via volunteering.

Similar to previous chapters, the result shows that trust in local government is a more important factor than trust in the federal government.

While a majority of demographic characteristics are relatively decisive at the lowest level, age is more decisive than other demographics and many of political disposition variables. Furthermore, while community experience variable is relatively decisive at the lowest level, personal experience seems to be relatively important than community experience and other demographic characteristics in predicting citizens' willingness for collective co-production via volunteering.

Finally, I look at both Figure 4.5 and Figure 4.6 to investigate the relative decisiveness of factors in shaping the general willingness for collective co-production in the context of tornadoes. As stated, I created the willingness for collective co-production variable by taking the average value of willingness for CERT and willingness for volunteering variables. The result shows that the relative importance of variables is very similar to the ones for citizens' willingness for collective co-production via CERT and via volunteering.

Social capital seems to be the most decisive factor in the structure of citizens' willingness for collective co-production via CERT. Figure 4.6 particularly shows that social capital is the most decisive factor by a notable margin (approximately 0.175 in relative decisiveness). It has been consistently observed that social capital is the most decisive factor in shaping citizen's willingness for any form of collective co-production. Following the social capital variable, efficacy, service importance trust in local government and trust in federal government in the context of emergency management are also one of the decisive factors than others. While I may argue that these three variables are definitely more decisive than any other demographic characteristics, given that I calculated the mean relative decisiveness by utilizing 40 random forests, I cannot conclude that service

importance is more decisive than efficacy or trust in local government.

However, as stated, these three variables and social capital variable is much more decisive than a majority of demographic characteristics and many of political dispositions. Similar to what I found in previous section, demographic characteristics are relatively decisive only at the lowest level. While scholars have heavily focused on risk perception in shaping citizen' behaviors and willingness to take actions in the context of disasters and emergencies, it has been observed that risk perception is relatively decisive at the moderate level.

4.4.2 Results of Ordered Probit Regression Analyses

I conducted random forest regressions to understand the motivations of citizens collective co-production and I found that social capital, efficacy, service importance, trust in the local and federal government as well as age consistently seem one of the most decisive factors to shape citizens' willingness to collectively co-produce emergency service in collaboration with government and nongovernment-led groups. In contrast, most basic demographic characteristics such as household location, education and gender and other political predisposition variables such as party identification and political ideology do not seem to be strongly decisive to structure citizens' collective co-production willingness.

While random forest regressions provide valuable information regarding the relative decisiveness of factors without requiring parametric assumptions and facing high correlation issues among explanatory variables, it does not allow us to understand the directions of variable effects. For instance, we can only guess that people with higher social capital may tend to collectively co-produce emergency service more than others, given that previous theoretical and empirical

studies have argued that. Random forest regression analysis can only say that social capital is important but it does not say whether it positively or negatively affects citizens' collective co-production willingness. To complement the limitations of random forest regressor results, I also took more traditional statistical approaches. Three dependent variables in this study, willingness to participate in CERT, willingness to participate in non-governmental groups and general willingness to co-produce, are measured as ordinal variables. Therefore, I conducted standardized ordered probit regressions to see the directions of effect size. The standardized ordered probit regressions also provide standardized coefficients, therefore, I can compare the effect size of variables. Table 4.2 shows the results of these analyses.

Table 4.2 indicates that age, one of the most decisive factors, is negatively and statistically associated with citizens' willingness to collective co-production. The results show that older people are less willing to participate in CERT or nongovernment-led groups to respond to and recovery from tornadoes. Income variable is also positively and significantly associated with citizens' willingness for collective co-production behaviors.

While trust in federal government emergency service is not statistically associated with citizens' willingness to collectively co-produce emergency service, trust in local government is positively and significantly associated with it. Those who trust in local government in the context of emergency service more are more willing to join CERT or to volunteer for non-governmental groups to respond to and recover from tornadoes. The size of standardized coefficient shows that trust in local government has the largest effects on citizens' willingness for collective co-productions. Furthermore, those who perceive higher efficacy are more willing to collectively co-produce emergency service for tornadoes. It has been also

Table 4.2: Standardized ordered probit regression analyses

	Dependent variable:		
	willing_certf		willing_collectivef
	(1)	(2)	(3)
Demographics			
Rural	0.119	0.119	0.107
	(0.130)	(0.130)	(0.131)
Age	-0.349^{***}	-0.349^{***}	-0.173
	(0.114)	(0.114)	(0.115)
High.school	-0.871	-0.871	-0.745
	(0.592)	(0.592)	(0.577)
College	-0.007	-0.007	-0.089
	(0.122)	(0.122)	(0.124)
Graduate	0.113	0.113	0.152
	(0.155)	(0.155)	(0.157)
Female	0.009	0.009	0.167
	(0.111)	(0.111)	(0.113)
Children	0.148	0.148	0.152
	(0.113)	(0.113)	(0.114)
Income	0.212^{*}	0.212^{*}	0.226^{**}
	(0.112)	(0.112)	(0.113)
White	-0.165	-0.165	-0.120
	(0.133)	(0.133)	(0.135)
Employment	0.251	0.251	0.283
	(0.174)	(0.174)	(0.177)
Home ownership	-0.142	-0.142	-0.094
	(0.113)	(0.113)	(0.115)
Disaster specific variables			
Personal experience	0.303^{**}	0.303^{**}	0.394^{***}
	(0.119)	(0.119)	(0.122)
Community experience	-0.022	-0.022	0.013
	(0.123)	(0.123)	(0.125)
Risk perception	0.108	0.108	0.094
	(0.139)	(0.139)	(0.140)
Salience	0.068	0.068	-0.055
	(0.140)	(0.140)	(0.141)
Service importance	0.251^{*}	0.251^{*}	0.410^{***}
	(0.131)	(0.131)	(0.133)
Trust in local govt.	0.369^{***}	0.369^{***}	0.389^{***}
	(0.142)	(0.142)	(0.143)
Political and social dispositions			
Social capital	0.231^{*}	0.231^{*}	0.452^{***}
	(0.124)	(0.124)	(0.127)
Efficacy	0.172	0.172	0.285^{**}
	(0.111)	(0.111)	(0.113)
Trust in federal	0.171	0.171	0.200
	(0.128)	(0.128)	(0.130)
Republican	0.097	0.097	-0.061
	(0.155)	(0.155)	(0.158)
Democrat	0.208	0.208	0.174
	(0.146)	(0.146)	(0.148)
Political ideology	0.026	0.026	0.184
	(0.147)	(0.147)	(0.148)
Observations	445	445	445
AIC	1260.576	1296.166	1100.376
BIC	1371.224	1406.814	1221.024
Note:			*p<0.1; **p<0.05; ***p<0.01

observed that eople who believe that emergency service is important are more willing to work with the government via CERT to co-produce emergency service.

Random forest regressor analyses show that social capital is the most decisive factor in shaping citizens' willingness to collectively co-produce emergency service. Table 4.2 indicates that social capital is positively and significantly associated with citizens' willingness to collectively co-produce emergency service. People with higher social capital are more willing to participate in CERT and to volunteer for non-governmental groups to respond to and recovery from tornadoes. According to the size of coefficient, social capital seems to be the fourth most important factor.

It should be noted that personal experience is strongly associated with citizens' willingness to collectively co-produce emergency service. The result shows that people who previously have tornado experience are more willing to collectively co-produce emergency service to respond to and recover from tornadoes. The size of the coefficient of personal experience is relatively much larger than any other variable, even than social capital. However, according to the random forest regressor analyses, personal experience is relatively less important than other variables such as social capital, efficacy, service importance, age and trust in the local and federal government.

Additionally, given that I argue the importance of social capital in this chapter, I also created first different plots of social capital for willingness for CERT, volunteering and collective co-production (See Table 4.7, Table 4.8, and Table 4.9 respectively). These first different plots show the difference in predicted probability of having the minimum and maximum social capital value when all the other variables are held constant. These three plots indicate that social capital has a positive effect on "a lot" and " a great deal" categories. In other words, higher

social capital increases the probability of getting into the higher willingness for CERT, volunteering and collective co-production groups. In contrast, a higher social capital has a negative effect on lower categories such as " a little" and " non at all".

