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Honey Bee Population Decline in Michigan: Causes, Consequences, and Responses to Protect the State's Agriculture and Food System

Michael Bianco, Jenny Cooper, and Michelle Fournier

Abstract

Michigan's current level of food production and its agricultural economy are in jeopardy due to drastic honey bee population declines across the state over the past seven years. This problem should be a priority for policy makers; honey bee losses affect almost everyone in the state because over a third of the food we consume is pollinated by bees. The causes of honey bee population decline are multiple and interconnected. A growing body of research shows that the principal factors involved are parasites and pathogens, environmental stressors, and monocrop farming, widespread use of pesticides, and industrial beekeeping practices within the paradigm of conventional industrial agriculture. In addition to individual stressors, there are synergetic interactions between some stressors that increase the vulnerability of managed honey bee colonies.

Many of Michigan's agricultural products—such as soybeans, dry beans, apples, blueberries, cherries, cucumbers, and other produce—depend on honey bee pollination to produce a good crop. Michigan is a state that relies heavily on pollination services to maintain its agricultural production, but it has been hard hit by honey bee population declines. Honey bee losses of more than 30% annually have been reported by Michigan beekeepers over the past few years, with the 2013/2014 winter poised to be even worse. Honey bee population declines in Michigan will likely not improve, and could continue to worsen, unless the problem is addressed by policy makers and other stakeholders in a substantive way. Because the problem involves many different causal factors and actors spanning agricultural production and consumption, potential solutions are also complex. There are various local-level mitigation measures that beekeepers, farmers, and the general public can implement, such as improving communication with beekeepers about pesticide application, reducing or eliminating the use of insecticides, and improving the area of habitat for bee-friendly forage. Initiatives to connect and support Michigan beekeepers using sustainable practices are also promising. But on their own, local steps are likely not enough to stem honey bee population declines; higher-level institutional approaches are also needed. A combination of facilitated dialogue among key Michigan stakeholders, legislation, and litigation originating at the state or national level could provide the additional impetus needed to rein in and reverse honey bee colony losses in the state. This paper provides recommendations for effectively implementing a multi-stakeholder dialogue process, and proposes modifications to legislation targeted at improving honey bee populations nationally.

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“The way humanity manages or mismanages its nature-based assets, including pollinators, will in part define our collective future in the 21st century. The fact is that of the 100 crop species that provide 90 per cent of the world's food, over 70 are pollinated by bees. Human beings have fabricated the illusion that in the 21st century they have the technological prowess to be independent of nature. Bees underline the reality that we are more, not less, dependent on nature's services in a world of close to seven billion people.”

-- Achim Steiner, UN Under-Secretary-General and UNEP Executive Director, 2011

The Road to Honey Bee Population Decline in Michigan

If you travel to the northern end of Michigan's famed highway M-22, you will find yourself in the pinky finger of the Michigan mitten, the Leelanau Peninsula. Leelanau is a rolling landscape of apples, pears, cherries, and grapes. Dotted among the orchards are fields of corn and soy, and patches of young woods. At first glance, the environment of the Leelanau Peninsula might appear to be an agricultural paradise. But where the asphalt turns into rough dirt at the dead end of the peninsula, you will find a bee yard strewn with discarded barrels of corn syrup and stacks of beehives from dead honey bee colonies. The bee yard belongs to Mr. Adams (name changed to protect confidentiality), a beekeeper who has kept honey bees almost his entire life. With nearly 10,000 hives, Mr. Adams maintains one of the largest commercial beekeeping operations in the state. He would be the first to acknowledge that his business, and the orchards that surround his bee yard, are endangered.

During the mid-1990s, Mr. Adams lost approximately 80 percent of his colonies to a tracheal mite epidemic. However, he, like the majority of other beekeepers who reported major losses, recovered his honey bee populations quickly as a result of a national tracheal mite mitigation campaign. In contrast to the brief dip in honey bee populations of the 1990s, Mr. Adams and beekeepers in many other countries have now been experiencing consistent heavy colony losses since 2005, which they say are unprecedented in severity and mystery.

Heading southeast across Michigan as the crow flies from the cherry capital of the world, Traverse City, toward the research and education hub of Ann Arbor, the path is flanked by some of the most important actors in the complex problem of honey bee population decline. At the beginning of the trip, one is surrounded by farms cultivating some of the nation's most robust crops of apples, blueberries, and cherries, all dependent on pollination services. Next along the path is Midland, home of Dow Chemical Company, a Fortune 50 corporation and one of the world's largest producers of pesticides. Then comes Lansing, Michigan's capital and home to the state Department of Agriculture and Michigan State University, a top agricultural research institution. All along the way, commercial and hobby beekeepers abound. In sum, Michigan exemplifies the diversity of actors invested in protecting food production and dealing with the crisis of honey bee population decline on a local, state, and national level.

This paper represents a one-year investigation into the complex causes and consequences of the current honey bee population decline, and potential responses that key stakeholders in Michigan can adopt to mitigate the problem. The investigation consisted of a literature review as well as author participation in various beekeeping conferences and meetings. Conversations with beekeepers

in Michigan and other states, as well as other key stakeholders, also helped guide our research and recommendations.

We begin the paper by outlining the state of honey bee population declines nationally and in Michigan. The second section describes some of the consequences of these declines for Michigan's agricultural production and economy. The third section summarizes the various factors that likely contribute to current honey bee population declines. In the fourth section we briefly identify local mitigation techniques that can be (and are being) implemented by farmers and beekeepers in Michigan. In the fifth section we present recommendations for combating honey bee population decline at the state and national level.

Honey Bee Population Decline

Honey bees (*Apis mellifera*) are currently in a state of rapid decline in many places around the world. Since 2005, colony collapse disorder (CCD) and other causes of honey bee mortality have resulted in the loss of about 30 percent of all managed honey bee colonies in the United States annually, about twice the expected mortality rate (Smith et al. 2014; VanEngelsdorp et al. 2012). CCD is characterized by the mysterious disappearance of honey bees from their hive, except for the queen and brood, without evidence of a hive invader or dead bees remaining in the hive (Smith et al. 2014). However, while CCD has been one of the most visible and perplexing manifestations of honey bee losses over the past nine years, particularly in the United States, it appears to be a relatively minor component of a much broader decline in managed honey bee populations and health. As some researchers have pointed out, “we must be careful to not synonymize CCD with all honey bee losses” (Williams et al. 2010). In this paper we consider honey bee population declines in general, including from colony collapse disorder and other causes.

Statistics regarding the magnitude of honey bee colony losses are shocking. The Bee Informed Partnership, coordinated by the International Bee Research Association, began conducting an annual survey in 2006 of thousands of beekeepers across the United States about colony mortality rates and perceived causes of mortality (VanEngelsdorp et al. 2012). In total surveyed beekeepers have hundreds of thousands of honey bee colonies. Even with a net purchase of tens of thousands of colonies each year among those surveyed, the average honey bee colony losses over the last seven years are about 30 percent per year, roughly double the expected rate (see Table 1). Beekeepers consider acceptable colony losses to be around 13 percent, and researchers consider a normal (before the advent of CCD) annual mortality rate to be about 15 percent (Rucker et al. 2011).

Table 1. Total estimated losses of managed honey bee colonies in the United States, 2006-2013.

Winter season	Estimated percent of total colony losses in the U.S.
2006/2007	32%
2007/2008	36%
2008/2009	29%
2009/2010	34%
2010/2011	30%
2011/2012	22%
2012/2013	31%

Source: VanEngelsdorp et al. 2012; Bee Informed Partnership 2013

In Michigan, beekeepers reported a loss of 34.8 percent of the total colonies in the state in 2011/2012 (VanEngelsdorp et al. 2012). While official statewide numbers have yet to be released for colony losses over the winter of 2013/2014, there is reason to believe that this winter caused high mortality among Michigan colonies, with some small-scale beekeepers reporting losses of up to 90% of their colonies (SEMBA 2014). A 2014 USDA report states that “the harsh winter has taken a toll on bees across [Michigan]. In the Southeast, 70 beekeepers were surveyed and reported severe losses: in September 2013, 581 hives were reported alive and by March 2014, only 256 hives had survived, or a 56% loss.... Similar statistics have been reported in other regions of the state” (USDA National Honey Report 2014).

In spite of growing scientific and public awareness of these massive honey bee die-offs, efforts to date have been unable to substantively address the crisis. The dearth of collaboration and coordination to assess the challenges and propose solutions among policy makers and the scientific, corporate, farming, and beekeeping communities has presented a major barrier to comprehensively combating honey bee losses. A lack of broad consensus among key stakeholders regarding the causes of honey bee population decline also presents formidable obstacles to action. However, there is an extensive and growing body of research on the issue, with enough evidence to begin drawing conclusions and taking action based on the results of existing studies.

Consequences of Honey Bee Population Decline in Michigan

The crisis of honey bee population decline merits a swift and serious response from policy makers and other actors in Michigan and nationally. This is principally because of the strong reliance of a large proportion of agricultural production on pollination by honey bees and wild pollinators. Out of the 115 most important food crops globally, 87 (or 75 percent) depend on pollination by animals, such as honey bees, for the production of the fruit, vegetable or seeds (Klein et al. 2007). In terms of the quantity of global food production, about 35 percent of the food we eat requires pollinators (Klein et al. 2007). Honey bees pollinate almost all of the fruits, vegetables, and nuts grown in the United States. Thus, honey bee population decline is emerging as a significant threat to food production in the United States and many other countries (Potts et al. 2010).

In Michigan, the sharp decline in survivorship and health of honey bee colonies is a problem because many crops require the pollination services provided by managed honey bees. These crops

generate significant income for producers and contribute to Michigan's food system and the cultural identity of the state. The agriculture and food industry in Michigan contributes over \$90 billion annually to the state's economy, with the largest growth sector coming from farming (MI Department of Agriculture and Rural Development 2013). Michigan stands ninth in the nation in honey production (USDA National Honey Report 2014). Fruit and tree nut production in the state was worth an average of \$344 million annually over the years 2008-2012, with the potential value being even higher (in 2007 these crops were worth close to \$420 million) (National Agricultural Statistics Service 2013). Vegetable production generated an average of \$249 million from 2008 to 2012 (National Agricultural Statistics Service 2013). In addition, some of these crops have significance for the cultural identity of Michigan and also contribute to tourism revenues, such as from the National Cherry Festival held in Traverse City.

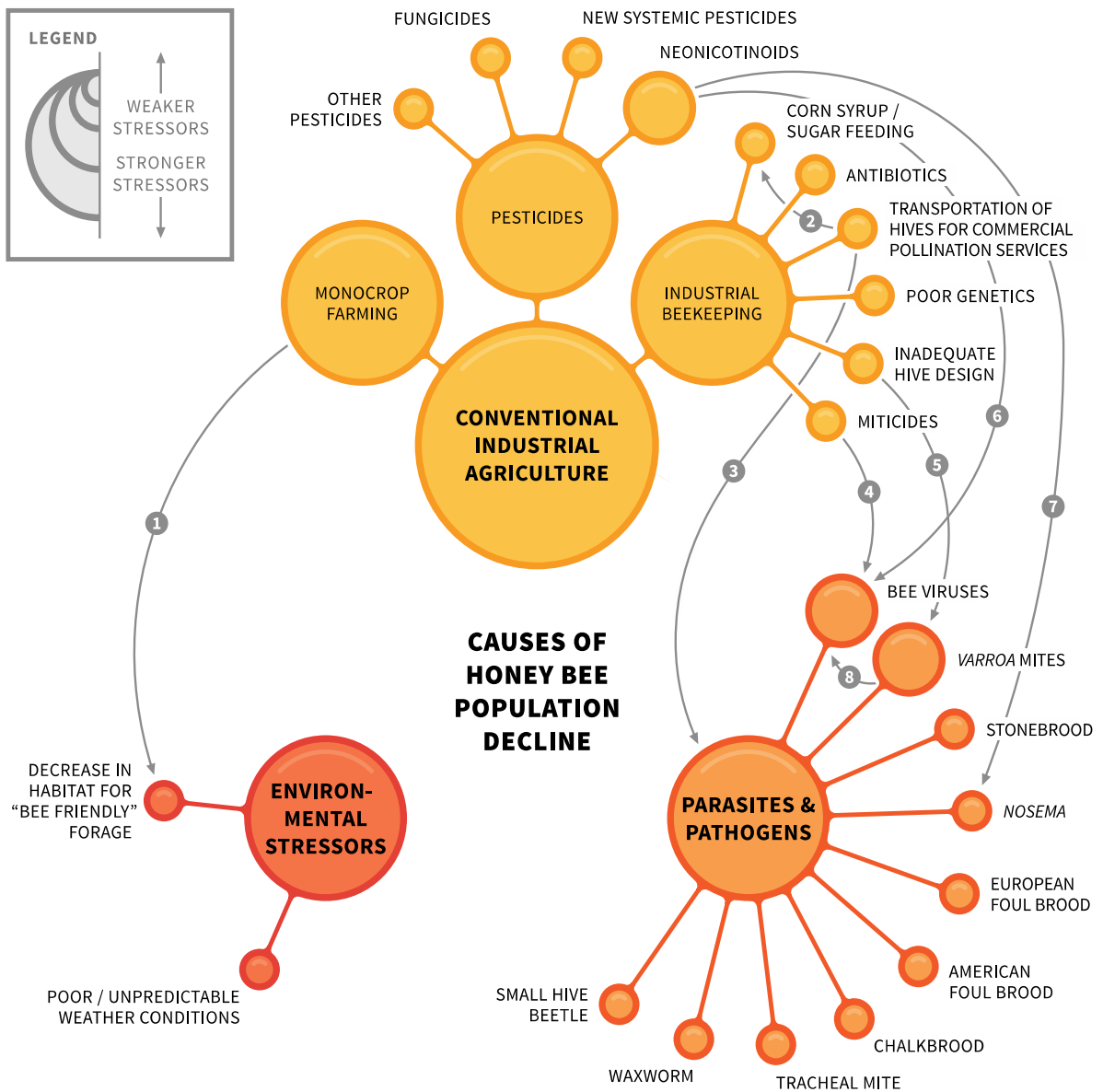
Apples, blueberries, cherries, cucumbers, dry beans, peaches, pears, plums, soybeans, and squash are all produced in Michigan. All of these either require animal pollination—mostly honey bees and wild pollinators—to produce, or the yield is significantly greater and of higher quality with animal pollination (Klein et al 2007). Estimations have not yet been made as to how much crop production and value has likely been lost in Michigan as a result of the decline in honey bee availability for crop pollination in recent years. But given the critical importance of pollination for the successful fruiting of so many crops produced in the state, we can expect further impacts of honey bee decline on the agricultural sector if the crisis is not rapidly mitigated. As just one example, the USDA's National Agricultural Statistics Service reported that in Michigan, usually the largest producer of tart cherries in the United States, "the majority of growers lost all of their harvestable crop" in 2012 because of atypical weather and the fact that "pollination conditions were poor." The combined factors resulted in a drop from 157.5 million pounds of tart cherries harvested in 2011 to an estimated 5.5 million pounds in 2012 (National Agricultural Statistics Service 2012).

In addition, with such high honey bee mortality rates, Michigan farmers face elevated and increasing costs of commercial pollination services. According to a local commercial beekeeper, the current price was \$65 to \$75 per hive in Michigan in the 2013 season. In California, where there is now an extreme shortage of honey bees owing to heavy losses, growers pay \$145 - \$165 per hive—more than triple the average cost before the emergence of CCD in 2005 (Olliver 2012).

Causal Factors

Research to date has identified several factors that are likely contributing to honey bee declines, and it is evident that the cumulative negative impacts of multiple stressors create lethal conditions for honey bees (Doublet et al. in press; Potts et al. 2010; Smith et al. 2014). Scientists and beekeepers have identified various causal factors which can be divided into three main categories: parasites and pathogens; environmental stressors; and conventional industrial agriculture. But rather than focus on individual stressors, it is critical to consider factors contributing to the current extremely high rates of honey bee mortality as an interconnected web of causality (Figure 1).

Figure 1. Web of causality for the current decline in honey bee populations across the United States.



CONNECTIONS BETWEEN STRESSORS

- 1 **Monocrop farming ► decrease in habitat.** Can create “food deserts” when the crop does not provide forage for the bees, or when a crop that does provide forage is not flowering. Also tends to eliminate uncultivated habitat that provides diverse forage for bees.
- 2 **Transportation of hives ► corn syrup/sugar feeding.** Beekeepers often feed the bees corn syrup or sugar mixtures while they are in transit and unable to forage.
- 3 **Transportation of hives ► parasites & pathogens.** Facilitates rapid and geographically broad transmission of bee parasites and pathogens to previously uninfected bees.
- 4 **Miticides ► bee viruses.** May increase honey bees’ susceptibility to viruses (Locke et al. 2012).
- 5 **Inadequate hive design ► Varroa mites.** The typical honeycomb foundation pattern used in industrial beekeeping has been found to facilitate *Varroa* infestation (Piccirillo and De Jong 2003).
- 6 **Neonicotinoids ► bee viruses.** Can increase honey bees’ susceptibility to viruses by weakening their immune systems (Di Prisco et al. 2013; Doublet et al. in press).
- 7 **Neonicotinoids ► Nosema.** Can increase the severity of honey bees’ infection with the microsporidian *Nosema* (Doublet et al. in press).
- 8 **Varroa mites ► bee viruses.** Serve as a mechanical and biological vector for viruses. The mites provide viruses an entry point into bees’ bodies and help transmit viruses between bees (Martin et al. 2012).

Parasites and Pathogens

Parasites and pathogens are considered by many to be principal actors in the high losses of bees that are occurring in many countries in the northern hemisphere (Dainat et al. 2012; Smith et al. 2014). In particular, the parasitic mite *Varroa destructor* has received much of the blame for honey bee colony failures, especially because of its ability to serve as a vector for bee viruses (Martin et al. 2012). Three viruses in particular have been associated with heavy losses of honey bees during the winter: deformed wing virus, acute bee paralysis virus, and Israeli acute bee paralysis virus (Dainat et al. 2012). Other important viruses that can weaken or kill honey bees include Kashmir bee virus, black queen cell virus, chronic paralysis virus, and sacbrood virus (Chen and Siede 2007). Very recently, tobacco ringspot virus has also been posited by one group of researchers as a significant causal factor in honey bee weakening and winter colony collapse (Li et al. 2014). *Nosema*, a type of microscopic parasitic fungus, has also been identified as a potential agent contributing to honey bee losses, though its role remains unclear (Chen et al. 2008). These pathogens and parasites represent a small portion of the many viruses, fungi, bacteria, and arthropods that endanger the health of managed honey bee colonies. As Figure 1 illustrates, many of the pathogens and parasites that affect honey bees also interact synergetically with other factors which have deleterious effects on colony health and survivorship.

Environmental Stressors

Like all organisms, honey bees are affected by aspects of the environment in which they live. Changes in this environment such as extreme weather events and shifts in the global climate regime, may directly influence honey bee behavior and physiology, potentially “giv[ing] rise to new competitive relationships among species and races [of honey bees], as well as among their parasites and pathogens” (LeConte and Navajas 2008). While beekeepers cannot control the climate (except by transporting their bees south out of Michigan in the winter, which some commercial beekeepers do), it needs to be taken into consideration, especially the potential for harsh weather to exacerbate other challenges to colony health.

The area of habitat that can provide “bee-friendly” forage, both for managed honey bees and wild pollinators, has also greatly decreased from historical levels. Bee-friendly habitat includes areas of vegetation with diverse flowering species, including melliferous trees and native vegetation that provide ample shelter, nectar, and pollen-producing sources on a constant blooming cycle throughout the months bees are active. Unlike many wild pollinators, managed honey bees can do well in disturbed and fragmented habitats, but they still require sufficient food sources in these areas (Potts et al. 2010). In addition, pesticide drift into areas where bees forage may be a concern, though little is known about the extent of this problem (Pettis et al. 2013). The effects of pesticides are discussed below in the context of agriculture, but it should also be mentioned that use of neonicotinoids on gardens and lawns also negatively affect honey bees and other pollinators (Hopwood et al. 2012; Larson et al. 2013).

Conventional Industrial Agriculture: Monocrop Farming

Conventional large-scale agriculture in the United States today typically includes a suite of practices such as planting large areas with a single crop species, or monocropping; application of chemical fertilizers, pesticides, and herbicides (depending on the type of crop and variety); and the use of

commercial pollination services for crops that rely on honey bee pollination. Monocropping to some extent necessitates the use of agrochemicals and industrial-scale beekeeping to provide pollination services. But on their own, large monocultures also pose a problem for the health and stability of honey bee populations as well as other pollinators. Monocultures have replaced large areas of native vegetation in some regions of the United States, including much of Michigan. Some researchers have suggested that poor bee nutrition resulting from foraging primarily on large monocultures is an important factor in honey bee losses (Johnson et al. 2010). Bee-pollinated monocultures provide an abundance of plants producing nectar and pollen for food, but only of one type and only for a brief period of time (Decourtye et al. 2010). Having access to a diversity of pollen sources at any given time may be an important missing link to maintain honey bee colony health.

Conventional Industrial Agriculture: Pesticides

An increasing number of studies have found that particular pesticides play a central role in the current high rates of honey bee mortality. Honey bees are exposed to pesticides and other chemicals commonly used in agriculture via numerous pathways including direct exposure, exposure through the pollen and nectar of plants treated with systemic pesticides, and exposure through the food that beekeepers feed to bees (pesticide residues in high fructose corn syrup).

Neonicotinoids are a type of systemic insecticide that act as a neurotoxin to honey bees and other insects. The neonicotinoid class of insecticides is the most widely used pesticide in the United States and internationally, and is increasingly being implicated in the decline of honey bee populations, despite a paucity of large-scale field studies (Blacquiere et al 2012). The neonicotinoid class of insecticides includes acetamiprid, clothianidin, dinotefuran, imidacloprid, thiamethoxam, and others, manufactured under many different trade names in the United States, mainly by Bayer CropScience and Syngenta. A growing number of studies are finding that “at field realistic doses, neonicotinoids cause a wide range of adverse sublethal effects in honey bee and bumble bee colonies, affecting colony performance through impairment of foraging success, brood and larval development, memory and learning, damage to the central nervous system, susceptibility to diseases, [and] hive hygiene” (Van der Sluijs et al. 2013). Researchers recently concluded that initially sub-lethal exposure of honey bees to thiamethoxam later causes high mortality owing to homing failure (Henry et al. 2012). Another study found “convincing evidence that exposure to sub-lethal levels of imidacloprid in HFCS causes honey bees to exhibit symptoms consistent to CCD 23 weeks post imidacloprid dosing” (Lu et al. 2012).

Citing evidence from a growing number of studies, the European Union tightly restricted the use of three types of neonicotinoids (clothianidin, imidacloprid, and thiamethoxam) in 2013, although Bayer CropScience and Syngenta have sued to overturn the ban (U.S. EPA 2013). The U.S. Environmental Protection Agency (EPA) does not currently ban or severely restrict the use of neonicotinoid pesticides, although, “based on currently available data, the EPA's scientific conclusions are similar to those expressed in the [European Food Safety Authority's] report with regard to the potential for acute effects and uncertainty about chronic risk” (U.S. EPA 2013).

A new type of systemic insecticide about which many beekeepers and public stakeholders have expressed concern are sulfoximines. Sulfoxaflor is so far the only pesticide synthesized in this class and it is produced exclusively by Dow AgroSciences. Sulfoxaflor is acutely toxic to honey bees, but it has a very short half-life in the environment, which purportedly reduces the risk to bees

(Brinkmeyer, Juberg and Kramer 2013). Because it has only recently gained EPA approval (Federal Register 2013), few independent studies have been published about its effects on pollinators. The National Honey Bee Advisory Board, national beekeeping organizations, and individual beekeepers filed an appeal to the EPA in 2013 to rescind the approval of sulfoxaflo on the grounds that it has not yet been proven safe (Earthjustice 2013). More extensive and field-realistic testing is needed on the effects of sulfoxaflo and other systemic insecticides on honey bees, including impacts on colony overwintering success.

Conventional Industrial Agriculture: Industrial Beekeeping

There are several stressors resulting from current conventional beekeeping practices that likely contribute to the weakening of honey bee colonies and colony losses. Industrial-scale beekeeping practices are likely the biggest contributor, but conventional small-scale beekeeping practices can also be detrimental. Long-distance transportation of bees to provide pollination services likely causes stress to transported colonies, though there is little information to date about the effects of transportation per se on honey bees. More importantly, transportation of honey bee colonies for pollination and long-distance shipment of bees to form new colonies provide an opportunity for the spread of parasites and pathogens such as *Nosema* (Klee et al. 2007).

Prolonged exposure to moisture in the hive poses a threat to honey bees. Many small-scale beekeepers are debating whether the current industry standard Langstroth hive design, which has been used since the nineteenth century, provides adequate ventilation of moisture in winter conditions. Other research suggests that current honeycomb foundation patterns are set to a diameter conducive to *Varroa* mite infestation, and that the reduction of cell size (small-cell combs) may be a viable option for combating mites (Piccirillo and De Jong 2003). Therefore, while current commercial hive designs may be conducive to large-scale pollination services, the design may be a factor endangering honey bee populations. As a result, some small-scale beekeepers are looking to alternative hive designs, such as the top bar hive, that allow bees to dictate their own cell diameter as a means to combating *Varroa* mite infestations (Piccirillo and De Jong 2003).

Commercial beekeepers also typically rely on high fructose corn syrup (HFCS) to feed their bees in the absence of adequate nectar sources and during transportation. Current research suggests that the use of HFCS may be dangerous to honey bee digestion because it may form a toxic compound under typical temperature conditions (LeBlanc et al. 2009). Additionally, conventional beekeeping practices often utilize miticides and antibiotics to treat infections and infestations in honey bee hives. At least one research group has found that while the application of miticides is generally effective at controlling *Varroa* mite infestations, the miticide itself appears to increase honey bees' susceptibility to viruses (Locke et al. 2011). Furthermore, small-scale beekeepers are beginning to question whether miticides are beginning to produce miticide-resistant *Varroa* (SEMBA 2014).

Some research has shown that a lack of genetic diversity among honey bee populations significantly lowers the probability of colony survivorship (Potts et al. 2010; Tarpy et al. 2013). Many beekeepers have expressed concern over the lack of genetic diversity among managed honey bee populations in the United States, and are concerned with the possible risks associated with a small honey bee gene pool. The United States Department of Agriculture has begun to take the positive step of importing Russian honey bees (*Apis mellifera cerana*) which are more resistant to *Varroa* mites.

However, further research is needed to assess the potential for increasing the diversity of the national honey bee gene pool by importing heritage breeds of Eastern and Western European bees including subspecies *Apis mellifera mellifera*, *Apis mellifera carnica*, and *Apis mellifera ligustica*.

Synergetic Effects

Further complicating the picture, some of the multiple factors that are likely contributing to honey bee losses also interact synergetically with one another: the combined effect is greater than the sum of the deleterious impacts of individual factors (also known as additive interaction). For example, researchers have demonstrated that exposure to field-realistic sub-lethal doses of neonicotinoid pesticides may weaken bees' immune systems, making them more vulnerable to pathogens and parasites such as *Nosema* and bee viruses (Di Prisco et al. 2013; Doublet et al. in press). Other researchers have found that the combinations of different insecticides and fungicides to which honey bees are exposed during foraging in agricultural fields and surrounding areas can have sub-lethal negative effects on the bees, including increased probability of *Nosema* infection (Pettis et al. 2013). The susceptibility of honey bees to pathogens and parasites is also likely influenced by climate. For example, particularly harsh winters seem to produce greater colony losses. However, much more research is needed to better understand the interactions between different factors that are likely contributing to the widespread decline in managed honey bee populations.

Local Steps to Mitigate Honey Bee Population Decline in Michigan

Considering the complex web of causality contributing to steep losses of honey bees in Michigan and across the United States, it is probable that multiple actors are contributing to the problem either directly or indirectly. In addition, it is clear that honey bee population declines are having negative effects on both large- and small-scale farmers, commercial and hobby beekeepers, the food processing industry, consumers of Michigan produce, and many others. To address the interconnected factors contributing to honey bee population decline, a multifaceted and coordinated response from a variety of stakeholders is required. We need to address honey bee population declines both on the ground—in farm fields and bee yards across Michigan—and at the level of local, state, and national institutions.

There are many strategies that farmers, beekeepers, and the general public can implement to reduce the number and intensity of stressors on honey bees, leading to healthier and more resilient colonies and a reduction in the incidence of hive mortality. These strategies promote the development of agricultural and ornamental (lawn and garden) environments that are more conducive to honey bees and native pollinators. A “bee-friendly” environment may have the following characteristics:

- Contains significant areas of habitat with diverse food sources throughout the months that bees are active, including melliferous species of trees and native vegetation (those with flowers that contain nectar and pollen accessible to honey bees).
- Provides an adequate supply of clean water.
- Reduces or eliminates the use of pesticides and other agrochemicals, with an emphasis on eliminating systemic pesticide exposure.

Strategies for farmers to promote bee-friendly environments include the following:

- Planting or allowing growth of native vegetation, including cropland margins, that provides a diverse range of food sources for honey bees.
- Reducing monocropping in favor of a more diversified planting scheme (intercropping), which could include the use of melliferous cover crops.
- Reducing or eliminating the application of pesticides, particularly systemic insecticides, and avoiding pesticide drift onto field margins and other native vegetation.
- Communicating with beekeepers within a six-mile radius of pesticide application sites to ensure that honey bees are kept away from fields during and after application (the duration of time depends on the type of insecticide), and treating crops long before blooming occurs to reduce the number of pollinators in the vicinity and provide time for the chemicals to break down.
- Incorporating beekeeping as an integral part of agricultural practices.

Some of these changes, such as improving communication between farmers and neighboring beekeepers, can be implemented relatively easily and are already occurring in some cases. Other changes, such as increasing the area of bee-friendly habitat and reducing the use of insecticides, require a fundamental shift in how conventional agricultural commodities are produced. But one doesn't need to look very far to find examples of Michigan farmers that are implementing viable solutions to protect local honey bee populations. One such farmer is Jim Koan, owner of Almar Orchards, an organic apple farm and cider brewery. Almar Orchards features a variety of melliferous crops maintained by agroecological methods that promote integrated pest management and a bee-friendly landscape. Almar Orchards demonstrates that a bee-friendly farm can adequately satisfy the triple bottom line of social, environmental, and economic sustainability, while producing high-value agricultural products.