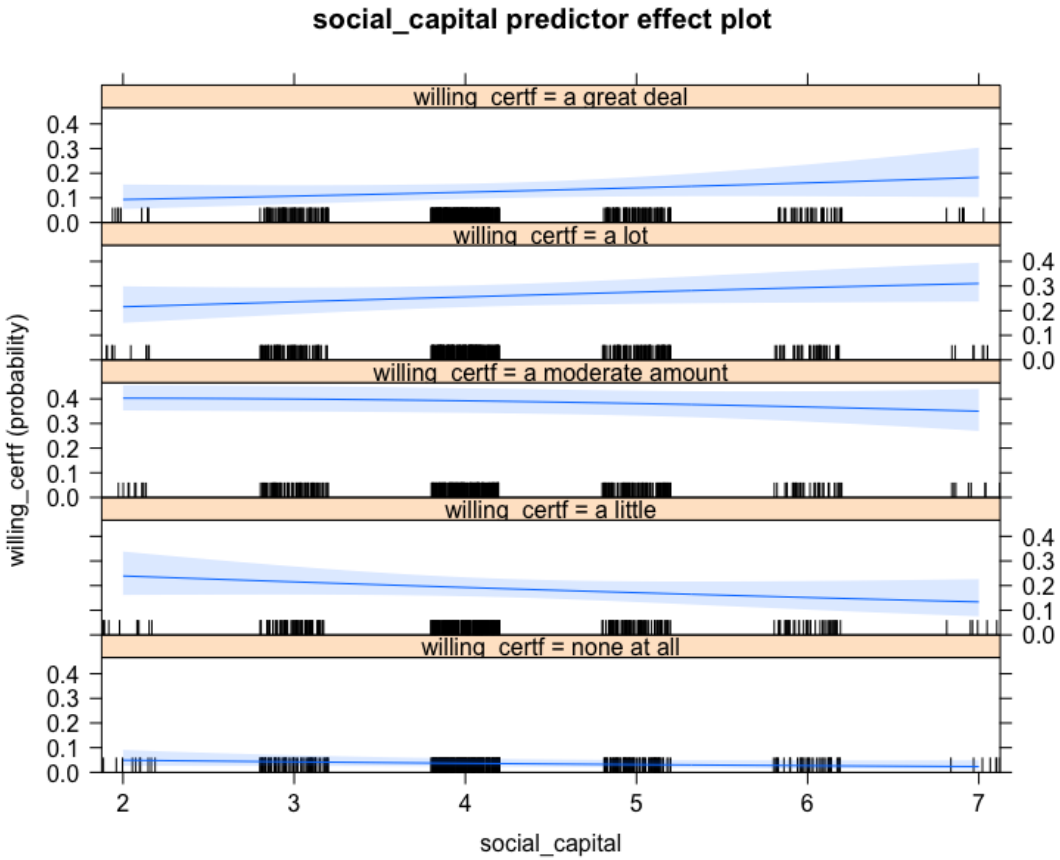

Figure 4.7: First difference plot of social capital for willingness for CERT

4.5 Discussions

In this chapter, I sought to understand the determinants and motivations of citizen's willingness for collective co-production in the context of emergency service. More specifically, I intended to understand the role of social capital in structure

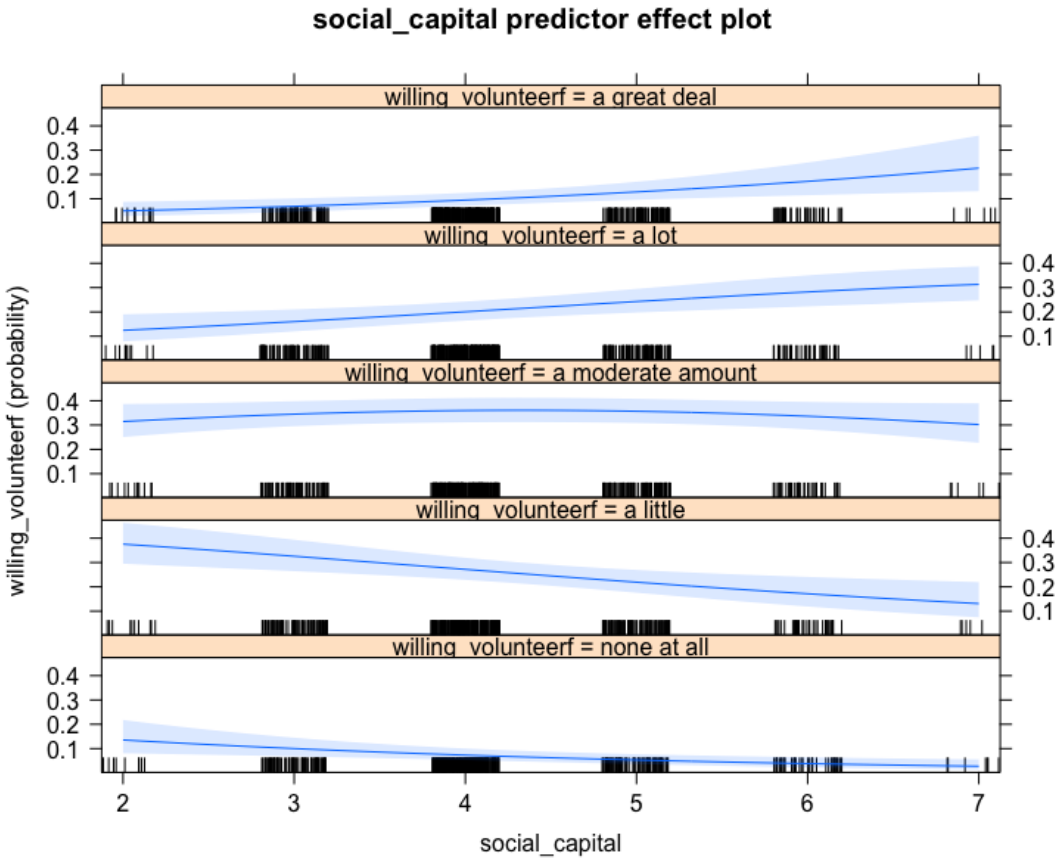

Figure 4.8: First difference plot of social capital for willingness for volunteering

citizens' willingness to collectively co-produce emergency service via the CERT program and volunteering for non-governmental groups to respond to tornadoes. Using survey data from states prone to tornadoes, I utilized random forest regressions and I found that social capital is the most decisive factor to structure citizen's willingness to collectively co-produce in collaboration with local government and non-governmental groups.

While scholars have recognized the importance of social capital in citizen co-production Ostrom (1996); Schafft and Brown (2000); Lachmund (1998), it has been under-investigated in co-production studies. Scholars have often more focused on basic demographic characteristics or citizens' general attitudes toward

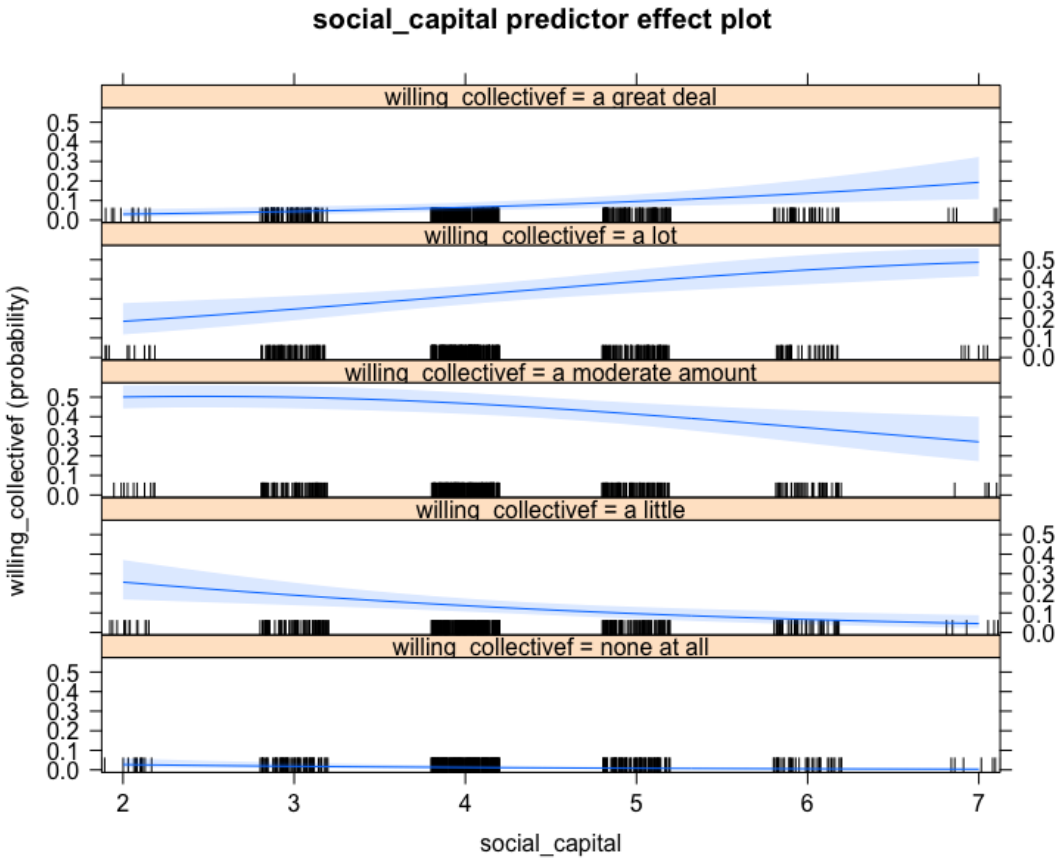

Figure 4.9: First difference plot of social capital for willingness for collective co-production

government Parrado et al. (2013); Bovaird et al. (2016, 2015). However, the analyses in this chapter suggest that social capital is the most decisive factor shaping willingness to collectively co-produce emergency service via both the CERT program and volunteering for non-governmental groups among citizens and community members. The standardized ordered probit regression models also show that the size of coefficient of social capital is relatively greater than many other variables although this does not have the greatest effect on the dependent variable. By utilizing ordered probit regression model, I found that when people have higher social capital, they are more likely to collectively co-produce emergency

service to respond to and recover from tornadoes. This result suggests that co-production scholars and practitioners may actively need to consider social capital as a key factor to understand and promote citizen's collective co-production of public service.

The results of these analyses are valuable, however, it should be noted that the generalization of these results is somewhat limited mainly due to the limited survey sample collected via MTurk. Further investigations with more representative data should be implemented. Furthermore, the results of these analyses may be only limited to citizens' co-production in the context of emergency service. It is required to investigate the decisiveness of social capital in shaping citizens' collective co-production behaviors and willingness in other public service areas to develop more rigorous arguments regarding the role of social capital in citizen co-production. Finally, as the previous chapter shows, the utilization of both random forest regressors and ordered probit regression models provided somewhat nuanced evidence regarding the effect of social capital and personal experience. While personal experience is one of the least decisive factors in random forest regressor analyses, it seems to have the strongest effect on citizens' willingness for collective co-production in emergency service. This indicates that further methodological investigation should be conducted.

Chapter 5

Conclusion

What is the role of citizens in public administration? How may public managers promote citizen participation in public administration? Through the lens of citizen co-production, I aim to build a research program to understand citizen participation in public service delivery particularly in the context of emergency management. As a first step, I sought to understand the determinants and motivations of citizen participation, denoted as citizen co-production, in emergency service delivery.

In this dissertation, I defined citizen co-production as the process that citizens contribute to public service delivery by providing knowledge, resources such as time, money and efforts and cooperating with professional public service providers. While there have been scholarly arguments, I argue in this dissertation that citizen co-production does not necessarily include direct relationships and interactions between citizens and professional public service providers. If citizens change their behaviors based on the policy recommendations and orders of professional public service providers and their behavioral changes enhance the public service delivery process and its outcomes, I consider it as citizen co-production

of public service.

As a part of a broader research program, I first sought to understand why and why not citizens decide to co-produce public service. More specifically, I examined the determinants and motivations of citizens' individual and collective co-production of emergency service before, during and after tornadoes with an emphasis of public trust. Scholars have sought to understand the motivations of citizen co0production and they have found that several demographic characteristics, perceptions of public service, attitudes toward general government and intrinsic and extrinsic motivations are shaping citizens' co-production behaviors and willingness.

While this body of literature has significantly contributed to the scholarly endeavors, it has been also criticized that there have been insufficient quantitative studies that may produce more generalizable conclusions. Furthermore, citizen co-production studies have heavily focused on several public service areas such as health, education, environment service and there has been a lack of investigation in other public service areas. Finally, scholars have found various variables that may be positively or negatively associated with citizens' co-production behaviors and willingness, scholars have not been able to conclude among all these variables, which one is the most decisive and important factor to structure citizens' co-production behaviors and willingness in public service delivery.

Given that, throughout three empirical chapters of this dissertation, I sought to contribute to addressing some of these limitations. First, using unique survey data sets, I particularly examine the emergency service area and citizens' motivation for co-production behaviors and willingness to prepare for, respond to and recover from tornadoes and related damages. Testing arguments and findings related to citizens' co-production motivations in different public service areas

expect to contribute to producing more generalizable conclusions regarding the subject matter. Furthermore, the novelty of this dissertation is that it utilized two different quantitative approaches, machine learning, and traditional statistical approaches to understand the relative decisiveness of factors among many others and examine how these decisive factors affect citizens' co-production behaviors and willingness.

In the first chapter, I first reviewed the traditional studies on public participation to describe how public administration scholars have looked at public participation in the administrative process. As stated previously, scholars have heavily focused on the role of the public in the administrative decision making and agenda setting context. However, citizen co-production scholars have argued that citizens may participate in the process of public service delivery. I then reviewed citizen co-production literature to examine the scholarly definitions and levels of citizen co-production. Based on the previous literature, I defined citizen co-production and also defined what citizens' individual and collective co-production mean in emergency service delivery. I described the examples of citizens' individual and collective co-production before, during and after disasters, particularly tornadoes. I also reviewed existing studies in public administration to select the variables for quantitative analysis that affect citizens' co-production of public service. Furthermore, given that I particularly focus on the emergency service area, I also reviewed emergency management literature to explore issue-specific variables that shape citizens' behaviors and willingness in the context of emergencies and behaviors. In this chapter, in addition to various variables discussed in the previous literature, I argued that public trust, both trust in issue-specific agencies and social capital may play primary roles in shaping citizens' co-production behaviors and willingness. Finally, I introduced a relatively uncommon machine learning

technique in public administration, a random forest regressor. I described how random forest regressor allows us to understand the relative decisiveness of factors in comparison to the traditional statistical approaches. However, I also argued that a random forest regressor is somewhat limited, therefore, the utilization of both random forest regressor and traditional statistical approaches is required for a comprehensive understanding of the determinants and motivations of citizens' co-production behaviors and willingness.

In the second chapter, I ask how does public trust in issue-specific agencies, in conjunction with individual characteristics, affect citizens' co-production of public service? Furthermore, I also investigated the relative decisiveness of public trust in shaping citizens' co-production behaviors. In this chapter, I particularly looked at citizens' cooperation with professional public service providers as a form of individual co-production in the context of emergency service. To that end, I examine how public trust in local emergency service agencies shapes the level of citizens' preparedness for tornadoes that are recommended by emergency service agencies. Utilizing a standardized OLS regression, I found that public trust in local emergency service agencies, as a mediator, is positively associated with citizens' preparedness for tornadoes. Furthermore, the random forest regressor analysis indicated that public trust in local emergency service agencies seems to be one of the most decisive factors in structuring citizens' cooperation with local emergency service agencies in addition to social capital. The standardized coefficients of public trust in an OLS model also supported the results of the random forest regressor analysis.

In Chapter Three, I focused on citizens' cooperation with local emergency service providers during tornadoes. More specifically, I sought to understand the factors shaping citizens' decisions on taking protective actions during tornadoes.

Citizens are recommended to move to a sheltered area when tornadoes warnings are issued. Drawing theories and empirical arguments from various disciplines, I investigated the decisiveness of factors that are associated with citizens' decisions on taking protective action during tornadoes and willingness for future events. Using unique survey data, the random forest regressor analyses indicated that in the case of citizens' co-production behaviors and willingness during tornadoes, the most decisive variables are related to risk perception, trust in local emergency service and social capital. However, logistic regression analyses conducted to complement the results of random forest regressor provide somewhat nuanced results particularly around the effect of social capital. While social capital seemed to be one of the most decisive factors to shape citizens' willingness to take protective actions during tornadoes in the random forest regressor, it doesn't seem to be statistically significant in the logistic regression model.

While scholars have argued that much of the potential benefits from co-production are more likely to occur from collective activities than individual co-production of public service, it has been observed that citizens are more likely and more willing to participate in co-production activity when the action required in the co-production process carried out individually. Given that, in Chapter Four, I sought to reveal how scholars and practitioners can promote citizens' willingness to collectively co-produce public service. To that end, I investigated citizens' willingness to participate in CERT and to volunteer for non-governmental groups to respond to and recover from tornadoes and related damages. In this chapter, in addition to various factors discussed in existing literature, I argued that social capital is the key to structure citizens' willingness to collectively co-produce emergency service. Utilizing a unique public survey, I found that social capital is the most decisive factor to shape citizens' willingness to co-produce emergency

service in the context of tornadoes via both government and nongovernment-led organizations to respond to and recover from tornadoes.

To summarize, throughout this dissertation, the empirical chapters showed that trust in issue-specific agencies and social capital are one of the most decisive factors to describe the variations in citizens' co-production behaviors and willingness before, during and after tornadoes. While scholars have been interested in citizen co-production, there has been a lack of effort to develop theories of citizen co-production. The results of this dissertation provide an opportunity to develop a theory of citizen co-production particularly around public trust. Further theoretical and empirical investigations are required to understand the dynamics of trust in issue-specific agencies and social capital in the entire process of public service delivery for the development of the theory of citizen co-production.