In addition to farming practices, some small-scale beekeepers are passionately pursuing sustainable practices with the goal of stabilizing honey bee populations in Michigan. One such beekeeper is Dr. Therese McCarthy, a veterinarian in southeast Michigan who began beekeeping four years ago. Dr. McCarthy has committed herself and her resources to fighting honeybee population declines. She is also a treatment-free beekeeper, rejecting the use of miticides, antibiotics, and sugar/HFCS feeding, and is a model for small-scale beekeepers committed to good practices. She keeps extensive journals for each colony to monitor conditions of the hive in relation to conditions in the environment. She regularly checks her bees and monitors for potential parasites and pathogens. In addition, she communicates with the farmer next door and locks her bees in the hive when she knows the fields around her are going to be sprayed with pesticides.

However, the emergence of better beekeeping practices such as Dr. McCarthy's has so far been slow and isolated. This is largely due to a lack of organization and communication among first-tier stakeholders. In response to this deficit, Dr. Meghan Millbrath, a beekeeper and researcher at Michigan State University, founded the Northern Bee Network (NBN) in 2014. The NBN is "an organization designed to support beekeepers in the Northern States by promoting collaboration between beekeepers and by providing resources for more sustainable beekeeping" (Northern Bee Network 2014). Its objectives include "improving the stock of locally adapted northern bees, providing an interface to connect Northern beekeepers, providing resources for sustainable apiary

expansion, [and] increasing access to local bees” (Northern Bee Network 2014). The project, which exists largely as a website, hosts a directory of beekeepers who sell honey bee drones and queens, and are willing to mentor new beekeepers. The NBN also seeks to facilitate a queen/drone exchange to promote genetic diversity and to facilitate bulk purchases of queens to strengthen desired genetic traits. The Network also provides a forum for clubs to list their information and events, thus allowing beekeepers in Michigan to communicate with each other and to build community. However, the NBN is largely a labor of love and is dependent on both Dr. Millbrath’s volunteered time and resources.

The efforts of individuals such as Jim Koan, Dr. Therese McCarthy, and Dr. Meghan Millbrath have yet to be supported at the state level. However, encouraging and providing resources to expand the implementation of sustainable bee-friendly practices on the ground and supporting incipient organizations like the Northern Bee Network are very proactive and feasible steps the state government could take to protect Michigan’s agriculture and food systems.

Institutional Approaches to Mitigate Honey Bee Population Decline in Michigan

To reduce the threat of continued honey bee population decline, we must pursue synergetic solutions at multiple levels of decision making. Stepping back from local mitigation strategies to a state- and national-level perspective, we have identified three avenues to protect Michigan’s food production from continued honey bee population decline: facilitated multi-stakeholder discussion, legislation, and litigation.

These three paths are not mutually exclusive and should not be pursued in isolation. Rather, these actions are interrelated and, if pursued without open communication among stakeholders, they could prove counterproductive to effectively mitigating honey bee population decline. For example, in the absence of attempted open dialogue, the path of litigation could result in inhibited information sharing and communication. Communication is critical to resolving the interwoven set of challenges associated with honey bee population decline. Similarly, legislation in the absence of open dialogue and stakeholder engagement can produce policy that fails to comprehensively address the challenges of honey bee population decline. Finally, open dialogue can arguably only go so far; in the absence of policy changes—whether governmental or organizational—discussion can have limited impact.

Facilitated Multi-Stakeholder Discussion

Taking into consideration these interconnections and the dearth of inter-sectoral collaboration on this issue, our recommendation is to create an inclusive, facilitated set of discussions among key stakeholders. Stakeholders should represent expertise in diverse areas related to pollinators, honey bee population decline, and the food system. This stakeholder engagement process could start in Michigan, but could also serve as a model for similar processes regionally and nationally.

There are many models for stakeholder engagement. However, given the diversity of key actors impacted by honey bee population declines in Michigan, it is critical to design a stakeholder engagement process that builds trust, transparency, and communication, and facilitates collaborative and effective solutions. Valuable lessons can be drawn from three examples of multi-stakeholder

engagement processes: Sustainable Harvest, a U.S.-based coffee importer founded in 1997; the Pebble Mine in Bristol Bay, Alaska; and the Dow Chemical Company's partnership with People for the Ethical Treatment of Animals (PETA).

Sustainable Harvest is a certified B Corporation, purchasing coffee from 84 producer organizations in Latin America and Africa. Their work supports nearly 200,000 farmers. This company, which has experienced rapid growth over the past decade, has been remarkably successful in tackling sustainability challenges through hosting annual "Let's Talk Coffee" gatherings, a series of events aimed at facilitating international, inter-sectoral, intra-supply chain collaboration (Sustainable Harvest 2013). "Let's Talk Coffee" involves key actors in the coffee supply chain, as well as experts in related subjects, in a multi-day conference aimed at relationship building and "cultivating a community of trust" (Sustainable Harvest 2013). The conference includes workshops, lectures, communal meals, and time for informal interactions and collaboration. Attendees include both small and large coffee producers and roasters, corporate executives from large-scale coffee buyers/sellers (e.g. Walmart), politicians, agronomists, climate scientists, and many others (Sinclair 2012). All of the participants' work and lives are intertwined with the coffee business in the fields, markets, and laboratories. Sustainable Harvest provides an innovative, scalable model that could inspire multi-stakeholder discussion to mitigate honey bee population decline in Michigan.

Additional lessons can be drawn from stakeholder engagement experiences with the Pebble Mine in Bristol Bay, Alaska and the Dow Chemical Company's partnership with PETA. While both of these cases have lengthy histories and warrant further study, there are two highly applicable lessons to the challenge of mitigating honey bee population declines in Michigan. First, productive, lasting partnerships, common ground, and collaboration can be cultivated between entities with seemingly divergent objectives. The Dow Chemical Company and PETA have starkly different missions; one is a leading chemical and plastics company, the other an international non-governmental organization dedicated to animal rights. However, the two have found some common ground and formed a strong partnership through a lengthy process that included shareholder petitions followed by open dialogue (Gregory Bond 2013).

Second, a neutral third party should convene the discussion series as well as choose the facilitator to mediate the process. Pebble Limited Partnership (PLP)—a large company that proposed a copper mine near Bristol Bay, Alaska—hired a policy resolution group to review the copper mine proposal and convene a stakeholder dialogue about mining in the area. However, key stakeholders in the process saw PLP's efforts as not being made in good faith and not helping to build trust (Reynolds 2012). This example shows that effective stakeholder dialogue around contentious problems is best when convened by a third party and when that third party selects the facilitators, as opposed to a party with vested interests facilitating the dialogue.

Weaving these lessons from Sustainable Harvest, Pebble Mine, and the Dow/PETA partnership together, an effective multi-stakeholder discussion series could be designed to find solutions to mitigate honey bee population decline in Michigan. A consortium of universities around Michigan, such as the University of Michigan, Michigan State, Michigan Tech, Central Michigan, and Wayne State, could serve as a convening body and provide or help select facilitators. The organizers of these discussions could pursue Federal and state government funding opportunities and reach out to Michigan-based foundations that may be invested in the issue. The multi-stakeholder discussion could include participants from the government, the private sector, NGOs, and research

universities, representing a diverse array of fields including, but not limited to: agriculture (industrial, small-scale, organic); apiculture (commercial and non-commercial, treatment-free and conventional); entomology; toxicology; agricultural chemical production and sales; ecology and biology (including entomological neuroscience and neurology); law; and local, state, and federal policy (including legislators, EPA, and the Michigan Department of Environmental Quality).

The objective of the discussion series would be to share cutting-edge research findings and best practices in a manner that enables and expedites constructive, scalable approaches to mitigating honey bee population decline and ensuring the viability and health of honey bee populations in perpetuity. This type of multi-stakeholder discussion series could take many forms, but looking to lessons learned from similar processes yields recommendations that the discussions should be

- convened by a neutral third party;
- facilitated by a neutral third party agreed upon by both public and private sector participants with objectives and timeline agreed upon by all parties;
- conducted using Chatham House rules (or similar to ensure candid participation from stakeholders);
- located in an environment and setting that facilitates both formal and informal interactions, community, and group cohesion (e.g., around communal meals, collaborative projects/activities).

Legislation and Litigation

Facilitated multi-stakeholder dialogue has the potential to catalyze trust and collaboration across sectors to develop strategies to mitigate honey bee population decline. However, in concert with discussions, the need for legislation or litigation may arise. Legislation and litigation have the potential to be collaborative, but if done in the absence of efforts to engage in constructive dialogue may be seen as divisive and antagonistic. Given the scale of the challenge of pollinator decline both in Michigan and the United States, there is a dire need for policy change via state and federal legislation on the issue, as well as shifts in the internal policies of major stakeholders that impact pollinators, such as commercial beekeepers, large-scale farmers, and agrochemical companies.

Legislation is currently pending in the U.S. House of Representatives that aims to, at least in part, address some potential causes of honey bee population decline. The legislation, titled “Save America’s Pollinators Act of 2013” (H.R. 2692), is sponsored by Michigan Representative John Conyers, Jr. It directs the EPA Administrator to suspend the registration of neonicotinoids until it is scientifically proven that such pesticides do not “cause unreasonable adverse effects on pollinators, including honey bees.” H.R. 2692 also calls on the EPA Administrator to conduct a series of additional studies regarding the impacts of neonicotinoids on pollinators. As of April 2014, the bill has bipartisan support and 57 co-sponsors. It was referred to the House Subcommittee on Horticulture, Research, Biotechnology, and Foreign Agriculture in July 2013 (Library of Congress 2013).

The introduction of H.R. 2692 demonstrates that the issue of honey bee population decline is of national importance. As the legislation goes through the process of committee mark-up, it would greatly benefit from additional stakeholder input. To be more comprehensively effective, the scope of the legislation should be broadened from only addressing the “nitro group of

neonicotinoid insecticides” to incorporate “all systemic insecticides, including the nitro group of neonicotinoid insecticides and sulfoximines.”

Successful enactment of much tighter protections of honey bees and other pollinators at the national level would probably be more effective at mitigating honey bee population decline than state-level legislation, in part because of the long interstate distances over which honey bees are transported. However, given that federal-level action seems unlikely in the short term, Michigan’s policy makers should take immediate action to protect the state’s food production and agricultural economy by promulgating legislation similar to the “Save America’s Pollinators Act of 2013.” Like national policy, state legislation should be developed as a collaboration among beekeepers, farmers, scientists, economists, agrochemical companies, environmental advocacy groups, and legislators. Such collaboration would not only strengthen the efficacy of pollinator legislation, but also prevent the promulgation of policies that threaten pollinator health.

Conclusion

The causes of honey bee population decline are multiple and interconnected. A growing body of research shows that the principal factors involved are parasites and pathogens such as *Varroa* mites and bee viruses; environmental stressors like loss of foraging habitat; and monocrop farming, widespread use of pesticides, and industrial beekeeping practices within the paradigm of conventional industrial agriculture. Synergetic interactions between some stressors reinforce the web of causality leading to honey bee population declines. For example, sublethal exposure to neonicotinoid insecticides has been shown to increase honey bees’ susceptibility to bee viruses. These various interacting stressors increase the vulnerability of managed honey bee colonies in the United States and many other countries, and jeopardize the yields of pollinator-dependent crops.

Michigan is a state that both relies heavily on pollination services to maintain its agricultural production and has been hard hit by honey bee population declines over the past few years. Many of Michigan’s agricultural products—such as soybeans, dry beans, apples, blueberries, cherries, cucumbers, and other produce—depend on honey bee pollination to produce a good crop. It is particularly concerning that honey bee losses of more than 30% annually have been reported by Michigan beekeepers over the past few years, with the 2013/2014 winter poised to be even worse. Honey bee population declines in Michigan will likely not improve, and could continue to worsen, unless the problem is addressed by policy makers and other stakeholders in a substantive way.

Because the problem involves many different causal factors and actors spanning agricultural production and consumption, potential solutions are also complex. No silver bullets are evident. There are various local-level mitigation measures that beekeepers, farmers, and the general public can implement, such as improving communication with beekeepers about pesticide application, reducing or eliminating the use of neonicotinoid insecticides, and improving the area of habitat for bee-friendly forage. Initiatives to connect and support Michigan beekeepers using sustainable practices such as the Northern Bee Network are also promising. But as important as they are, these local steps are likely not enough to stem honey bee population declines because the problem transcends the local level. Higher-level institutional approaches are also needed. A combination of facilitated dialogue among key Michigan stakeholders, legislation, and litigation originating at the state or national level could provide the additional impetus needed to rein in and reverse honey bee

colony losses in the state. In addition to further identifying the causes and impacts of honey bee population decline, facilitated multi-stakeholder dialogue and collaboration could prove critical to exploring and implementing solutions to this wicked problem.

The reality is that honey bee population decline affects almost everyone in Michigan; we all buy food that was pollinated by honey bees. Michigan's current level of food production and its agricultural economy are clearly in jeopardy unless honey bee populations are stabilized. This problem should be a priority for policy makers in Lansing and Washington, D.C. alike.

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Two

Red Dirt, Red Alert: How Oklahoma State Energy Policy Harms National Security

Charles Dickerson

Abstract

In 2008, the Defense Science Board released a report that found multiple points of vulnerability in the U.S. electrical grid, which include cascading power outages caused by accidental overload, severe weather, and sabotage. Despite its frailty, domestic military installations derive nearly all of their electricity from the commercial grid. By conducting an analysis of pertinent government and private-sector reports, this paper argues that the state of Oklahoma can have a substantial effect on installation energy security by changing its utility regulation and renewable energy policies. Because of its inadequate renewable energy policy and critical military installations, Oklahoma provides a telling example of how individual states can affect both national and international security. This paper finds that renewable energy sources are uniquely suited to provide energy security to military bases.

Charles Dickerson is a political science student at the University of Central Oklahoma. His research interests include defense and strategic studies.

Introduction

In 2008, the Defense Science Board (DSB) released a report, *More Fight, Less Fuel*, that found multiple points of vulnerability in the commercial electrical grid. These include cascading power outages from accidental overload; severe weather; and acts of sabotage such as a cyber-attack, electro-magnetic pulse (EMP), and terrorist attacks on critical infrastructure. Castillo (2012) provides reasons why on-site solar photovoltaic (PV), which converts sunlight into electricity, could potentially shield U.S. military installations from the devastating effects of a prolonged black-out. Unfortunately, neither the DSB nor Castillo (2012) discuss the role individual states could play to ensure energy security for the Department of Defense (DOD).

The literature on DOD energy security in Oklahoma is sparse. Nesse et al. (2011) examines the possibilities for alternative energy sources at Fort Sill. However, this report only focuses on one of Oklahoma's five military installations, barely mentions the role of state energy policy, and does not approach renewable energy as a tool to provide energy security. At the time of this writing (October 2013), I could not find any scholarly articles discussing how Oklahoma's renewable energy policy can help or hinder DOD's energy security goals.

Through a thorough analysis of DOD, private sector, and various think-tank reports, this paper outlines a theoretical basis to support the claim that the State of Oklahoma can have a significant effect on national and state security by making changes to its utility regulation and renewable energy policies. This paper argues that the State of Oklahoma should reform its renewable energy policy to protect U.S. military installations.

In order to support my contention that renewable energy technology can contribute to installation energy security, I make three fundamental assumptions. First, DOD will harden any on-site wind or solar PV systems against cyber or EMP attacks. Second, the Nesse et al. (2011) report's claims of the viability of on-site renewable resources for Fort Sill are applicable to the entire State of Oklahoma. Third, DOD will attempt to integrate on-site renewable energy if project economics improve.

The Impact of Grid Disruption on Oklahoma's Military Installations

The Grid: Scope and Future

The electrical grid is a marvel of modern engineering, and has been called the "supreme engineering achievement of the 20th century" by the National Academy of Engineering (MIT 2011, 1). The grid consists of about 6 million miles of transmission and distribution lines, which are owned by over 3,000 different public, private, and cooperative institutions. This complex system provides power to around 145 million users, such as homes, factories, and offices (MIT 2011, 1).

However, the state of the electrical grid is rapidly deteriorating, as evidenced by the steadily rising rate of grid outages. Amin analyzes the total number of power outages of 100 Megawatts or more during consecutive five-year periods from 2000-2009, and finds that:

Adjusting for a 2 percent per year increase in load to 2000 levels, these outages reflect a trend. First, there were 147 outages of 100 megawatts or more during 2000-

2004; such outages increased to 230 during 2005-2009. Second, assuming the same 2 percent annual demand growth, the number of U.S. power outages affecting 50,000 or more consumers increased from 140 during 2000-2004 to 303 during 2005-2009 (Amin 2011).

The grid is also increasingly vulnerable to both natural and intentional disruptions. These vulnerabilities do not stem from a lack of energy, as the United States has large reserves of critical energy resources, such as coal and natural gas. Rather, the problem stems from the frailty of the grid itself, and its susceptibility to acts of sabotage (Defense Science Board 2008, 11; Sameras and Willis 2013, xi). The DSB (2008) isolated four scenarios for grid collapse. First, overload, which makes power lines sag and overheat, can create cascading power outages. Second, natural disasters, such as tornados and hurricanes, may severely impact the grid. Third, and potentially most damaging, are targeted terrorist attacks using physical, cyber, or EMP weapons that can disable the grid for months. Fourth, interruption of fuel supplies from natural, terrorist, or economic forces can disrupt electrical generation.

The 2003 Northeastern power outage is a particularly instructive example of electrical grid weakness. This outage caused a loss of power to over 50 million customers in both the United States and Canada. Moreover, over 500 power generation facilities were taken off-line, including 22 nuclear power stations (MIT 2011, 36; Defense Science Board 2008, 54). The task force sent to investigate this incident found that the blackout originated from an Ohio utility's failure to distance a power line from a nearby tree. Simply put, 50 million people lost power for up to two weeks because of an untrimmed tree branch. What is most surprising, however, is that precautionary load-protection measures were primarily to blame for the grid's failure. Differences in load (electrical demand) and supply can severely damage the electrical infrastructure. This suggests that seemingly small failures can have a cascading effect on the entire system. (MIT 2011).

DOD has a massive domestic presence. It occupies more than 300,000 structures with a combined building space of 2.2 billion square feet, three times Wal-Mart's total retail and support space. (Robyn 2012; "Department of Defense Annual" 2011; Sameras and Willis 2013; Marqusee 2012). Furthermore, DOD installations use immense amounts of power. In fact, DOD alone consumes more energy than Nigeria, which has a population of 140 million (Castillo 2012, 2). Facility energy needs represent about 25 percent of this usage, while the rest is for operational needs. However, this balance is likely to shift with the recent and continuing drawdowns in Iraq and Afghanistan (Robyn 2010). Even with a relatively low share of total DOD energy use, facility energy costs DOD nearly \$4 billion annually. (Kleber 2009; Department of Defense Annual" 2011; Robyn 2010).

Despite the grid's frailty, the U.S. military's domestic installations are almost entirely dependent on it, with about 99 percent of all power used by DOD coming from the grid (Defense Science Board 2008; Sameras and Willis 2013; Aimone 2012). There are few methods to provide external electrical support to military installations, and the military only retains enough mobile energy capability to sustain a few large bases at any one time. Even worse, many units responsible for this task are located too far away or are too small to provide adequate support to domestic installations (BENS 2012). This means many installations must rely on power produced on-site.

Some on-site power capability exists on nearly all military installations. However, this energy comes from diesel generators, which were not built for long-term operation. As such, most bases typically keep enough fuel for only three days of operation (Broekhoven et al. 2013). Additionally, there are numerous problems associated with reliance on diesel generators. First, these generators usually provide power to individual buildings, and therefore cannot be re-tasked to feed power to mission-critical loads. This lack of energy management means some large installations can have over one hundred generators not well-integrated with other sources of power (Broekhoven et al. 2013; Defense Science Board 2008). Second, diesel generators require increasingly more maintenance as they are used, which implies that bases may have to temporarily power down for major repairs (Castillo 2012, 27). While an operational lapse may have been acceptable when these generators were first installed, this system is not feasible for modern military operations that require real-time support from domestic military installations. Third, diesel generators have proven vulnerable to cyber-attacks, as evidenced by a Department of Homeland Security test that caused a generator to self-destruct (Castillo 2012). Finally, the same factors that can destroy the electrical grid can also disrupt the transportation of petroleum. This suggests it would be difficult to resupply generators after their stored fuel supplies are exhausted (Defense Science Board 2008).

The Importance of Domestic Installations

Domestic bases, regardless of geographic location, are critical to U.S. military activities at home and abroad. This is because advanced technologies have fundamentally shifted the role of domestic installations from training and deploying forces, to providing real-time support and intelligence to U.S. forces. For example, predator drone missions in Afghanistan are frequently piloted from bases in Nevada (Robyn 2010, 3; Aimone 2012, 3). Furthermore, domestic bases often provide critical command and control and strategic deterrence functions (Defense Science Board 2008; Sameras and Willis 2013).

Oklahoma has two Army and three Air Force installations, which fill vital military roles. Altus Air Force Base (AFB), located in Southwest Oklahoma, hosts the 97th Air Mobility Wing, which commands the only heavy mobility and air fueling school in the U.S. Air Force (USAF). Altus also hosts the HQ Air Mobility Command Detachment 2 that certifies the performance of air training simulators. Fort Sill, in Southwest Oklahoma, is one of five army basic combat training sites – as well as the Army’s premier field artillery training school. In Southeast Oklahoma, McAlester Army Ammunition Plant produces and stores conventional ammunition and missiles. Tinker AFB, located in Central Oklahoma, is a critical installation hosting several specialized units. Finally, Vance AFB, in Northwest Oklahoma, hosts the 71st Training Wing (Oklahoma Department of Commerce 2011).

Tinker AFB is arguably Oklahoma’s most strategically important military installation because it hosts the Navy’s Strategic Communications Wing ONE, which is responsible for the maintenance and support of the E-6B Mercury aircraft fleet (Office of Economic Adjustment 2013; Oklahoma Department of Commerce 2011). These aircraft are tasked with allowing the President and Secretary of Defense to communicate with strategic nuclear forces, including bombers, missile silos, and nuclear submarines (Office of Economic Adjustment 2013; ACOG 2008). Presently, Strategic

Communications Wing ONE is the only one of its kind under the control of the Department of the Navy (ACOG 2008, I-4). Tinker was originally chosen by the Navy because its location, near the center of the continental U.S., ensured the E-6B aircraft could survive a nuclear attack. After such an attack, these aircraft are to provide communication capability to surviving U.S. nuclear forces (Schill 1995, 7). Unfortunately, the E-6B might be unable to take-off after a devastating attack on the electrical grid, since airfield communications, lighting, and approach systems require power to function (Samerias and Willis 2013, 21).

As a result of electrical grid vulnerability, Tinker, and other bases that hold similar strategic importance, may appear to be extremely vulnerable targets to an enemy. Further, during tense relations, a rival state could decide that a cyber or EMP attack on the electrical grid could entirely prevent a nuclear response, which would make the idea of a nuclear first-strike seem like a viable course of action. While this scenario is unlikely, state policy makers should be aware of the strategic role that their installations play, and the possible consequences of leaving those bases unprotected.

The strategic importance of these military installations depends primarily on how long the United States can maintain military readiness without their individual contributions. These bases also provide security in the form of available disaster relief to their local communities. In the aftermath of Hurricane Katrina, military bases played three critical roles: as bases of operation for relief and rescue missions, as command and control stations for various national resources, and as providers of skilled personnel to aid in rescue efforts. Oklahoma's military installations have undertaken similar operations. During both the 2013 Moore tornado and a 1999 tornado outbreak, Tinker AFB provided substantial relief aid (O'Brien 2013). And amid an ice storm in 2007, Tinker aided Oklahomans whose homes had lost power and heat (ACOG 2008, II-10). Furthermore, these bases would be required to ensure the well-being of civilians in the aftermath of a terrorist attack. But without a stable supply of electrical power, military bases will be unable to fulfill their disaster relief obligations (Defense Science Board 2008, 53). These obligations will become even more important as climate change increases the likelihood of natural disasters (President's Council of Economic Advisors 2013).

The Potential for Additional Installation Energy Security from On-Site Renewable Energy Sources

Considering the vulnerability of the commercial electrical grid, along with the unreliability of diesel generators and, to a lesser extent, natural gas generation, renewable energy sources appear best suited to provide energy security. Renewable energies offer a massive advantage over other conventional fuel sources. Namely, unlike diesel and natural gas, neither sunlight nor wind have to be trucked or pipelined to an installation, suggesting that only renewable energy can truly be considered on-site generation. Further, to provide critical support to deployed forces, military installations must be self-sustainable for months (BENS 2012). In the event of a catastrophic disruption to the electrical grid, conventional fuels will not be able to provide steady, high-quality power. Renewable energy sources, along with an advanced micro-grid system, can provide sustained power to critical military loads (Castillo 2012; "Department of Defense Annual" 2011). There are challenges associated with integrating renewable energy generation with a micro-grid. However,

current technologies and technical understanding should prevent these issues from inhibiting the effectiveness of on-site renewable energy (BENS 2012).

Renewable energy potential, such as sunlight and wind, must be adequate before renewable energy technologies can be considered feasible. In a report describing renewable energy project economics at Fort Sill, Nesse et al (2011) found that Oklahoma has moderate solar and moderate-high wind potential. However, DOD's Annual Energy Management Report (2011) found that the availability of renewable energy sources was not the primary inhibitor of renewable energy development. Rather, factors such as permitting, mission execution, and land ownership were the cause of limited renewable development.

Renewable Energy: Challenges and Potential

This paper focuses on the two most common renewable energy technologies, solar PV and wind. Solar PV seems the most viable technology for a number of reasons (Castillo 2012). First, there are numerous examples of the effectiveness of solar PV. Nellis AFB installed a 14-megawatt solar PV array that provides a quarter of its energy needs, reduces its CO₂ emissions by 24,000 tons, and saves \$1 billion annually (Robyn 2010, 6). Santa Rita Jail, the fifth largest in the United States, installed a 1.2- megawatt rooftop solar array that coupled with other technologies, saves the jail up to \$20,000 per year and helps provide uninterrupted power. The Sendai Project in Japan was designed to test a micro-grids ability to control a complex electrical system. The Sendai micro-grid, augmented with a 25-kilowatt solar array, survived a two-day blackout caused by the 2011 Japan earthquake (Marney et al. 2012, 66).

A second advantage of solar is that during heat waves, which place tremendous stress on the grid, sunlight is abundant. As a result, solar PV would become much more effective and be able to reinforce grid stability. In fact, the 2003 Northeastern blackout, caused in-part by a heat wave, would not have spread so far if the commercial grid had a moderate amount of solar PV generation (Perez et al. 2011). Third, solar PV technologies have a relatively long life-span. A properly maintained solar array will still produce about 60 percent of its initial rating after 50 years of operation (Perez et al. 2011). However, the promise of solar PV is reduced by its largest, and most obvious, flaw. It cannot produce electricity at night, which along with a lack of high-quality batteries, will undermine its contribution to installation energy security (Sadler et al. 2008, xx).

Wind power also has potential. Unfortunately, wind power has several serious problems that make it a sub-par choice. The wind power industry is not as mature as solar PV, since the solar industry has gained much experience on the residential level. Wind also has high up-front capital costs. Furthermore, siting large-scale wind farms is difficult because of environmental, military, and local concerns. The most daunting obstacle to the effectiveness of wind projects is the turbine's spinning blades. Wind turbines can severely disrupt radar tracking systems, since the spinning blades have a larger radar signature than a Boeing 747. While several agencies are attempting to find solutions to this problem, at present, wind technologies do not seem viable as an option to provide energy security to military installations (Scholtes 2013; Robyn 2010).

There is also a question of whether an on-site renewable system should be owned and operated by the military or the private sector. BENS (2012) finds that private sector ownership

offers the better option. The first reason is because energy production is not currently a military competency. This implies that DOD does not have the expertise to manage renewable energy systems, especially large-scale systems (Broekhoven et al. 2013). Second, since DOD faces uncertainty in funding, it is unlikely to budget for developing electrical infrastructure without help from private sector financing (McAlister 2011; Nesse et al. 2011). Moreover, there seems to be a positive correlation between the presence of private industry and the quality of military electrical systems (BENS 2012, 30). Despite the promise of private ownership, BENS (2012, 29) has postulated that the private sector may not be able to function in many localities, such as Oklahoma, because of regulatory and siting concerns.

Resolving Barriers to the Deployment of On-Site Renewable Energy Technologies in Oklahoma

How PPAs Can Solve Cost Concerns

There are two main cost impediments to the introduction of on-site solar PV or wind power on U.S. military installations in Oklahoma. First, high up-front capital costs make it difficult for the Defense Department to afford on-site solar PV or wind projects, since these project may require hundreds of millions of dollars just to install (McAlister 2011, 9). Second, Oklahoma's electricity prices are far below the national average. In 2010, Oklahoma's average electricity price was 7.59 cents per Kilowatt hour (Kwh), compared to the national rate of 9.83 cent per Kwh (EIA 2012). These price trends have held relatively constant, with Oklahoma's July 2013 average retail price at 8.38 cents per Kwh compared to the national average retail price of 10.71 cents per Kwh (EIA 2013). Low electricity prices undermine the economic basis for renewable energy, since wind and solar PV are more costly than conventional fuels (Nesse et al. 2011, 6). Indeed, the Navy has stated it will only purchase renewable energy if it is competitive with other conventional sources of power ("Department of Defense Annual" 2011).

These barriers can be broken with the help of innovative financing mechanisms, such as a third-party power purchase agreement (PPA). A third-party PPA includes a customer, system owner, and utility. The system owner installs, operates, and maintains the on-site renewable energy system, usually solar PV. The customer (i.e., a military installation), purchases power by Kwh from the system owner, and may purchase additional power from a local utility if needed. Alternatively, if the system owner generates more power than the customer requires, it can be sold to the utility. Lastly, the system owner also gets to keep any federal or state incentives payments (Cory, Caravan, and Koenig 2009).

PPAs are attractive to DOD for a number of reasons. First, PPAs require little or no upfront capital from DOD, since the system owner is responsible for installation. Second, DOD pays a lower price for energy because the system owner passes down savings earned through government incentives, such as the Production Tax Credit (PTC), a refund for each Kwh the power producer generates. Third, the costs of power are more stable and predictable, since PPAs are usually long-term contracts. Fourth, DOD does not have to deal with system design and permitting. Fifth, since DOD does not maintain or operate the system, it can focus on its primary operations (Cory,

Caravan, and Koenig 2009). Taken together, these advantages can dramatically reduce costs, and may make \$100 million projects viable (Scholtes 2013, 64; McAlister 2011; Nesse et al. 2011). For example, White Sands Missile Range in New Mexico saves nearly \$1 million annually through its twenty-five year solar PV PPA (Scholtes 2013, 80).