Furthermore, while scholars in public administration and emergency management have heavily focused on demographic characteristics and political dispositions to understand citizens' co-production behaviors and willingness, the findings of this dissertation indicate that issue-specific factors are more important. This provides an implication that citizens' co-production of public service should be understood in a more specific context of each public service area instead of focusing on more generalized factors.

One of the biggest potential critics might be centered around the question of the scope of citizen co-production. Some may argue that citizens co-production can be anything or nothing especially given that citizen co-production does not necessarily require direct relationships. I still argue that as long as citizens behavioral changes can enhance public service delivery and its outcomes, citizen co-production may occur with and without direct relationships and interactions with professional public service providers. However, it should be required to see

whether citizens behavioral changes actually occur due to policy recommendations and orders. For instance, it is reasonable to argue that citizens prepare for tornadoes and any other emergencies because they have been recommended to do so by emergency service providers. However, it is also required to see if they actually made those decisions based on the recommendations and orders of emergency service providers. In Chapter Two, it is not clear whether or not citizens prepared for tornadoes as a means of cooperating with local emergency service agencies: they might have prepared due to the recommendations of non-governmental organizations. Future investigation is required to utilize more qualitative data collection and analysis to address this issue.

This dissertation is a small part of a broader research program. I aim to understand the effect of public trust in the process of citizen co-production and how citizen co-production shapes public service process and its outcomes. By utilizing a multi-method approaches, I seek to keep exploring the aspects of citizen co-production in public service delivery, particularly in the context of emergency service. For instance, while scholar have normatively and empirically argued the positive role of citizen co-production of public service, it is under-investigated whether public managers are willing to involve citizens in the process of public service delivery while scholars have argued that public managers' willingness may play an important role in including citizens in the administrative process. Do public managers trust citizens to be capable of co-producing public service? How does their trust in citizen affect their willingness to promote citizens' co-production of public service? I seek to answer these questions through the interactions with public managers, particularly emergency managers and other emergency service providers. Another important question to be answered is whether citizen co-production can in fact improve public service delivery and its outcomes particu-

larly in the context of emergency service. In order to do so, it is first required to come up with the ways of measuring emergency service outcomes. What does it mean by emergency service performance and outcomes? How do we operationalize them? This process will build steps for investigation the relationship between citizen co-production of emergency service and emergency service delivery and outcomes.

Methodologically, this dissertation introduces a relatively uncommon machine learning technique in public administration and shows how scholars may utilize both machine learning and traditional statistical approaches together. While the introduction of machine learning technique came from the limitation of traditional statistical approaches, this dissertation does not argue that machine learning techniques are superior than traditional statistical approaches or vice versa. Instead, I argue that the utilization of both approaches may give us opportunities to complement the limitations of each method and produce more comprehensive knowledge about the subject matter. However, as previously stated, the utilization of both methods has also showed that there are some contradicting results. In the future research, I seek to assess these two methods to understand this issues particularly by quantifying uncertainties around these two methods.

Bibliography

Ablah, Elizabeth, Kurt Konda and Crystal L Kelley. 2009. "Factors predicting individual emergency preparedness: a multi-state analysis of 2006 BRFSS data." *Biosecurity and bioterrorism: biodefense strategy, practice, and science* 7(3):317–330.

Adams, Brian. 2004. "Public meetings and the democratic process." *Public Administration Review* 64(1):43–54.

Agranoff, Robert and Michael McGuire. 2003. *Collaborative public management: New strategies for local governments*. Georgetown University Press.

Albrecht, Frederike. 2017. "Government accountability and natural disasters: The impact of natural hazard events on political trust and satisfaction with governments in europe." *Risk, Hazards & Crisis in Public Policy* 8(4):381–410.

Alford, John. 1998. "A public management road less travelled: Clients as coproducers of public services." *Australian Journal of Public Administration* 57(4):128–137.

Alford, John. 2002. "Why do public-sector clients coproduce? Toward a contingency theory." *Administration & Society* 34(1):32–56.

Alford, John. 2009. *Engaging public sector clients: From service-delivery to coproduction*. Springer.

Alford, John. 2014. "The multiple facets of co-production: building on the work of Elinor Ostrom." *Public Management Review* 16(3):299–316.

Alford, John and Sophie Yates. 2016. "Co-Production of public services in australia: The roles of government organisations and Co-Producers." *Australian Journal of Public Administration* 75(2):159–175.

Alonso, José M, Rhys Andrews, Judith Clifton and Daniel Diaz-Fuentes. 2019. "Factors influencing citizens' co-production of environmental outcomes: a multi-level analysis." *Public Management Review* 21(11):1620–1645.

Anessi-Pessina, Eugenio, Carmela Barbera, Mariafrancesca Sicilia and Ileana Steccolini. 2016. "Public sector budgeting: a European review of accounting and public management journals." *Accounting, Auditing & Accountability Journal* .

Arlikatti, Sudha, Michael K Lindell and Carla S Prater. 2007. "Perceived stakeholder role relationships and adoption of seismic hazard adjustments." *International Journal of Mass Emergencies and Disasters* 25(3):218.

Arnstein, Sherry R. 1969. "A ladder of citizen participation." *Journal of the American Institute of planners* 35(4):216–224.

Baker, Earl J. 1991. "Hurricane evacuation behavior." *International journal of mass emergencies and disasters* 9(2):287–310.

Baker, Lisa R and Loretta A Cormier. 2013. "Disaster preparedness and families of children with special needs: a geographic comparison." *Journal of community health* 38(1):106–112.

Balluz, Lina, Laura Schieve, Talmage Holmes, Stephanie Kiezak and Josephine Malilay. 2000. "Predictors for people's response to a tornado warning: Arkansas, 1 March 1997." *Disasters* 24(1):71–77.

Bandura, Albert. 2013. "The role of self-efficacy in goal-based motivation.".

Banyan, Margaret and WA Olympia. 2006. "The Night of the Long Knives: Citizen Rhetoric in a 'Shared'Community Based Planning Process.".

Barber, Benjamin. 2003. *Strong democracy: Participatory politics for a new age*. Univ of California Press.

Basolo, Victoria, Laura J Steinberg, Raymond J Burby, Joyce Levine, Ana Maria Cruz and Chihyen Huang. 2009. "The effects of confidence in government and information on perceived and actual preparedness for disasters." *Environment and behavior* 41(3):338–364.

Berry, William D. 1993. *Understanding regression assumptions*. Vol. 92 Sage Publications.

Biernacki, Wojciech, J Działek, K Janas and Tomasz Padło. 2008. "Community attitudes towards extreme phenomena relative to place of residence and previous experience." *The influence of extreme phenomena on the natural environment and human living conditions* pp. 207–37.

Bingham, Lisa Blomgren, Rosemary O' Leary and Tina Nabatchi. 2005. "Legal frameworks for the new governance: Processes for citizen participation in the work of government." *National civic review* 94(1):54–61.

Blanchard-Boehm, R Denise and M Jeffrey Cook. 2004. "Risk communication and public education in Edmonton, Alberta, Canada on the 10th anniversary of the 'Black Friday'tornado." *International Research in Geographical & Environmental Education* 13(1):38–54.

Blessman, James, James Skupski, Mada Jamil, Hikmet Jamil, David Bassett, Roger Wabeke and Bengt Arnetz. 2007. "Barriers to at-home-preparedness in public health employees: implications for disaster preparedness training." *Journal of occupational and environmental medicine* 49(3):318–326.

Bord, Richard J., Ann Fisher and Robert E. O'Connor. 1998. "Public perceptions of global warming: United States and international perspectives." *Climate research* 11(1):75–84.

Bouckaert, Geert and Steven Van de Walle. 2003. "Comparing measures of citizen trust and user satisfaction as indicators of 'good governance': difficulties in linking trust and satisfaction indicators." *International Review of Administrative Sciences* 69(3):329–343.

Bovaird, Tony. 2007. "Beyond engagement and participation: User and community coproduction of public services." *Public administration review* 67(5):846–860.

Bovaird, Tony and E Loeffler. 2008. "User and community co-production of public services: Fad or fact, nuisance or necessity." *Retrieved July* 9:2012.

Bovaird, Tony, Gerry Stoker, Tricia Jones, Elke Loeffler and Monica Pinilla Roncancio. 2016. "Activating collective co-production of public services: influencing citizens to participate in complex governance mechanisms in the UK." *International Review of Administrative Sciences* 82(1):47–68.

Bovaird, Tony, Gregg G Van Ryzin, Elke Loeffler and Salvador Parrado. 2015. "Activating citizens to participate in collective co-production of public services." *Journal of Social Policy* 44(1):1–23.

Brandsen, Taco and Marlies Honingh. 2016. "Distinguishing different types of coproduction: A conceptual analysis based on the classical definitions." *Public Administration Review* 76(3):427–435.

Brandsen, Taco and Victor Pestoff. 2006. "Co-production, the third sector and the delivery of public services: An introduction." *Public management review* 8(4):493–501.