Unfortunately, third-party PPAs are impractical in Oklahoma (DsireSolar 2013). This impracticality derives from the Oklahoma Corporation Commission Code, Okla. Stat. tit. 17, §151 (2013):

The term "public utility" as used in Sections 151 through 155 of this title, shall be taken to mean and include every corporation, association, company, individuals, their trustees, lessees, or receivers, successors or assigns, except as hereinafter provided, and except cities, towns, or other bodies politic, that now or hereafter may own, operate, or manage any plant or equipment, or any part thereof, directly or indirectly, for public use, or may supply any commodity to be furnished to the public.

(a) For the conveyance of gas by pipeline.

(b) For the production, transmission, delivery or furnishing of heat or light with gas.

(c) For the production, transmission, delivery or furnishing electric current for light, heat or power.

(d) For the transportation, delivery or furnishing of water for domestic purposes or for power...

While this regulation does not explicitly restrict the use of third-party PPAs, it does not distinguish between a system owner engaged in a PPA and a traditional utility. Therefore, a system owner is subject to a flood of administrative and regulatory restrictions, which may undermine profitability, and, as a result, partnership potential. (Scholtes 2013; McAlister 2011).

However, it remains unclear whether DOD is subject to state utility laws. United States Code 10 sec 2922a states that "...the Secretary of a military department may enter into contracts for periods up to 30 years for the provision and operation of energy production facilities on real property under the Secretary's jurisdiction or on private property and the purchase of energy produced from such facilities..." Still, the law does not clarify how to resolve state barriers to PPA adoption (McAlister 2011). DOD would probably be able to fend off legal challenges from the State of Oklahoma, but this legal uncertainty will likely dissuade private groups from participating in PPAs (Scholtes 2013).

Oklahoma's Renewable Failure

Other than the restriction of PPAs, there is no single cause of Oklahoma's scant renewable energy economy. A 2003 Union of Concerned Scientists report, which graded states based on renewable energy generation, placed Oklahoma in the "hall of shame" because its renewable generation was paltry, despite adequate wind and solar potential. A number of political factors seem to contribute to Oklahoma's reluctance to support local renewable energy development. Wiener and Koontz (2010, 641-643), who conducted a qualitative analysis by interviewing prominent state employees, environmental advocates, and wind turbine installers, found that Oklahoma's political culture strongly supports oil and gas development, mainly because it was responsible for the state's early

economic activity. As a result, the oil and natural gas lobby consistently undermines environmental and renewable interests. It is also possible that, even if the power of oil and gas interest is overstated, the very perception of such influence may discourage a supportive renewable energy agenda from coalescing. Further, Oklahoma is a politically conservative state, which evidenced by strong Republican majorities in both the state's House of Representatives and Senate. As a consequence of this conservative ideology, Oklahoma's citizenry strongly supports free-market principals, is 'very suspicious of change, especially if it is coming from the government', and is apathetic to environmental degradation.

Unfortunately, the level of state support and the strength of incentives are major factors in determining DOD renewable energy project economics (BENS 2012; Nesse et al. 2011). This is not likely to change as states take the lead in alternative energy (Williamson and Sayer 2012). This shift, from a federally led to state led renewable agenda, is likely to continue for many reasons. First, state governments have begun to associate renewable energy with long-term economic growth. Second, many states perceive that climate change may be responsible for violent storms and other natural disasters, and this perception may lead them to conclude that supporting renewable energy technologies is a necessary cost (Rabe 2008). Third, at 16 percent, renewable energy's share of federal R&D funding is low (Rosenberg 2009). Last, a comprehensive federal policy regarding renewable energy is not likely to appear in the near future (Rabe 2008). This suggests that if Oklahoma's military bases are to be secure, then the state must foster an energy environment conducive to their security.

A small, but potentially productive, step Oklahoma could take is strengthening its Renewable Portfolio Standard (RPS), which is a mandate requiring utilities to derive a certain percentage of their electrical load from specified renewables by a specified date (Rabe 2008). Though, there is some doubt as to whether an RPS is an effective policy tool. An empirical study on RPS effectiveness found that while they do not usually succeed in increasing the share of renewable energy production compared to conventional fuel sources, they do increase total renewable energy production (Carley 2009). Regardless, a mandate requiring an increase in renewable energy generation, along with financing schemes like the PPA, may drive more private entities to seek to develop on-site solar PV or wind.

Oklahoma currently has a voluntary goal, enacted by the legislature in 2010, of achieving 15 percent of electrical generation from renewable sources by 2015 (Brunette 2011; DsireSolar 2013). There are multiple problems with this goal. It is only voluntary and is to expire in 2015, so it is not clear whether Oklahoma will replace it with similar or more stringent requirements. Additionally, efficiency improvements can count toward up to a quarter of the 15 percent goal, which means the actual renewable energy generation target is just 11.25 percent (Nesse et al. 2011, A-4).

Conclusion

The U.S. electrical grid is a marvel of modern science and engineering. Unfortunately, the grid is falling into disrepair, and a large and prolonged power outage would nearly collapse U.S. military capability by disabling domestic military installations (Defense Science Board 2008). This paper

advocates solar photovoltaic (PV) as the most versatile and effective technology to achieve energy security.

There are two main cost impediments to the introduction of on-site solar PV on U.S. military installations in Oklahoma: high up-front capital costs and electricity prices far below the national average in Oklahoma. Since DOD is facing a period of austerity, these low electricity prices effectively undermine the economic basis for renewable energy (Nesse et al. 2011). A third party PPA is the best way to mitigate the challenges associated with high costs. Unfortunately, third-party PPAs are impractical in Oklahoma due to regulatory measures.

Furthermore, the level of state support and the strength of incentives are major factors in determining DOD renewable energy project economics (BENS 2012; Nesse et al. 2011). A small, but potentially productive step Oklahoma could take is to strengthen its Renewable Portfolio Standard (RPS), which mandates that utilities derive a certain percentage of their electrical load from specified renewables by a set date (Rabe 2008).

The commercial electrical grid, along with other energy infrastructure, will be a vulnerable target for the foreseeable future. Unless the federal government creates a national renewable energy policy, states will have to encourage a private sector environment conducive to profitable renewable development and innovative financing mechanisms, such as the PPA. While the State of Oklahoma alone will not alone decide the security of the United States, it can take can positive steps to ensure both regional and national security.

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Three

Agency Politicization and the Implementation of Executive Order 13514

Aaron Ray

Abstract

Federal agencies are responsible for implementing policies created by the United States Congress and the president. However, a tension exists between an agency's independence and its responsiveness to the preferences of elected officials. Berry and Gersen (2010) argue that the more political appointees there are in control of an agency, the more influence political principals have over that agency. The implementation of a presidential requirement that agencies engage in climate change adaptation planning allows for a test of this hypothesis. This paper uses the variation in implementation of this requirement across agencies to test factors which may explain that variation. Results of this analysis indicate that the degree of agency politicization is a significant predictor of responsiveness to the president's preferences.

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Background

President Barack Obama took office in 2009 promising to make addressing climate change a national priority. Although the administration has achieved little progress legislatively on the issue, it has used executive orders to begin the process of reducing emissions and adapting to the impacts of climate change.

President Obama issued Executive Order (EO) 13514, “Federal Leadership in Environmental, Energy, and Economic Performance,” on October 5, 2009. EO 13514 mandates that a number of measures be taken to reduce greenhouse gas (GHG) emissions by the federal government. In addition to these climate change mitigation efforts, the EO includes measures to promote adaptation to climate change impacts.¹ Section 16 of the EO requires federal agencies² to participate in the Interagency Climate Change Adaptation Task Force (ICCATF) and develop policies to reinforce the strategy being developed by the ICCATF. The EO also directs the Council on Environmental Quality (CEQ) Chair to oversee the development of a progress report and make additional recommendations to promote adaptation by the federal government. Since the signing of the EO, CEQ and the ICCATF have produced two progress reports on climate change adaptation – one in 2010 and another in 2011.

CEQ and ICCATF have also released a set of instructions to guide agencies in developing and implementing coordinated climate change adaptation plans in accordance with provisions of the EO (CEQ, “Instructions,” 2011). Adaptation plans are meant to enable agencies to evaluate the risks that climate change presents to agency missions and operations. The CEQ Chair monitors agency compliance with these instructions through the Office of the Federal Environmental Executive (OFEE). The instructions require each agency to take the following steps:

- Establish an agency climate change adaptation plan.
- Increase agency understanding of how the climate is changing.
- Apply understanding of climate change to agency mission and operations.
- Develop, prioritize, and implement actions.
- Evaluate and learn.

Given the difficulty the Obama administration has had moving comprehensive climate change legislation through Congress, the implementation of the adaptation provisions of the EO represents an attempt to pursue climate change policy through non-legislative avenues. This involves three related efforts. First, the administration has designated the relevant organ (CEQ) within the Executive Office of the President (EOP) to oversee implementation of the EO. Second, the administration tasked an existing interagency body, the ICCATF, with developing policy and recommendations for CEQ and federal agencies. Third, the administration has used its authority over federal agencies to mandate implementation of the recommendations of the ICCATF and CEQ.

While the EO instructs agencies to comply with the mandates of the ICCATF and CEQ, agencies vary in responsiveness to these instructions. For example, of 76 federal agencies identified by scholars, only 35 submitted adaptation plans. This variation presents an opportunity to test theories from the literature on policy implementation and agency responsiveness. This paper uses

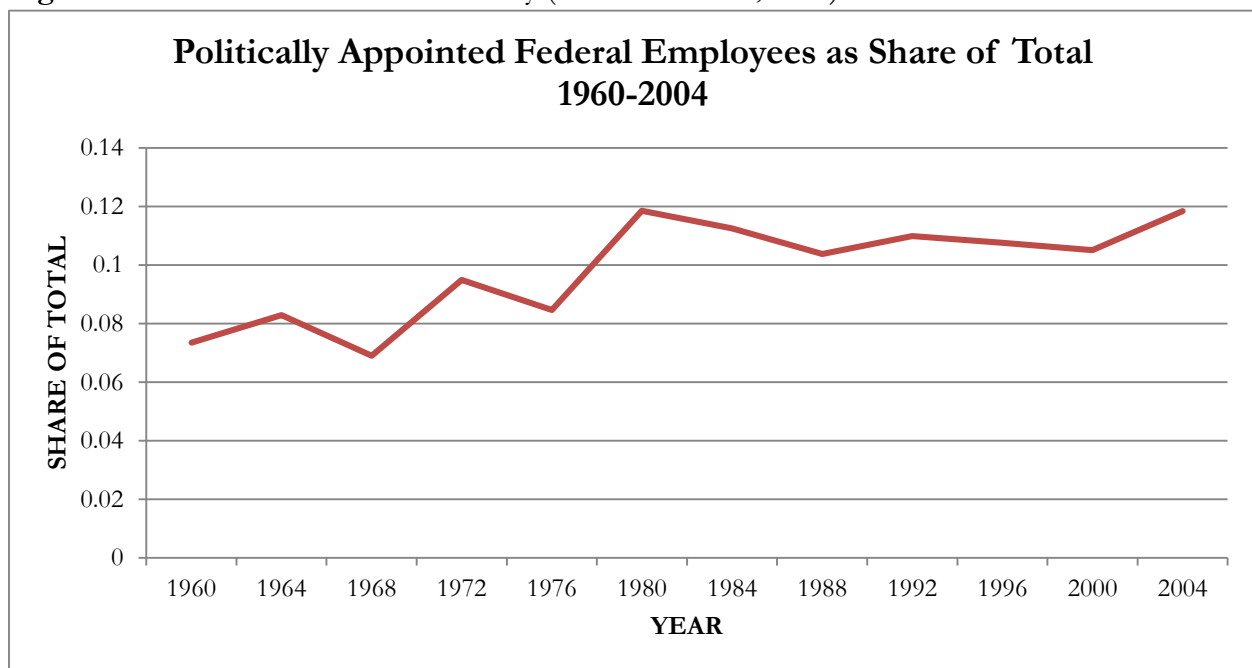
early data on the progress of agencies in drafting climate change adaptation plans to test explanations of agency responsiveness to executive orders.

Theory

An extensive literature exists exploring the role of federal agencies in implementing policy. Theory and practice suggest that a tension exists between the independence of an agency and its responsiveness to the preferences of elected officials. Calvert et al. (1989) developed a model in which agencies exercise considerable bureaucratic discretion in implementation while policy choice reflects the preferences of elected officials. The model attempts to capture policy implementation as a dynamic and multi-stage game. This game includes the appointment stage, in which the legislature or executive creates the set of choices available to bureaucrats. It also includes mechanisms of continuous control, both active and latent, such as budgeting and oversight powers available both to the legislature and to the executive. Executive orders represent one mechanism by which the executive exerts control over federal agencies.

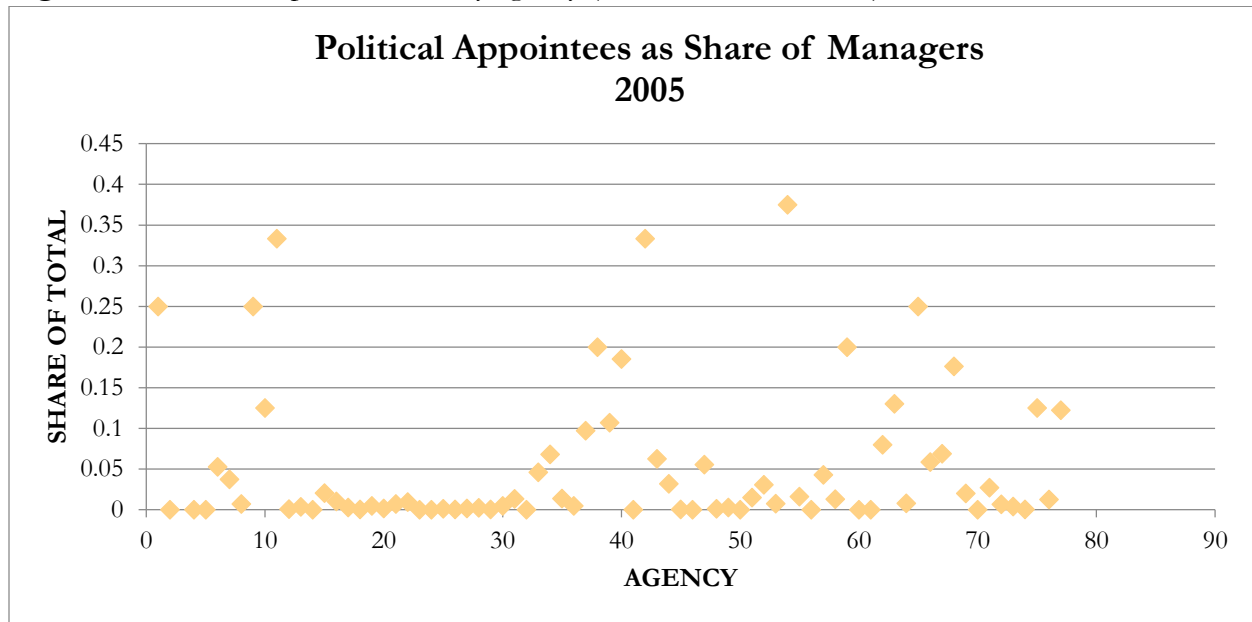
Another mechanism through which the legislature and executive exercise control over agencies is the politicization of agencies in the appointment stage, in this case measured as a ratio of political appointees to career staff. Berry and Gersen (2010) find that the more political appointees there are in control of an agency, the more influence political principals have over that agency. Presidents have actively increased the number of appointees over time as a means to increase their control over executive agencies. Figure 1 illustrates this increase in the politicization of federal agencies since 1960.

Figure 1. Politicization of the bureaucracy (data from Lewis, 2005).



While the trend is toward increased politicization, there is variation within agencies that may help to explain variation in the responsiveness of those agencies to the preferences of the president. Figure 2 illustrates the number of political appointees as a share of the number of managerial positions in federal agencies.

Figure 2. Variation in politicization by agency (data from Lewis, 2005).



This paper tests Berry and Gersen's finding that the degree of politicization influences the responsiveness of the bureaucracy to the preferences of elected officials. To do so, this paper will exploit the variation in politicization across agencies and investigate the degree of responsiveness of those agencies to the requirements of EO 13514. In particular, I focus on the requirement that agencies submit climate change adaptation plans.

Hypotheses

Starting with the theory presented by Berry and Gersen, I have identified three hypotheses about agency responsiveness that can be tested with the available data. First, I expect that more politicized agencies will be more likely to have submitted an agency climate change adaptation plan. This hypothesis follows Berry and Gersen's finding that more politicized agencies are more responsive to political principals. Second, given that climate change is an ideologically charged issue area, it is possible that agency ideology may influence agency responsive. It is also possible, given Berry and Gersen's findings, that agencies whose prevalent ideology most closely aligns with that of the sitting president will be most responsive. Therefore, I will test the hypothesis that liberal agencies, as defined by David Lewis on the basis of a survey of experts on bureaucratic politics, will be more likely to have submitted a plan. Third, as climate change is an issue area in which science plays a prominent role, it is possible that an agency's responsiveness may be influenced by whether that

agency's mission revolves around science. The third hypothesis, then, is that science-oriented agencies will be more likely to have submitted a plan. I will discuss the operationalization of these hypotheses in the next section.

Model and Data

The model described below is used to test the influence of the relevant theoretical variables on the submission of agency climate change adaptation plans in response to EO 13514 and the subsequent implementation instructions developed by the ICCATF and CEQ. The dependent variable of interest is the submission status of an agency adaptation plan in 2012. The instructions required agencies to develop initial adaptation plans as part of the Strategic Sustainability Performance Plans submitted to the Office of Management and Budget (OMB) in 2012. On February 7, 2013, 35 federal agencies released their climate change adaptation plans (CEQ 2013).

The independent variables of interest include a number of agency characteristics. These data were collected from the website of David Lewis, professor of Political Science at Vanderbilt University. The most recent data available from Professor Lewis are from 2005. This dataset includes 76 federal agencies.³ Table 1 lists the independent variables included in the data set and descriptive statistics.

Table 1. Independent variables.

Variable Name	Description	Mean	Minimum	Maximum	Standard Deviation
apt	Number of Senate-confirmed appointees	5.07	0	31	5.94
year	Year oldest unit created	1940	1789	1993	54.7
science	1=identified by Lewis as science agency	0.185	0	1	0.356
regulat	1=identified by Lewis as regulatory agency	0.294	0	1	0.435
totalemp	Number of employees	24,343	10	235,846	53,176
manage	Number of managers	2,731	2	24,389	5,841
ideo	Measure of agency ideological preferences; 1=liberal, 1=conservative	-0.010	-0.929	0.962	0.550
pol	Measure of politicization; number of appointees as fraction of managers	0.068	0	1	0.140

The independent variables described in Table 1 include both the theoretically relevant variables and controls for other agency characteristics. The three theoretically relevant independent variables are *pol*, *ideo*, and *science*.

The variable that measures the degree of politicization (*pol*) is a measure designed by Lewis in which the number of senate-confirmed political appointees in an agency are divided by the number of managerial positions in that agency. This measure creates a ratio of political appointees to management level staff in each agency, which can be used as a proxy for the influence of political principals on the agency. The first hypothesis outlined above predicts that a higher degree of politicization (i.e., a higher ratio) will correlate with a greater likelihood of plan submission. The variable that measures agency ideology (*ideo*) was constructed by Lewis after a survey of experts in bureaucratic politics. Lewis surveyed 39 top experts from academia, journalism, and think tanks and asked them to rate the ideology of government agencies. The higher the value of this measure, the more liberal the agency. The second hypothesis then predicts that higher values of this measure will correlate with a greater likelihood of plan submission. The third variable (*science*) is a dichotomous indicator with a value of one if the agency was identified by Lewis as having a mission that is closely aligned with scientific processes or outcomes (See Appendix 1 for a list of science-oriented agencies). Lewis identified agencies as science-oriented by utilizing data from three National Academy of Science reports on presidential appointments to leadership positions in science. The third hypothesis suggests that being identified as a science agency will correlate with a greater likelihood of plan submission.

Of the 76 agencies for which data were available, 29⁴ submitted agency adaptation plans to OMB in 2012. The analytical model in this paper uses logistic regression to test the effect of the independent variables identified in Table 1 on the likelihood that an agency submitted a plan. The model⁵ is expressed as:

$$Y_{plan} = B_0 + B_{1pol} + B_{2ideo} + B_{3totalemp} + B_{4regular} + B_{5science} + B_{6age}$$

Results

Table 2 presents results, in the form of odds ratios, from a logistic regression of the submission of an agency adaptation plan on various agency characteristics. The results indicate that of the factors included in the model, only agency politicization has a significant ($p=0.032$) effect on the likelihood of plan submission. Controlling for the other factors included in the model, a one unit increase in politicization increases the odds of submission by 0.986 times. Thus, an agency that is completely made up of political appointees would be nearly 100% more likely to submit a plan than one without any political appointees. While this is a small substantive effect, as the mean level of politicization among agencies in the sample is only 6%, it is the only statistically significant effect in the model. This result is consistent with the theory tested by Berry and Gersen that politicized agencies are more responsive to the preferences of elected officials. In this case, more politicized agencies were more likely to comply with the provisions of EO 13514 and the associated instructions.

Table 2. Results of logistic regression.

Variable Name	Log Odds Ratio (Std. Error)
pol	0.986** (0.007)
ideo	1.043 (0.583)
totalemp	0.999 (7.08)
regulat	0.924 (0.621)
science	2.436 (1.959)
age	1.012 (0.008)
N=74 Log likelihood=-39.7 Pseudo R ² =0.198	
*** p<0.01; ** p<0.05; * p<0.10	

These results provide some preliminary support for the first hypothesis, that agency politicization increases responsiveness. The results do not support either of the second two hypotheses. Based on these data and model specification, the factors of agency ideology and having a science-related mission do not increase the likelihood of plan submission. However, as discussed below, there are limitations in the data that require some caution in interpreting these results.

Discussion

These findings provide empirical confirmation for the theory and observations of Berry and Gersen. They also suggest that in the arena of environmental policy generally, and climate adaptation in particular, policy making by executive order involves limitations in terms of agency responsiveness. These findings provide further explanation for the trend toward politicization of executive agencies. If presidents want to make policy through executive orders, there is evidence to suggest that their interests are served by politicizing executive agencies in order to increase the likelihood that their instructions will be followed. As predicted by Berry and Gersen, presidents' ability to exert control over agencies is strengthened by appointing a higher percentage of political staff in those agencies.

There are a number of limitations to this preliminary finding that present opportunities for further research. The limitations presented by the availability of data are clear. First, the Lewis data were only available up to 2005. Having data from more recent years would likely improve the theoretical link between agency characteristics and policy outcomes. Using the 2005 data requires the assumption that the level of politicization and ideological orientations of agencies has remained stable since 2005. This assumption is a significant limitation and stands to be tested if more recent

data can be obtained. Second, the budget information was not available even in the 2005 data. Having information on agency budgets would allow the model to be refined and alleviate justifiable concerns about omitted variable bias. Third, the construction of the dependent variable as a dichotomous one, indicating submission of plan, may not capture variation in the quality and comprehensiveness of the plans or the effort devoted to their creation. Collecting data from each agency on how many people were involved in the plan development, what resources were devoted to the process, and the how close the process was to the agency leadership would allow for a more nuanced analysis of agency responsiveness.

In spite of these limitations, this research provides additional evidence to support the view that the politicization of federal agencies may increase the power presidents exert over the bureaucracy. The trend towards politicization seems to increase the responsiveness of the bureaucracy to the president, but potentially reduces agency independence. The potential link between agency independence and responsiveness to the executive will remain an issue requiring thoughtful consideration by scholars, politicians, and voters alike.

¹ The United Nations Environment Program (UNEP) defines mitigation as “efforts to reduce or prevent emissions of greenhouse gases.” UNEP defines adaptation policy as measures to “reduce vulnerabilities and build resilience to the impacts of climate change.” See United Nations Environment Program.

² Throughout this paper, “agency” and “agencies” are used to refer to all federal executive units.

³ Of the 76 agencies included in the dataset from 2005, 74 remained in 2013 and were included in the regression analysis.

⁴ Of the 35 agencies that submitted plans, only 29 were represented in the data set constructed using Lewis’ data.

⁵ The following modifications were made to the model: 1) *apt* and *manage* were not included as they are components of *pol*; 2) *age* was calculated as the difference between the year the agency was started and 2013.

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Appendix 1. Science Agencies, as defined by David Lewis

Consumer Product Safety Commission
Council of Economic Advisers
Council on Environmental Quality/Office of Environmental Quality
Department of Agriculture
Department of Commerce
Department of Defense
Department of Energy
Department of Health and Human Services
Department of Homeland Security
Department of Interior
Department of Justice
Department of Labor
Department of Transportation
Environmental Protection Agency
National Aeronautics and Space Administration
National Science Foundation
National Transportation Safety Board
Nuclear Regulatory Commission
Office of Science and Technology Policy
U.S. Agency for International Development

Four

Disorganization and Network Institution: A Possible Source of Economic Downturn

Endrizal Ridwan

Abstract

This article considers the roles of networks on investment decisions to explain the existence of a possible economic downturn during a transition period from a dictatorship towards a democracy. A supplier is willing to invest in a state production only if there are enough other suppliers taking part such that the return on investment is at least equal to their private alternatives. The suppliers build knowledge of others' private alternatives through a communication network. The investment model presented here shows that a decision to invest not only depends upon knowledge about others, but also, more importantly, understanding of others' knowledge. When networks fail to fully disseminate knowledge, investment decisions are suboptimal. These suboptimal decisions consequently lead to a decline in output in the early stage of market decentralization as the state loses power to force suppliers into joining state production.

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Introduction

The fundamental economic problems in all societies are questions of what is to be produced, how to efficiently allocate resources, and how to distribute the production. These decisions can be made at the hand of a single dictator, which may be called a central planner, or a centralized government; these decisions can also be decentralized to all individuals of economic agents through some market mechanism. For instance, a decision to produce pencils, whether to use machines in the process of production and how to distribute its value among resource owners can be made by one entity, a dictator. This nation is under a regime of a dictatorship. In other situations, society as a whole can also make such decisions through a market mechanism; instead of force, markets work voluntarily to guide the decision-making process. When pencils are more valuable as indicated by an increase in their price, the society will voluntarily allocate their resources to produce pencils without being forced to do so. In this governance structure, the nation is under a regime of a decentralized market. Sometimes, political situations, such as a coup or revolution, may change the economic regime from a dictatorship to fully decentralized market. This typical regime change, as widely accepted by the neoclassical theorists, is expected to boost economic output.

However, changing economic regimes from a state where there is powerful government intervention to a state where there is strong market decentralization does not guarantee an increase in economic output. In fact, historical case studies show that output has a tendency to fall immediately after the collapse of a dictatorship and continue to decline during the transition from the centralized government to a decentralized governance structure (Blanchard and Kremer 1997, Brenton, Gros, and Vanadille 1997, and Duflo and Senik-Leygonie 1997). For example, most countries of the former Soviet Union experienced a large decline in output after the collapse of the Soviet Union. Their output was less than half of its pre-decentralization period (Blanchard and Kremer 1997). Despite a myriad of economic distortions during centralized planning and under dictatorships, the movement towards competitive, decentralized markets failed to increase output, contrary to common expectations.

This type of decline in output is an interesting puzzle for neoclassical theory because decentralized transactions between suppliers and buyers do not instantly boost economic growth. The existing literature has tried to explain the economic reasons behind this downturn. The explanations for these temporary output declines vary, ranging from changing the reporting incentives, the need to restructure enterprises and redeploy assets, to the increase in uncertainty that affects investment. Blanchard and Kremer (1997), for instance, argue that the economic downturn is due to the presence of incomplete contracts and asymmetric information. During the regime of dictatorships in the Soviet Union, the central government had the power to force each supplier to participate in state owned firms. The characteristics of the state firms' production processes were complex; they involved many stages of production starting from planning and designing to delivering the final product. The firms were served highly specified functions, in which the suppliers were almost perfect complements to each other, i.e. each supplier had its own specific roles in the production processes that was difficult to be substituted by other suppliers.

This specific relationship among suppliers opened an opportunity for each supplier to bargain for a higher wage for its services immediately after the regime of dictatorship collapsed. This bargaining mostly resulted in inefficiency due to asymmetric information in which some relevant information was hidden from each supplier. Moreover, the complexity in production stages resulted in incomplete contracts because it was difficult to accurately state all the production steps in the contracts from beginning to the end. Thus, both incomplete contract and inefficient bargaining caused a drop in national output shortly after the end of the dictatorship. The output loss may be even larger if more parties were involved in the complex set of specific relations, increasing the cost of disorganization.

One limitation of many existing theories, including Blanchard and Kremer (1997), is that they put too little attention on the communication relationship among individual suppliers when analyzing bargaining outcomes. Most of the existing literature uses models of non-cooperative game theories. That is, by assuming no communication among agents, the models predict the outcome of non-cooperative bargaining. In reality, however, some parties communicate to each other or rely on their prior existing communication network when deciding which strategic actions to take.¹ Therefore, I believe that the outcomes of bargaining are also influenced by the presence of communication network among those suppliers.

This paper proposes an alternative explanation of the reduction in output during transition by introducing the role of networks. This explanation will complement other studies using asymmetric information to explain the possible dramatic fall in output. I first modify the Blanchard and Kremer (1997) model on how specificity and complexity may create coordination failure between a state firm and its suppliers. I then transfer this coordination game into a type of collective action game by linking the supplier's private opportunities to the number of participants in the state firm. Finally, I borrow Chwe's (1999) style of network analysis on collective action problems to explain how a fall in output may result from the network structures among the suppliers.

Section 2 presents the model of an economy with one state firm and several suppliers. The suppliers are strategically rational and also take into account that the others are completely rational. Section 3 analyzes the equilibrium outcome for various institutions and shows that none of these institutions would produce efficient investments. Section 4 discusses the model's implications for a solution to coordination problems, and possible extensions to a more sophisticated and realistic network structures. The model has implications for countries in a transition period from a strong government power into more market-dominant or democratic structure, such as Turkey, Libya, or Egypt. The message is that the transition cannot be done radically if countries are attempting to maintain pre-transition levels of output. Section 5 draws conclusions that a better network relationship among suppliers is necessary to solve coordination problems and achieve the most efficient economic outcome during a transition period from a more centralized government regime to a more market-oriented regime.