Brändström, Annika, Sanneke Kuipers and Pär Daléus. 2008. "The politics of blame management in Scandinavia after the tsunami disaster." *A. Boin, P.'t*

Hart and A. McConnell (eds), Governing After Crisis: The politics of investigation, accountability and learning, Cambridge University Press, Cambridge pp. 114–47.

Brodie, Mollyann, Erin Weltzien, Drew Altman, Robert J Blendon and John M Benson. 2006. "Experiences of Hurricane Katrina evacuees in Houston shelters: Implications for future planning." *American Journal of Public Health* 96(8):1402–1408.

Brommer, David M and Jason C Senkbeil. 2010. "Pre-landfall evacuee perception of the meteorological hazards associated with Hurricane Gustav." *Natural hazards* 55(2):353–369.

Brudney, Jeffrey L. 1983. "The evaluation of coproduction programs." *Policy Studies Journal* 12(2):376–385.

Brudney, Jeffrey L. 1987. "Coproduction and privatization: Exploring the relationship and its implications." *Journal of Voluntary Action Research* 16(3):11–21.

Brudney, Jeffrey L and Robert E England. 1983. "Toward a definition of the coproduction concept." *Public administration review* pp. 59–65.

Bryan, Frank M. 2010. *Real democracy: The New England town meeting and how it works*. University of Chicago Press.

Bryson, John M, Barbara C Crosby and Laura Bloomberg. 2014. "Public value governance: Moving beyond traditional public administration and the new public management." *Public administration review* 74(4):445–456.

Bubeck, Philip, Wouter JW Botzen, Heidi Kreibich and Jeroen CJH Aerts. 2013. "Detailed insights into the influence of flood-coping appraisals on mitigation behaviour." *Global environmental change* 23(5):1327–1338.

Bubeck, Philip, Wouter JW Botzen and Jeroen CJH Aerts. 2012. "A review of risk perceptions and other factors that influence flood mitigation behavior." *Risk Analysis: An International Journal* 32(9):1481–1495.

Bullock, Jane A, George D Haddow and Damon P Coppola. 2017. *Introduction to emergency management*. Butterworth-Heinemann.

Buss, Terry F, F Stevens Redburn and Kristina Guo. 2014. Modernizing democracy: An overview of the issues. In *Modernizing democracy: Innovations in citizen participation*. Routledge pp. 13–38.

Cepiku, Denita and Filippo Giordano. 2014. "Co-Production in Developing Countries: Insights from the community health workers experience." *Public Management Review* 16(3):317–340.

Chanley, Virginia A, Thomas J Rudolph and Wendy M Rahn. 2000. "The origins and consequences of public trust in government: A time series analysis." *Public opinion quarterly* 64(3):239–256.

Choi, Junghwa and Wesley Wehde. 2019. "Venue Preference and Earthquake Mitigation Policy: Expanding the Micro-Model of Policy Choice." *Review of Policy Research* 36(5):683–701.

Choi, Junghwa and Wesley Wehde. N.d. "Trust in Emergency Management Authorities and Individual Emergency Preparedness for Tornadoes." *Risk, Hazards & Crisis in Public Policy*. Forthcoming.

Christensen, Tom and Per Lægreid. 2005. "Trust in government: The relative importance of service satisfaction, political factors, and demography." *Public Performance & Management Review* 28(4):487–511.

Clark, Michael and Susan Fairlie. 2015. "Coproduction: a personal journey." *Mental Health Review Journal* .

Coleman, James S. 1988. "Social capital in the creation of human capital." *American journal of sociology* 94:S95–S120.

Comstock, R Dawn and Sue Mallonee. 2005. "Get off the bus: sound strategy for injury prevention during a tornado?" *Prehospital and disaster medicine* 20(3):189–192.

Cooper, Christopher A, H Gibbs Knotts and Kathleen M Brennan. 2008. "The importance of trust in government for public administration: The case of zoning." *Public Administration Review* 68(3):459–468.

Creighton, James L. 2005. *The public participation handbook: Making better decisions through citizen involvement*. John Wiley & Sons.

Cunningham, James V. 1972. "Citizen participation in public affairs." *Public Administration Review* 32:589–602.

Dash, Nicole and Hugh Gladwin. 2007. "Evacuation decision making and behavioral responses: Individual and household." *Natural Hazards Review* 8(3):69–77.

Day, Diane. 1997. "Citizen participation in the planning process: An essentially contested concept?" *Journal of planning Literature* 11(3):421–434.

Demiroz, Fatih and Ali Unlu. 2018. "The Role of Government Legitimacy and Trust in Managing Refugee Crises: The Case of Kobani." *Risk, Hazards & Crisis in Public Policy* 9(3):332–356.

Demuth, Julie L, Rebecca E Morss, Jeffrey K Lazo and Craig Trumbo. 2016. "The effects of past hurricane experiences on evacuation intentions through risk perception and efficacy beliefs: A mediation analysis." *Weather, Climate, and Society* 8(4):327–344.

Denhardt, Janet V and Robert B Denhardt. 2015. "The new public service revisited." *Public Administration Review* 75(5):664–672.

DeVellis, Robert F. 2016. *Scale development: Theory and applications*. Vol. 26 Sage publications.

DeYoung, Sarah E and Melissa Peters. 2016. "My Community, My Preparedness: The Role of Sense of Place, Community, and Confidence in Government in Disaster Readiness." *International Journal of Mass Emergencies & Disasters* 34(2).

Díaz, Paloma, John M Carroll and Ignacio Aedo. 2016. "Coproduction as an approach to technology-mediated citizen participation in emergency management." *Future Internet* 8(3):41.

Diekman, Shane T, Sean P Kearney, Mary E O'Neil and Karin A Mack. 2007. "Qualitative study of homeowners' emergency preparedness: Experiences, perceptions, and practices." *Prehospital and disaster medicine* 22(6):494–501.

Dixon, David S, Pallab Mozumder, William F Vásquez and Hugh Gladwin. 2017. "Heterogeneity within and across households in hurricane evacuation response." *Networks and Spatial Economics* 17(2):645–680.

Drabek, Thomas E. 2012. *Human system responses to disaster: An inventory of sociological findings*. Springer Science & Business Media.

Dunston, Roger, Alison Lee, David Boud, Pat Brodie and Mary Chiarella. 2009. "Co-production and health system reform–from re-imagining to re-making." *Australian Journal of Public Administration* 68(1):39–52.

Ebdon, Carol and Aimee L Franklin. 2006. "Citizen participation in budgeting theory." *Public administration review* 66(3):437–447.

Edwards, Margie L. 1993. "Social location and self-protective behavior: Implications for earthquake preparedness." *International Journal of Mass Emergencies and Disasters* 11(3):293–303.

Egerton, Muriel. 2002. "Higher education and civic engagement." *The British journal of sociology* 53(4):603–620.

Eisenman, David P, Cheryl Wold, Jonathan Fielding, Anna Long, Claude Setodji, Scot Hickey and Lillian Gelberg. 2006. "Differences in individual-level terrorism preparedness in Los Angeles County." *American journal of preventive medicine* 30(1):1–6.

Filner, Matthew F. 2006. "The limits of participatory empowerment: Assessing the Minneapolis neighborhood revitalization program." *State and Local Government Review* 38(2):67–77.

Fledderus, Joost. 2015. "Does user co-production of public service delivery increase satisfaction and trust? Evidence from a vignette experiment." *International Journal of Public Administration* 38(9):642–653.

Fledderus, Joost, Taco Brandsen and Marlies Honingh. 2014. "Restoring trust through the co-production of public services: A theoretical elaboration." *Public Management Review* 16(3):424–443.

Flint, Courtney G and Joanne Stevenson. 2010. "Building community disaster preparedness with volunteers: Community Emergency Response Teams in Illinois." *Natural Hazards Review* 11(3):118–124.

Fothergill, Alice. 1996. "Gender, risk, and disaster." *International journal of mass emergencies and disasters* 14(1):33–56.

Fothergill, Alice and Lori A Peek. 2004. "Poverty and disasters in the United States: A review of recent sociological findings." *Natural hazards* 32(1):89–110.

Fotheringham, A Stewart and Taylor M Oshan. 2016. "Geographically weighted regression and multicollinearity: dispelling the myth." *Journal of Geographical Systems* 18(4):303–329.

Fox, Jonathan. 1997. "POLICY ARENA: The World Bank and social capital: contesting the concept in practice." *Journal of International Development: The Journal of the Development Studies Association* 9(7):963–971.

Franklin, Aimee L, Alfred T Ho and Carol Ebdon. 2009. "Participatory budgeting in Midwestern states: Democratic connection or citizen disconnection?" *Public Budgeting & Finance* 29(3):52–73.