The Model

The economy consists of only one state firm and several private firms. Both types of firms use intermediate capital inputs from $n + 1$ number of suppliers; the suppliers outnumber the private firms. We assume that profit-maximizing private firms have monopoly power, which allows them to offer take-it-or-leave-it rent to the suppliers. Hence, the suppliers will get paid their private thresholds if they decide to supply their intermediate inputs in the forms of capital, k , to private firms.²

The state firm

The state firm operates on an increasing return to scale with an $Y = Ak^\alpha$ type of production function where $\alpha \geq 1$. This type of economic scale is common for the state firm since the state usually is a natural monopolist for publicly crucial output such as electricity, telecommunication, and mining. Instead of being constant, however, we assume that the technology coefficient, A , increases with capital k . We can think of k as smart capital, which has positive externalities. In other words, this capital is more productive when it interacts with other forms of capital.³ Specifically, for this model $A(k) = k$ so that the technology coefficient is just the units of capital. Hence, the state firm's effective production function would be

$$y = k^{1+\alpha} \quad (1)$$

We further assume for the purpose of the model that $\alpha = 1$, so that the effective production function is

$$y = k^2 \quad (2)$$

In addition, the state firm is not a profit-maximizing firm, but a welfare-maximizing firm. It operates under zero-profit conditions and ensures the equality of income among its suppliers. We can also think of suppliers as workers, where the state firm aims to distribute its output equally to its workers. To ensure equality, the state firm pays rent, r , to supplier i according to the firm's average product. With the above effective production function, as in (2), the rent is

$$r_i = \frac{y}{k} = k \quad \forall i \quad (3)$$

Equation (3) reads the state firm as paying rents to every supplier equal to the units of capital used in production. Note here that only the quantity of capital matters, not the quality. Suppose, for instance, that two suppliers each supply one unit of capital to the state firm. Each capital supplied is not necessarily equal in quality. With two units of capital, the state firm's output is four units. The return on capital from the state firm to both suppliers is, therefore, $r_i = \frac{4}{2} = 2$ units, although each supplier supplies only one unit of capital. Of course, this does not mean that every supplier will join the state firm since they may have sufficiently high opportunity costs, which are alternatives from private firms. Consider, as an example, the case of public transportation, such as city buses. In some developing countries, the public transportation company is owned and controlled by state enterprises. However, these individual buses can be owned privately by community members or suppliers. Since the state firm controls the bus fare, the rent payment to the bus suppliers is based on the quantity of buses, not the quality. Each bus may have a different seat

capacity and a unique bundle of other accessories, but each gets paid equally. If the bus were hired by a private enterprise, the payment would be based on its quality.

The suppliers

There are $n + 1$ suppliers to decide whether to engage in the state firm production or to accept take-it-or-leave-it rent from private firms. Each supplier has one unit of capital. The capital differs in quality, which is indicated by different threshold levels $c_i \in (2, \dots, n + 2)$.⁴ As mentioned above, the private firms will pay each supplier exactly the supplier's threshold in regards to the supplier's product quality. The suppliers then compare these private alternatives to the rents earned from the state firm. However, each supplier must decide simultaneously whether or not to participate in the state firm's production without knowing the actions of other suppliers.

The decision of any particular supplier i is obvious. That is, to join (j) the state firm if $r_i \geq c_i$; or stay (s) and take the private opportunities at c_i . Notice, due to the specific production function in (2) and the value of private alternatives, the supplier decisions to join the state firm depend upon how many other suppliers would join the state production. This specific relation is the critical feature of this model. For example, supplier A with threshold of $c = 2$ would join the state firm only if accompanied by at least one other supplier. To see this, suppose that only supplier A joined the state firm. This supplier then gets rent equal to one, which is lower than its threshold. If, instead, two other suppliers join, supplier A gets rent equal to three, which is strictly higher than its threshold. Moreover, a supplier with a threshold of $n + 1$, which is equal to the number of suppliers, would prefer to join only if everyone else does. Meanwhile, a supplier with threshold of $n + 2$ would never join the state firm. Thus, we can formulate the profit of supplier i given its own threshold and everyone else's actions $a = (a_1, \dots, a_N)$ as follows:

$$\pi_i(c_i, a_i, \dots, a_N) = \begin{cases} c_i, & \text{if } a_i = s \\ r_i = k, & \text{if } a_i = j \text{ and } \#h_{\{s.t. a_h=j\}}=k \end{cases} \quad (4)$$

This profit equation (4) simply states that the supplier's profit (π) would be its private value, c , if it stays and takes an offer from a private firm. Otherwise, when it joins the state firm, the profit would be $r = k$, where k is the total number of suppliers that take part in the state production. Thus, the suppliers' decision simply depends on whether *ex-ante* $r_i \geq c_i$. The only problem for the supplier, then, is to accurately predict the value of r . In the following section, I describe how the supplier uses knowledge from networks to predict r_i .

Network

Suppliers use a network to communicate their thresholds and to gain knowledge of others. Since the decision under this type of network is voluntary, a commitment is not necessary. Even if there is a commitment, no penalties are levied for deviances. Following Chwe (1999), I define network $\rightarrow$ as a binary relation over n suppliers, where $g \rightarrow i$ means that supplier g communicates to supplier i . I define the neighborhood of i as every supplier who communicates to i . I also assume that supplier

i knows the thresholds of everyone in its neighborhood. Furthermore, supplier i knows all network relations among members in its neighborhood, i.e., whether the neighborhood members communicate with each other.

Succinctly, for supplier i , let $B(i) = \{g \in N: g \rightarrow i\}$ be its neighborhood, where $i \in B(i)$ and for all $p, q \in B(i)$, supplier i knows whether $p \rightarrow q$. Take 4 suppliers as an example: supplier 1, 2, 3 and 4. Supplier 2 and 3 communicate to supplier 1 but supplier 4 does not communicate back. However, supplier 4 communicates to supplier 2. Then, we write $B(1) = \{2, 3\}$ and $B(2) = \{1, 4\}$. In other words, supplier 2 and 3 are in the neighborhood of supplier 1 since both supplier 2 and 3 communicate with supplier 1. Moreover, supplier 1 also knows whether supplier 2 and 3 communicate with each other. Supplier 4 is not in the neighborhood of supplier 1, but it is in the neighborhood of supplier 2 for the same reason. Supplier 2 knows whether or not supplier 1 and 4 communicate each other.

Finally, since the suppliers' decisions depend upon the decisions of other suppliers joining the state firm, it is sufficient to model this situation as a collective action problem in which all players have to collectively take the same action in order to get the best outcome. If any players deviate from that action, it would cost all players since more costs are born to those who cooperate. Thus, everyone is reluctant to cooperate unless everyone confidently knows that everyone else will cooperate. Thus, the best outcome may not be achieved if players are uncoordinated. We will see how network structures play important roles in disseminating knowledge and predicting actions taken by others. In particular, networks have the potential to solve coordination problems among suppliers.

Equilibrium

Equilibrium under central planning and perfect decentralization

Before looking at the role of networks, let us analyze the outcomes of the economy under central planning and perfect decentralization with uncertainty. First, note that the best outcome of the economy is when there is no uncertainty and every supplier is free to choose its trading partners. In this environment, every supplier knows the other suppliers' thresholds due to perfect information. As mentioned above, there are $n + 1$ available suppliers in the economy and suppose that k of them voluntarily join the state firm where $k \leq n + 1$. The value of k is endogenous, not predetermined, depending on the suppliers' decisions. Consequently, a supplier with threshold of $c_i \in \{2, \dots, k\}$ would join the state firm when k suppliers join. The supplier with threshold $c = k + 1$ or more would be better off staying (not joining); this supplier would take the rent offered by the private firms since the maximum rent the state firm can provide is only k , but the private firm will pay according to its threshold of $k + 1$. However, this option may not be available in an imperfect information environment.

In a fully centralized economy or dictatorship, the central planner or dictator has full power to force all suppliers to engage in state production for the purpose of advancing state interests. In this case, $k = n + 1$ since all suppliers are forced to join the state firm, where k is the number of

firms that join the state firm. The supplier with threshold $c = n + 2$ has no option but to join the state firm. Unfortunately, this forced participation creates distortion in the economy because it makes suppliers with threshold $n + 2$ or more worse off, as the state firm will pay only $n + 1$, which is equal to the number of total suppliers. If this supplier had been given the choice of joining the private firms and not the state firm, it would have been paid its threshold of $n + 2$. The degree of distortion is much larger when the upper limit of private thresholds is higher than $n + 2$. Hence, the outcome of central planning is suboptimal.

Under full market decentralization, all $n + 1$ suppliers are free to invest in the state production or in the private firms. The existence of asymmetric information among suppliers and between suppliers and private firms causes suboptimal investment decisions. The market may even collapse. In this case, an adverse selection problem may exist since the suppliers' thresholds are private information unknown to other suppliers and firms. What the firms and suppliers may know is the distribution of the suppliers' thresholds. For example, if we assume that each supplier has equal probability of having a certain threshold, then a uniform distribution would be appropriate to use. When the thresholds are uniformly distributed on the interval $[2, n + 2]$ the private firms will offer all suppliers the same rent, which is the expected value of the thresholds level, $n/2$. Thus, a supplier will join the private production if its threshold is no higher than $n/2$. Those whose thresholds are higher than $n/2$ will leave the market. They will not join the state production because they have high thresholds and need to coordinate prior to investing. This adverse selection phenomenon is familiar in economics and is known as a lemon problem, where the low quality suppliers drive out the good quality suppliers from the market (Akerlof 1970). Knowing that only low quality suppliers are available to trade, the private firms may lower the offered rent, causing more suppliers to leave the market. Thus, the market may collapse.⁵ In short, asymmetric information among suppliers makes it hard to coordinate and asymmetric information between suppliers and firms triggers adverse selection causing the market to collapse.

We have seen that both central planning and perfect decentralization fail to produce optimal decisions. Communication networks, as we will see, may solve the coordination problems and eliminate the adverse selection problem associated with asymmetric information. However, we shall see that mere certainty about other suppliers' thresholds is not sufficient to induce suppliers to participate in the state firm. More important to this decision is whether one firm knows about the other firms' decisions.

Equilibrium under networks

A supplier is assumed to be rational and takes into account that other suppliers are also rational. Their rational decisions depend on their knowledge acquired from networks. This knowledge determines the supplier's ability to distinguish between states of the world – the set of all possible outcomes. If a supplier cannot distinguish between several states of the world, it must take the same action in all of them. Take for example that there are only two suppliers: $i = (1, 2)$ and three possible threshold levels $c_i = (1, 2, 3)$. Hence, there are nine possible states of the world $\{1, 1; 1, 2; 1, 3; 2, 1; 2, 2; 2, 3; 3, 1; 3, 2; 3, 3\}$, where 2, 3 means supplier 1 has threshold 2 and supplier 2

has threshold 3. The rest of this section will present how each supplier distinguishes each state of the world through a communication network. Three network structures are discussed: null network, full network, and incomplete network.

Figure 1. Null network (no communication).

Supplier 1's partition			Supplier 2's partition		
1,1	1,2	1,3	1,1	1,2	1,3
2,1	2,2	2,3	2,1	2,2	2,3
3,1	3,2	3,3	3,1	3,2	3,3

Supplier 1's actions			Supplier 2's actions		
j	j	j	j	s	s
s	s	s	j	s	s
s	s	s	j	s	s

Figure 1 presents a null network in which supplier 1 does not communicate to supplier 2 and supplier 2 does not communicate to supplier 1. Hence, supplier 1 knows its own threshold, but does not know supplier 2's threshold. The best supplier 1 can do is realize that supplier 2's threshold is either 1, 2, or 3, but supplier 1 cannot be sure. The same situation also applies to supplier 2. Therefore, supplier 1's knowledge can be represented by the partition set $\{1,1;1,2;1,3\}$, $\{2,1;2,2;2,3\}$, and $\{3,1;3,2;3,3\}$. Similarly, supplier 2's knowledge is represented by $\{1,1;2,1;3,1\}$, $\{1,2;2,2;3,2\}$, and $\{1,3;2,3;3,3\}$. Each partition, $\{.\}$, means that the owner of the partition cannot distinguish between its contents; therefore, the owner has to take the same action when facing any content within the partition.

Let us consider supplier 1. It chooses whether to join (j) or stay (s) given a state of the world. If it has a threshold of one, it will surely join the state firm. If instead it has a threshold of three, it will never join the state firm, regardless of the threshold of supplier 2. How about if it has a threshold of two? In this case, it ideally joins if the state is (2,1) or (2,2) and stays if the state is (2,3). However, since it cannot distinguish between these three states, it has to take the same action. If it decides to stay, the state could be (2,1). But if it decides to join, the state could be (2,3) and the other supplier will not join. Thus, the number of suppliers joining the state firm would be lower than its threshold. If the latter happens, (2,3), I assume that supplier 1 suffers a large cost from joining the state firm and its profit is then lower than its threshold.⁶

An analogy for the situation above is as follows. Imagine two community members Adam and Eve who each wants to decide whether to volunteer for community work, which requires a total of two hours. If only one shows up, he or she will work for two hours and, if both show up, each will work for 1 hour. Each member may not be available to volunteer at all, or may be available for one hour or two hours, but neither of them knows the other's availability with certainty. In this case, Adam will show up if he has a free time of two hours and will not show up if he has no free time, regardless of Eve's decision. Eve will make a similar decision. The problem arises if Adam is only

available for one hour. Should he volunteer? His decision depends on his knowledge of Eve's availability. Since he does not communicate with Eve, he is not sure whether she will show up or not. Therefore, to minimize loss, Adam will stay home when he has only one hour of free time and does not know Eve's threshold.

Back to the supplier-state firm case above, supplier 1 joins only if it knows for certain that supplier 2 will join. Hence, in this example, if supplier 1 has a threshold of two, it stays in all three states: (2,1), (2,2), and (2,3). Supplier 2 takes similar actions. It joins only if it has a threshold of one and stays if it has a threshold of two or three. Their set of actions is depicted in Figure 1. The coordination problem here is when they have threshold of (2,2). Social efficiency requires that they both join the state firm but their knowledge gaps prevent them from doing so. Thus, the outcome of the null network is inefficient. In general, each supplier joins only if it knows with certainty that a sufficient number of the other suppliers will join the state firm

Figure 2. Full network (complete communication).

Supplier 1's partition			Supplier 2's partition		
1,1	1,2	1,3	1,1	1,2	1,3
2,1	2,2	2,3	2,1	2,2	2,3
3,1	3,2	3,3	3,1	3,2	3,3

Supplier 1's actions			Supplier 2's actions		
j	j	j	j	j	s
j	j	s	j	j	s
s	s	s	j	s	s

Figure 2 depicts a full network or complete communication. Here, supplier 1 communicates to supplier 2 and vice versa. Both suppliers know each other's threshold and can distinguish among all states of the world. The difference between figure 1 and figure 2 is best seen when supplier 1 has a threshold of two. In a null network, it stays in state (2,1); (2,2); and (2,3) because it cannot distinguish between the three states. Now, supplier 1 can distinguish between these three states and can take different actions in regards to each of them. Supplier 1 will definitely join in state (2,1) because it knows with certainty that supplier 2 has a threshold of one and hence will also join. In contrast, supplier 1 stays in state (2,3) because it knows that supplier 2 has a threshold of three and will also stay. Supplier 2 has a similar case in which it will join at state (1,2) and stay at state (3,2).

What if the state is (2,2)? In this case, there would be two equilibria: one point where both suppliers join and the other point where neither chooses to join. In this model, whenever there is this kind of indeterminacy, I assume that the equilibrium is one point where both choose to join. In other words, when each supplier with a threshold of two discovers the other also has a threshold of two, I assume they both join the state firm.

No coordination problem arises when the threshold is (2,2). Both suppliers join the state firm. That is because each supplier knows the other's threshold and each knows that it has mutual

knowledge of each other's threshold. Networks here materialize the gains from participation and hence solve the coordination problem

Figure 3. Incomplete network (partial communication).