Frederickson, H George. 1980. *New public administration*. University, Ala.: University of Alabama Press.

Frederickson, H George. 1996. "Comparing the reinventing government movement with the new public administration." *Public administration review* pp. 263–270.

Fukuyama, Mr Francis. 2000. *Social capital and civil society.* International monetary fund.

Fung, Archon. 2006. "Varieties of participation in complex governance." *Public administration review* 66:66–75.

Fung, Archon. 2015. "Putting the public back into governance: The challenges of citizen participation and its future." *Public Administration Review* 75(4):513–522.

Funk, Sebastian, Marcel Salathé and Vincent AA Jansen. 2010. "Modelling the influence of human behaviour on the spread of infectious diseases: a review." *Journal of the Royal Society Interface* 7(50):1247–1256.

Garson, G David. 2012. "Testing statistical assumptions." *Asheboro, NC: Statistical Associates Publishing* .

Gawthrop, Louis C. 1998. *Public service and democracy: Ethical imperatives for the 21st century.* Chatham House Pub.

Gawthrop, Louis C and Dwight Waldo. 1984. "Civis, civitas, and civilitas: A new focus for the year 2000." *Public Administration Review* 44:101–111.

Gelman, Andrew. 2008. "Scaling regression inputs by dividing by two standard deviations." *Statistics in medicine* 27(15):2865–2873.

Goldstein, Herman. 1977. "Policing a free society." *Policing a Free Society Cambridge, Mass: Ballinger Pub. Co* .

Grothmann, Torsten and Fritz Reusswig. 2006. "People at risk of flooding: why some residents take precautionary action while others do not." *Natural hazards* 38(1-2):101–120.

Han, Ziqiang, Xiaoli Lu, Elisa I Hörhager and Jubo Yan. 2017. "The effects of trust in government on earthquake survivors' risk perception and preparedness in China." *Natural Hazards* 86(1):437–452.

Hastie, Trevor, Robert Tibshirani, Jerome Friedman and James Franklin. 2005. "The elements of statistical learning: data mining, inference and prediction." *The Mathematical Intelligencer* 27(2):83–85.

Heller, Kenneth, Douglas B Alexander, Margaret Gatz, Bob G Knight and Tara Rose. 2005. "Social and personal factors as predictors of earthquake preparation: The role of support provision, network discussion, negative affect, age, and education." *Journal of Applied Social Psychology* 35(2):399–422.

Hetherington, Marc J and Thomas J Rudolph. 2008. "Priming, performance, and the dynamics of political trust." *The Journal of Politics* 70(2):498–512.

Hodler, Thomas W. 1982. "Residents' preparedness and response to the Kalamazoo tornado." *Disasters* 6(1):44–49.

Hough, Mike, Jonathan Jackson, Ben Bradford, Andy Myhill and Paul Quinton. 2010. "Procedural justice, trust, and institutional legitimacy." *Policing: a journal of policy and practice* 4(3):203–210.

Innes, Martin, Colin Roberts, Helen Innes, Trudy Lowe and Suraj Lakhani. 2011. "Assessing the effects of prevent policing: a report to the Association of Chief Police Officers.".

Irvin, Renee A and John Stansbury. 2004. "Citizen participation in decision making: is it worth the effort?" *Public administration review* 64(1):55–65.

Jackson, Edgar L. 1981. "Response to earthquake hazard: The west coast of North America." *Environment and Behavior* 13(4):387–416.

Jaeger, Carlo, Gregor Dürrenberger, Hans Kastenholz and Bernhard Truffer. 1993. "Determinants of environmental action with regard to climatic change." *Climatic Change* 23(3):193–211.

Jakobsen, Morten and Simon Calmar Andersen. 2013. "Coproduction and equity in public service delivery." *Public Administration Review* 73(5):704–713.

Jo, Suyeon and Tina Nabatchi. 2016. "Getting back to basics: advancing the study and practice of coproduction." *International Journal of Public Administration* 39(13):1101–1108.

Jo, Suyeon and Tina Nabatchi. 2019. "Coproducing healthcare: individual-level impacts of engaging citizens to develop recommendations for reducing diagnostic error." *Public Management Review* 21(3):354–375.

Job, Jenny. 2005. "How is trust in government created? It begins at home, but ends in the parliament." *Australian Review of Public Affairs* 6(1):1–23.

Johnson, Branden B and Paul Slovic. 1995. "Presenting uncertainty in health risk assessment: initial studies of its effects on risk perception and trust." *Risk analysis* 15(4):485–494.

Johnston, David M, Mark S Bebbington Chin-Diew Lai, Bruce F Houghton and Douglas Paton. 1999. "Volcanic hazard perceptions: comparative shifts in knowledge and risk." *Disaster Prevention and Management: An International Journal* 8(2):118–126.

Kang, Sinah and Gregg G Van Ryzin. 2019. "Coproduction and trust in government: evidence from survey experiments." *Public Management Review* 21(11):1646–1664.

Kearney, Richard C and Chandan Sinha. 1988. "Professionalism and bureaucratic responsiveness: Conflict or compatibility?" *Public Administration Review* pp. 571–579.

Keim, Mark E. 2008. "Building human resilience: the role of public health preparedness and response as an adaptation to climate change." *American journal of preventive medicine* 35(5):508–516.

Kettl, Donald F. 2019. "From Policy to Practice: From Ideas to Results, From Results to Trust." *Public Administration Review* .

Kievik, Milou and Jan M Gutteling. 2011. "Yes, we can: motivate Dutch citizens to engage in self-protective behavior with regard to flood risks." *Natural hazards* 59(3):1475.

Kim, Seok-Eun. 2005. "The role of trust in the modern administrative state: An integrative model." *Administration & Society* 37(5):611–635.

King, Cheryl Simrell. 2015. Citizens, citizenship, and democratic governance. In *Democracy and public administration*. Routledge pp. 76–95.

King, Cheryl Simrell, Kathryn M Feltey and Bridget O'Neill Susel. 2015. The question of participation: Toward authentic public participation in public administration. In *The age of direct citizen participation*. Routledge pp. 391–408.

Kox, Thomas and Annegret H Thieken. 2017. "To act or not to act? Factors influencing the general public's decision about whether to take protective action against severe weather." *Weather, climate, and society* 9(2):299–315.

Krocak, Makenzie J, Sean Ernst, Jinan N Allan, Wesley W Wehde, Joseph T Ripberger, Carol Silva and Hank Jenkins-Smith. 2020. Thinking outside the polygon: A study of tornado warning reception outside of warning polygon bounds. In *100th American Meteorological Society Annual Meeting*. AMS.

Lachmund, Jens. 1998. "Between scrutiny and treatment: Physical diagnosis and the restructuring of 19th century medical practice." *Sociology of Health & Illness* 20(6):779–801.

Lai, Chih-Hui, Arul Chib and Rich Ling. 2018. "Digital disparities and vulnerability: mobile phone use, information behaviour, and disaster preparedness in Southeast Asia." *Disasters* .

Leiserowitz, Anthony. 2006. "Climate change risk perception and policy preferences: The role of affect, imagery, and values." *Climatic change* 77(1–2):45–72.

Leroy, Pieter and Bas Arts. 2006. Institutional dynamics in environmental governance. In *Institutional dynamics in environmental governance*. Springer pp. 1–19.

Levi, Margaret. 1998. "A state of trust." *Trust and governance* 1:77–101.

Levi, Margaret and Laura Stoker. 2000. "Political trust and trustworthiness." *Annual review of political science* 3(1):475–507.

Levine, Charles H and Glenn Fisher. 1984. "Citizenship and service delivery: The promise of coproduction." *Public Administration Review* 44:178–189.

Lindell, Michael K and Ronald W Perry. 2000. "Household adjustment to earthquake hazard: A review of research." *Environment and behavior* 32(4):461–501.

Lindell, Michael K and Ronald W Perry. 2012. "The protective action decision model: theoretical modifications and additional evidence." *Risk Analysis: An International Journal* 32(4):616–632.

Liu, Simin, Lynn E Quenemoen, Josephine Malilay, Eric Noji, Thomas Sinks and James Mendlein. 1996. "Assessment of a severe-weather warning system and disaster preparedness, Calhoun County, Alabama, 1994." *American journal of public health* 86(1):87–89.

Liu, Xinsheng, Scott Robinson and Arnold Vedlitz. 2017. "A Micro Model of Problem Definition and Policy Choice: Issue Image, Issue Association, and Policy Support of Power Plants." *Policy Studies Journal* 0(0).
URL: *https://onlinelibrary.wiley.com/doi/abs/10.1111/psj.12233*

Loeffler, Elke and Tony Bovaird. 2016. "User and community co-production of public services: What does the evidence tell us?" *International Journal of Public Administration* 39(13):1006–1019.

Löffler, Elke, Salvador Parrado, Tony Bovaird and Gregg Van Ryzin. 2008. "If you want to go fast, walk alone. If you want to go far, walk together." *Citizens and the co-production of public services. Report to the EU Presidency. Ministry of Finance, Budget and Public Services, Paris* .

Longstaff, Patricia H and Sung-Un Yang. 2008. "Communication management and trust: their role in building resilience to "surprises" such as natural disasters, pandemic flu, and terrorism." *Ecology and Society* 13(1).

Maestas, Cherie, Jacqueline Chattopadhyay, Suzanne Leland and Jaclyn Piatak. 2018. "Fearing Food: The Influence of Risk Perceptions on Public Preferences for Uniform and Centralized Risk Regulation." *Policy Studies Journal* .

Makkai, Toni and John Braithwaite. 1994. "Reintegrative shaming and compliance with regulatory standards." *Criminology* 32(3):361–385.

Marschall, Melissa J. 2004. "Citizen participation and the neighborhood context: A new look at the coproduction of local public goods." *Political Research Quarterly* 57(2):231–244.

Martikke, Susanne, Holly Cumbers, Nigel Cox, Lucy Webb, Emma Gedzielewski and Mariam Duale. 2019. "Building bridges into the community: Social capital in a volunteering project for care leavers." *Children & Society* 33(2):111–125.

Martín, Yago, Susan L Cutter and Zhenlong Li. 2020. "Bridging Twitter and survey data for evacuation assessment of Hurricane Matthew and Hurricane Irma." *Natural Hazards Review* 21(2):04020003.

McComas, K and T Derville. 2005. "Collaborative decision making." *Encyclopedia of public relations* 1:145–147.

McGregor, Eugene B and Richard Sundeen. 1984. "The great paradox of democratic citizenship and public personnel administration." *Public Administration Review* 44:126–135.

Mees, Hannelore, Ann Crabbé, Meghan Alexander, Maria Kaufmann, Silvia Bruzzone, Lisa Lévy and Jakub Lewandowski. 2016. "Coproducing flood risk management through citizen involvement: insights from cross-country comparison in Europe." *Ecology and Society* 21(3).

Miceli, Renato, Igor Sotgiu and Michele Settanni. 2008. "Disaster preparedness and perception of flood risk: A study in an alpine valley in Italy." *Journal of environmental psychology* 28(2):164–173.

Mileti, Dennis S and Colleen Fitzpatrick. 1992. "The causal sequence of risk communication in the Parkfield earthquake prediction experiment." *Risk Analysis* 12(3):393–400.

Mileti, Dennis S and JoAnne DeRouen Darlington. 1997. "The role of searching in shaping reactions to earthquake risk information." *Social Problems* 44(1):89–103.

Mileti, Dennis S and John H Sorensen. 1990. Communication of emergency public warnings: A social science perspective and state-of-the-art assessment. Technical report Oak Ridge National Lab., TN (USA).

Mulilis, John-Paul, T Shelley Duval and RandY Rogers. 2003. "The Effect of a Swarm of Local Tornados on Tornado Preparedness: A Quasi-Comparable Cohort Investigation 1." *Journal of Applied Social Psychology* 33(8):1716–1725.

Mumpower, Jeryl L, Liu Shi, James W Stoutenborough and Arnold Vedlitz. 2013. "Psychometric and demographic predictors of the perceived risk of terrorist threats and the willingness to pay for terrorism risk management programs." *Risk Analysis* 33(10):1802–1811.

Mumpower, Jeryl L, Xinsheng Liu and Arnold Vedlitz. 2016. "Predictors of the perceived risk of climate change and preferred resource levels for climate change management programs." *Journal of Risk Research* 19(6):798–809.

Murphy, Haley, Alex Greer and Hao-Che Wu. 2018. "Trusting Government to Mitigate a New Hazard: The Case of Oklahoma Earthquakes." *Risk, Hazards & Crisis in Public Policy* .

Murphy, Sheila T, Michael Cody, Lauren B Frank, Deborah Glik and Alfonso Ang. 2009. "Predictors of emergency preparedness and compliance." *Disaster Med Public Health Prep* 7:S1–S8.

Mushkatel, Alvin H. and Joanne M. Nigg. 1987. "OPINION CONGRUENCE AND THE FORMULATION OF SEISMIC SAFETY POLICIES." *Review of Policy Research* 6(4):645–656.

Nabatchi, Tina, Alessandro Sancino and Mariafrancesca Sicilia. 2017. "Varieties of participation in public services: The who, when, and what of coproduction." *Public Administration Review* 77(5):766–776.

Nagele, Danielle E and Joseph E Trainor. 2012. "Geographic specificity, tornadoes, and protective action." *Weather, Climate, and Society* 4(2):145–155.

Norris, Fran H, Tenbroeck Smith and Krzysztof Kaniasty. 1999. "Revisiting the experience–behavior hypothesis: the effects of Hurricane Hugo on hazard preparedness and other self-protective acts." *Basic and Applied Social Psychology* 21(1):37–47.

O'Connor, Robert E, Richard J Bord and Ann Fisher. 1999. "Risk perceptions, general environmental beliefs, and willingness to address climate change." *Risk analysis* 19(3):461–471.

Olsen, Marvin Elliott. 1982. *Participatory pluralism: Political participation and influence in the United States and Sweden*. Burnham Inc Pub.

Osborne, Stephen P and Kirsty Strokosch. 2013. "It takes Two to Tango? Understanding the C o-production of Public Services by Integrating the Services Management and Public Administration Perspectives." *British Journal of Management* 24:S31–S47.

Osborne, Stephen P, Zoe Radnor and Kirsty Strokosch. 2016. "Co-production and the co-creation of value in public services: a suitable case for treatment?" *Public Management Review* 18(5):639–653.

Osborne, Stephen P et al. 2010. "The new public governance." *Emerging Perspectives on the theory and practice of public governance* 1.

Ostrom, Elinor. 1972. "Metropolitan reform: Propositions derived from two traditions." *Social Science Quarterly* pp. 474–493.

Ostrom, Elinor. 1996. "Crossing the great divide: coproduction, synergy, and development." *World development* 24(6):1073–1087.

Ostrom, Elinor and Toh-Kyeong Ahn. 2009. "The meaning of social capital and its link to collective action." *Handbook of social capital: The troika of sociology, political science and economics* pp. 17–35.

Palm, Ria I, Michael E Hodgson, R Denise Blanchard and Donald I Lyons. 1990. "Earthquake Insurance in California: Environmental Policy and Individual Decision-Making." *WESTVIEW PRESS, 5500 CENTRAL AVE., BOULDER, CO 80301(USA). 1990.* .

Parks, Roger B, Paula C Baker, Larry Kiser, Ronald Oakerson, Elinor Ostrom, Vincent Ostrom, Stephen L Percy, Martha B Vandivort, Gordon P Whitaker and Rick Wilson. 1981. "Consumers as coproducers of public services: Some economic and institutional considerations." *Policy studies journal* 9(7):1001–1011.

Parrado, Salvador, Gregg G Van Ryzin, Tony Bovaird and Elke Löffler. 2013. "Correlates of co-production: Evidence from a five-nation survey of citizens." *International Public Management Journal* 16(1):85–112.

Paton, Douglas. 2008. "Risk communication and natural hazard mitigation: how trust influences its effectiveness." *International Journal of Global Environmental Issues* 8(1-2):2–16.

Peacock, Walter Gillis, Betty Hearn Morrow and Hugh Gladwin. 1997. "Hurricane Andrew: Ethnicity." *Gender and the Sociology of Disaster London: Routledge* .

Peek, Lori A and Dennis S Mileti. 2002. "The history and future of disaster research.".

Perry, Ronald W and Michael K Lindell. 1991. "The effects of ethnicity on evacuation decision-making." *International journal of mass emergencies and disasters* 9(1):47–68.

Pestoff, Victor. 2006. "Citizens and co-production of welfare services: Childcare in eight European countries." *Public management review* 8(4):503–519.

Pestoff, Victor. 2012. "Co-production and third sector social services in Europe: Some concepts and evidence." *Voluntas: International Journal of Voluntary and Nonprofit Organizations* 23(4):1102–1118.

Przeworski, Adam, Susan Carol Stokes Stokes, Susan C Stokes and Bernard Manin. 1999. *Democracy, accountability, and representation*. Vol. 2 Cambridge University Press.

Putnam, Robert. 1993. "The prosperous community: Social capital and public life." *The american prospect* 13(Spring), Vol. 4. Available online: http://www. prospect. org/print/vol/13 (accessed 7 April 2003).

Putnam, Robert. 2001. "Social capital: Measurement and consequences." *Canadian journal of policy research* 2(1):41–51.

Putnam, Robert D. 1995. "Tuning in, tuning out: The strange disappearance of social capital in America." *PS: Political science & politics* 28(4):664–683.

Rahn, Wendy M and Thomas J Rudolph. 2005. "A tale of political trust in American cities." *Public Opinion Quarterly* 69(4):530–560.

Realpe, Alba and Louise M Wallace. 2010. "What is co-production." *London: The Health Foundation* pp. 1–11.

Reckhow, Sarah, Matt Grossmann and Benjamin C. Evans. 2015. "Policy Cues and Ideology in Attitudes toward Charter Schools." *Policy Studies Journal* 43(2):207–227.
URL: *https://onlinelibrary.wiley.com/doi/abs/10.1111/psj.12093*

Redlener, Irwin E, Roy F Grant, David M Abramson and Dennis G Johnson. 2008. "The 2008 American preparedness project: why parents may not heed evacuationorders and what emergency planners, families and schools need to know.".

Roberts, Nancy. 2004. "Public deliberation in an age of direct citizen participation." *The American review of public administration* 34(4):315–353.

Robinson, Scott E, James W Stoutenborough and Arnold Vedlitz. 2017. *Understanding Trust in Government: Environmental Sustainability, Fracking, and Public Opinion in American Politics*. Taylor & Francis.

Robinson, Scott E., Jason M. Pudlo and Wesley Wehde. 2019. "The New Ecology of Tornado Warning Information: A Natural Experiment Assessing Threat Intensity and Citizen-to-Citizen Information Sharing." *Public Administration Review* 79(6):905–916.

Robinson, Scott E, Xinsheng Liu, James W Stoutenborough and Arnold Vedlitz. 2012. "Explaining popular trust in the department of homeland security." *Journal of Public Administration Research and Theory* 23(3):713–733.

Robinson, Scott E, Xinsheng Liu, James W Stoutenborough and Arnold Vedlitz. 2013. "Explaining popular trust in the department of homeland security." *Journal of Public Administration Research and Theory* 23(3):713–733.

Rudolph, Thomas J and Jillian Evans. 2005. "Political trust, ideology, and public support for government spending." *American Journal of Political Science* 49(3):660–671.

Ruscio, Kenneth P. 1997. "Trust in the administrative state." *Public Administration Review* 57(5):454.

Russell, Lisa A, James D Goltz and Linda B Bourque. 1995. "Preparedness and hazard mitigation actions before and after two earthquakes." *Environment and behavior* 27(6):744–770.

Ryzin, Gregg G Van. 2004. "The measurement of overall citizen satisfaction." *Public Performance & Management Review* 27(3):9–28.

Sabet, Daniel. 2014. "Co-Production and Oversight: Citizens and Their Police." *Building Resilient Communities in Mexico: Civic Responses to Crime and Violence* pp. 245–262.

Sadiq, Abdul-Akeem, Kevin Tharp and John D Graham. 2016. "FEMA versus local governments: Influence and reliance in disaster preparedness." *Natural Hazards* 82(1):123–138.

Sadri, Arif Mohaimin, Satish V Ukkusuri and Hugh Gladwin. 2017. "The role of social networks and information sources on hurricane evacuation decision making." *Natural Hazards Review* 18(3):04017005.

Schafft, Kai A and David L Brown. 2000. "Social capital and grassroots development: the case of Roma self-governance in Hungary." *Social problems* 47(2):201–219.

Scholz, John T and Mark Lubell. 1998. "Trust and taxpaying: Testing the heuristic approach to collective action." *American Journal of Political Science* pp. 398–417.

Scholz, John T and Neil Pinney. 1995. "Duty, fear, and tax compliance: The heuristic basis of citizenship behavior." *American Journal of Political Science* pp. 490–512.

Scolobig, Anna, Bruna De Marchi and Marco Borga. 2012. "The missing link between flood risk awareness and preparedness: findings from case studies in an Alpine Region." *Natural Hazards* 63(2):499–520.

Sicilia, Mariafrancesca, Enrico Guarini, Alessandro Sancino, Martino Andreani and Renato Ruffini. 2016. "Public services management and co-production in multi-level governance settings." *International Review of Administrative Sciences* 82(1):8–27.

Siegrist, Michael and Heinz Gutscher. 2006. "Flooding risks: A comparison of lay people's perceptions and expert's assessments in Switzerland." *Risk analysis* 26(4):971–979.

Silver, Amber and Jean Andrey. 2014. "The influence of previous disaster experience and sociodemographics on protective behaviors during two successive tornado events." *Weather, climate, and society* 6(1):91–103.

Simmons, Kevin M and Daniel Stutter. 2007. "The Groundhog Day Florida tornadoes: A case study of high-vulnerability tornadoes.".

Sims, John H and Duane D Baumann. 1972. "The tornado threat: Coping styles of the North and South." *Science* 176(4042):1386–1392.

Stallings, Robert A and Enrico L Quarantelli. 1985. "Emergent citizen groups and emergency management." *Public administration review* 45:93–100.

Stoker, Gerry. 2006. "Public value management: a new narrative for networked governance?" *The American review of public administration* 36(1):41–57.

Stoutenborough, James W., Shelbi G. Sturgess and Arnold Vedlitz. 2013. "Knowledge, risk, and policy support: Public perceptions of nuclear power." *Energy Policy* 62:176–184.

Strange, John H. 1972. "The impact of citizen participation on public administration." *Public Administration Review* 32:457–470.

Sundeen, Richard A. 1988. "Explaining participation in coproduction: A study of volunteers." *Social Science Quarterly* 69(3):547.

Taber, Charles S and Milton Lodge. 2006. "Motivated skepticism in the evaluation of political beliefs." *American Journal of Political Science* 50(3):755–769.

Talsma, L and JFM Molenbroek. 2012. "User-centered ecotourism development." *Work* 41(Supplement 1):2147–2154.

Terpstra, Teun. 2011. "Emotions, trust, and perceived risk: Affective and cognitive routes to flood preparedness behavior." *Risk Analysis: An International Journal* 31(10):1658–1675.

Thomas, Craig W. 1998. "Maintaining and restoring public trust in government agencies and their employees." *Administration & society* 30(2):166–193.

Thomas, John Clayton. 1995. *Public participation in public decisions: New skills and strategies for public managers*. Jossey-Bass San Francisco.

Torabi, Mohammad R and Dong-Chul Seo. 2004. "National study of behavioral and life changes since September 11." *Health Education & Behavior* 31(2):179–192.

Tyler, Tom R. 2005. "Policing in black and white: Ethnic group differences in trust and confidence in the police." *Police quarterly* 8(3):322–342.

Uzochukwu, Kelechi and John Clayton Thomas. 2018. "Who engages in the coproduction of local public services and why? The case of Atlanta, Georgia." *Public Administration Review* 78(4):514–526.

Van de Graaff, Shashi. 2016. "Understanding the nuclear controversy: An application of cultural theory." *Energy Policy* 97:50–59.

van der Weerd, Willemien, Daniëlle RM Timmermans, Desirée JMA Beaujean, Jurriaan Oudhoff and Jim E van Steenbergen. 2011. "Monitoring the level of government trust, risk perception and intention of the general public to adopt protective measures during the influenza A (H1N1) pandemic in the Netherlands." *BMC public health* 11(1):575.

Van Eijk, Carola and Trui Steen. 2016. "Why engage in co-production of public services? Mixing theory and empirical evidence." *International Review of Administrative Sciences* 82(1):28–46.

Vanleene, Daphne, Joris Voets and Bram Verschuere. 2018. "The co-production of a community: Engaging citizens in derelict neighbourhoods." *VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations* 29(1):201–221.

Verschuere, Bram, Taco Brandsen and Victor Pestoff. 2012. "Co-production: The state of the art in research and the future agenda." *VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations* 23(4):1083–1101.

Voorberg, William H, Viktor JJM Bekkers and Lars G Tummers. 2015. "A systematic review of co-creation and co-production: Embarking on the social innovation journey." *Public Management Review* 17(9):1333–1357.

Voorberg, William, Sebastian Jilke, Lars Tummers and Victor Bekkers. 2018. "Financial rewards do not stimulate coproduction: Evidence from two experiments." *Public Administration Review* 78(6):864–873.

Wehde, Wesley, Jason M Pudlo and Scott E Robinson. 2019. ""Is There Anybody Out There?": Communication of Natural Hazard Warnings at Home and Away." *Social Science Quarterly* .

Whitaker, Gordon P. 1980. "Coproduction: Citizen participation in service delivery." *Public administration review* pp. 240–246.

Wise, Sean, Robert A Paton and Thomas Gegenhuber. 2012. "Value co-creation through collective intelligence in the public sector." *Vine* .

Wybron, Ian and Ally Paget. 2016. "Pupil power.".

Yang, Kaifeng and Marc Holzer. 2006. "The performance–trust link: Implications for performance measurement." *Public Administration Review* 66(1):114–126.