Supplier 1's partition			Supplier 2's partition		
1,1	1,2	1,3	1,1	1,2	1,3
2,1	2,2	2,3	2,1	2,2	2,3
3,1	3,2	3,3	3,1	3,2	3,3

Supplier 1's actions			Supplier 2's actions		
j	j	j	j	s	s
j	j	s	j	s	s
s	s	s	j	s	s

After establishing the difference between the null and complete network, let us consider the incomplete network presented in Figure 3. Here, supplier 2 communicates with supplier 1, but supplier 1 does not communicate back to supplier 2. In this case, only supplier 1 has full knowledge of the exact state of the world. An interesting question here is whether supplier 1 chooses to join the state firm when it knows the exact state of the world is (2,2). The answer depends upon its expectation about supplier 2's decision. To join, supplier 1 has to make sure that supplier 2 also joins. However, it knows that supplier 2 cannot distinguish between the states of the world, and therefore it predicts that supplier 2 stays. From supplier 2's point of view, the state of the world could be (3,2). This indeterminacy would predict that supplier 2 chooses to stay and hence, supplier 1 will also stay. In short, under the incomplete network, both suppliers stay at state (2,2) because one supplier knows that the other supplier does not know for certain whether its counterpart will join the state firm. Thus, the coordination problem still exists and gains from participation cannot be materialized.

It is easy to extend the model to n players, which is simply a matter of writing down all states of the world. The point here is that *knowing the state of the world per se is not sufficient for a supplier to join the state firm*. It is more important to know what others know, and also to know that others know what we know (common knowledge), in order to solve the coordination problem.

Discussion and Extension

Chwe (1999) defines transition as moving "from plan and plan institution to market and market institutions." In this paper, this means moving from involuntary participation under the central planning (dictatorship) towards voluntary participation under networks (market decentralization). This transition may harm a nation's total economic production or output despite a common belief that market decentralization boosts economic growth. The main problem with voluntary participation under market decentralization is the existence of asymmetric information. Since

voluntary participation involves coordination, asymmetric information may inhibit the ability of economic agents to coordinate and to collectively take the preferred actions. This inability contributes to suboptimal investment decisions and hence suboptimal outcomes. During a transition period, after a regime change from a dictatorship towards democracy, economic agents such as laborers, capital owners, and entrepreneurs may not yet be ready to coordinate with each other due to limited knowledge of required information. The example below shows that a country can experience a sharp decline in output during a transition from dictatorship towards decentralization.

Suppose that there are two electrical power companies: one is state-owned and the other is private-owned. These companies require several electrical components, each supplied by an individual private supplier. Each supplier has its respective marginal cost of production. The lower its marginal cost, the higher the quality of the components. Thus, each supplier has its own threshold for a minimum rent at which the supplier is willing to sell its components. The thresholds are measured by units of capital equivalent. Suppose there are five suppliers with thresholds of one, two, two, nine, and nine units of capital, respectively. Here, I allow the upper limit of private thresholds to be sufficiently high to indicate the more advanced private sectors. Each supplier can provide its components to the state firm or to a private firm. The state firm has production function as in (2) and distributes the output equally to the suppliers. The private firm produces output equal to the sum of suppliers' thresholds and pays each supplier equal to their thresholds.

Under central governance or dictatorship, everyone is forced to engage in state production. The private firm does not exist in such regime. With a production function of the state firm of $y = k^2$ as defined earlier in (2), the total production of those five suppliers is 25 units. Every supplier then has capital income of five units since the state firm divides its value of output equally. Notice that two suppliers with a threshold of nine are worse off because their incomes are below their thresholds (incomes of five versus incomes of nine). Meanwhile, the other three suppliers are better off.

Under a regime of market decentralization with a network, the national output may be higher or lower than that under the central planner. This paper's purpose is to show that the output *may be lower*. If the network is empty, or there is a null network where there is no communication among the suppliers, only supplier 1 will voluntarily join the state firm while the other suppliers take their private alternatives from the private firm. Hence, the total output and income produced in the economy would be $1 + 2 + 2 + 9 + 9 = 23$ units, which is lower than that under the central planner. Under full networks or complete communication, three suppliers with thresholds of one, two, and two join the state firm while two suppliers with a threshold of nine join the private firm and take their private alternatives, delivering total output or total income of $3 + 3 + 3 + 9 + 9 = 27$ units, which is higher than that under the central planner. Finally, if the network is incomplete, the outcome will depend on the network's structure, i.e., who communicates to whom. When networks are incomplete, lower income is more likely to occur, but when networks are fully developed, higher income will be more probable.

There are two conditions that can make output fall after the collapse of dictatorship: *imperfect network communication* and *rapid growth in private industries*. Rapid growth in private sector industries, indicated by relatively high productivity or low marginal cost, gives suppliers more opportunities to

earn higher rents. Those opportunities are disseminated through a communication network. Hence, when information is well disseminated and the private sectors are relatively well developed, the economic distortions caused by central planning are relatively larger. However, if the network to disseminate information is ill developed and private sectors are still primitive, central planning or dictatorship provides a better solution to coordination problems.

This model is applicable to current political transitions and can be seen as a warning to countries that are now at the early stage of democracy such as Turkey, Libya, Egypt, Afghanistan, and Syria, among others. One could expect that their economic output would fall shortly after the collapse of the dictatorship or powerful central government. The main reason is the communication networks, which transmit relevant information, may not be feasible and may take some time to develop. Along with a fear of political instabilities, business owners need an economic adjustment period from the former forced participation by the central government to the voluntary participation under market institution. During this adjustment period, output is predicted to fall. Moreover, if the transition periods run radically instead of gradually, the fall in output would be even worse.

By the example above, this paper is able to show the importance of network development during a transition period from a centralized governance structure to a decentralized governance structure. Nevertheless, the model presented has some shortcomings in that it only deals with a simple network model that relies on an increasing return to scale in state production. In reality, networks are more complex and sophisticated. The assumption of increasing returns to scale is plausible under monopoly but too restricted for a competitive market economy. In a competitive market literature, firms are commonly assumed to have a technology of constant return to scale. Therefore, one possible extension of this paper's model would be to develop more sophisticated communication network models. These would allow for an exploration of the value of each economic agent in a network; in other words, the contribution each player makes in a network to disseminate information can be analyzed. Thus we can detect who the key players are and what their roles are in their respective strategic positions (Ballester, Calvo-Armengol, and Zenou, 2006). For example, in a star communication network, one can analyze the central player, the gains and costs of being at the center of the network and its roles in transmitting information.

Another possible extension of this paper is to allow for a more flexible production function in both public and private sectors. This relaxation would allow the production function to reflect different market structures such as monopoly, oligopoly, and perfect competition. Given market structures, a more flexible production function would also allow us to encompass firms with stronger network interactions. For example, in industrial organization literature, networks among suppliers play a crucial role when the market is oligopolistic rather than when it is monopolistic, as the suppliers use the network as a barrier to entry. Therefore, using a more flexible production function and a more sophisticated network, one should be able to better explain the decline in output during governance transitions.

Conclusion

This paper provides a theory for why changing institutions from dictatorship towards democracy does not necessarily improve economic performance. The theory is based on the argument that suppliers need to be able to predict their partner's knowledge in order to voluntarily invest in state production. During dictatorship, no voluntary decisions are necessary since all agents are forced to work for state production. Once this central government loses its power to compel actions, the availability of information plays a crucial role in mitigating coordination problems among suppliers. Unfortunately, no immediate set of institutions exists that can disseminate knowledge to society. As suppliers are heterogeneous and some information is hidden from other suppliers, investment decisions produce an inefficient outcome. Only when communication networks among suppliers are well developed can the hidden information be revealed and transferred through the network. These knowledge dissemination structures are necessary to reach the optimal economic decision.

We have seen various equilibrium scenarios. Under full centralization, all suppliers are forced to participate in state production leading to suboptimal investment for higher threshold suppliers. Under complete market decentralization, imperfect information may cause the entire market to collapse due to adverse selection problems. Under a communication network, output depends crucially on how the network has developed. When networks fail to produce common knowledge, investment decisions are also not optimal, even if there is no uncertainty about the other players' information. In all these scenarios, investment decisions are suboptimal and coordination problems exist as long as information is not fully transmitted.

Common knowledge is therefore a key to solve the coordination problems. Once every supplier knows each other and they have a mutual understanding of each other, investment decisions can be optimal. However, it takes some time to build this common knowledge. In the meantime, lack of communication causes output to fall. Moreover, output may continuously fall at the beginning of a transition period but start to recover once networks are developed and information is well disseminated. This prediction therefore can be seen as an early warning to countries which are now at the beginning of their transition periods. Those countries should let the transition process proceed gradually instead of radically to foster the development of networks among economic agents.

¹ The literature on networks has been fast growing since the last decade. Readers may refer to Jackson (2008) for an excellent survey.

² An example for the existence of these three firms in reality is seen in any electronic products. Apple for example uses many components produced by several independence firms. This component-producing firms are called suppliers in this paper.

³ It is relatively easy to show the externalities in terms of skilled labor. It can be argued that a smart worker is more productive when he or she collaborates with other smart workers than with less skilled workers.

⁴ We set the thresholds as integer just to simplify the analysis in the following sections and we restrict the upper limit to just to make sure that there are suppliers that are always better off taking their private alternatives even when all n suppliers are forced to engage in the state firm. As stated above, if n suppliers

join the state firm, they each will get return of n units regardless their thresholds. The higher the upper limit, then, shows the larger economic distortions caused by the state firm. We will relax this assumption in later discussion to compare the outcomes under different institutions.

⁵ The analysis is independent on the distribution of threshold. The uniform distribution is just used as an example.

⁶ In case of workers, we can assume that the worker gets very large negative disutility when the number of people joining the state firm is less than his or her threshold.

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Five

Big Ag Talks Going Green: Public Opinion Research on Large Scale Farmer Attitudes and Activities on Conservation Practices on Illinois Farms

Betsy Riley

Abstract

This research looks at farmers' opinions toward conservation measures, specifically those related to the environmental movement. Two versions of a mail survey, altered slightly to determine language preferences, were distributed to a randomly selected group of Illinois farmers. Participants were asked whether they agree with certain statements about environmental management. Results of the study suggest that farmers are sensitive to word choice such as "sustainable," which is traditionally associated with the environmental movement. Additional differences were found due to demographic preferences, such as political affiliation. Farmers also demonstrated an awareness of scientific vocabulary and concepts, seeing no difference between the terms "global warming" and "climate change," and preferring terms such as "ecosystem" to equivalent layman terminology. Results indicate that conservationists working with farmers should strongly consider word choice and issue framing.

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Introduction

While a great deal of research has been done regarding general public opinion towards American agricultural practices, comparatively little research directly explores farmer opinions. Most existing research concerns scientific advancements like biofuels, GMOs, and organic farming (Rossi 2011, Guehlstorf 2008, Duram 2000). The research presented here is an overview of the currently available public opinion research as it relates to large scale, industrial farmers and their attitudes and opinions toward environmentalism and water quality conservation initiatives. This review will address the main research findings, focusing on farmers' perspectives of economic incentives, environmental stewardship and policy, along with noted demographic trends.

Economic Incentives

Economic incentives for farming are frequently assumed to be a determining factor for implementation of conservation initiatives (Heilman and D.S. Yakowitz 1997), and some research supports this. Federal funding programs have been shown to jumpstart conservation practices, though little is known about farmer attitudes toward the initiatives (Trout, Francis, and Jr. 2005), and such conservation efforts may begin and end with the availability of funding. A study on Michigan farmers found that subsidies alone could not account for farmer motivations to engage in conservation practices (Ryan, Erickson, and DeYoung 2003).

While economic incentives are a high priority for farmers, and necessary to stay in business, there are instances that suggest that these are not the sole motivation for enactment of such measures. Ahnstrom et al.'s review found farms with higher incomes used more pesticides than low-income farms although high-income farms were also more likely to enroll in more conservation programs (Ahnstrom et al. 2009). This finding suggests that motivations besides income could account for conservation efforts.

Environmental Stewardship

There is a great deal of agricultural marketing that portrays the American farmer as a steward of her or his environment (Hanson 2001). Some research supports this idea, though it is often more complex than a simple desire to be a good steward of the land. One hypothesis on farmers' values for their land looks at understanding farmers within their social network, by theorizing that farmers are more likely to engage in conservation work if they believe it will impress their neighbors. Ryan et al. (2003) showed that Michigan farmers were more likely to join conservation programs that emphasized tidy conservation management practices, rather than the less kept wildlife habitats, leading the researchers to speculate that the physical appearance of their land was an important component in farmer decision making (Ryan, Erickson, and DeYoung 2003). A small scale interview project found that when farmers were posed with questions about environmental stewardship, they frequently pointed out neighbors who failed to engage in such initiatives (Yakatan 2008). Should further research find similar phenomena in Midwestern farmers, this could have significant implications for the sort of conservation practices that are most likely to appeal to farmers, particularly those conservation practices which are visually appealing.

Research on Midwest farmers indicates that should the appropriate conservation strategies be developed, agricultural producers do not require a great deal of convincing that they are worthwhile. Around 94 percent of survey respondents agreed that water quality in Kansas needed to be protected, in a 2007 survey of 136 Kansas agricultural producers, and few disagreed with the statement that Kansas waters were polluted (Smith, Peterson, and Leatherman 2007). A study of Michigan farmers found that farmers rated soil conservation extremely highly (average of 4.41 on a five point scale) and believe that it makes economic sense for their farms (Ryan, Erickson, and DeYoung 2003). When asked about hypoxia (oxygen depletion caused by fertilizers) in the Gulf of Mexico, farmers in a small-scale interview study emphasized that they do everything they can to prevent run-off, since it does not make economic sense for them to waste fertilizer (Yakatan 2008).

Policy

Some themes have been found regarding farmer support for general types of policies. Interviews with Midwestern farmers along the Mississippi River from Iowa, Illinois, Missouri, Arkansas, and Indiana, found support for the “free market with a safety net” mentality towards subsidies, with displeasure over the bureaucracy farmers must go through to get such subsidies (Yakatan 2008). “Being over-regulated” was cited by 80 percent of ranchers in one California survey as one of the most likely reasons they would quit ranching (Liffman, Huntsinger, and Forero 2000).

Of the 15 farmers that were interviewed in the Mississippi research project, few expressed support of President Obama, but the majority appreciated his increased funding for ethanol production (Yakatan 2008), indicating that these farmers would be unlikely to support reductions in economic incentives for this production.

Some research shows a general distrust of conservationists, with a Michigan based study finding 56 percent of farmers refusing to have their land surveyed for fear of being subjected to regulations, with responders specifically stating a mistrust of government regulators and conservation biologists (Brook, Zint, and DeYoung 2003). In the study of Mississippi farmers, the interviewer describes “viscerally negative reactions” towards environmentalists and conservation initiatives (Yakatan 2008). A survey of Kansas farmers found that slightly over half of producers believed that environmental legislation in general is unfair to agricultural producers (Featherstone and Goodwin 1993).

Farmer Demographics and Values

Research has indicated that willingness to engage in conservation practices depends on some general demographics. Although the majority of this research was done prior to 2005 and exact percentages may have changed, the general trends served as part of the basis for this research. The difficulty in finding recent research emphasizes the need for updated work in the area.

Farm Size. New York farmers were shown to favor the use of conservation practices if they owned smaller farms, rather than larger farms (Buttel and G.W. Gillespie 1988). However, further research on Kansas farmers showed an anomaly in the trend of smaller farms using more conservation practices if the larger farms *also* had larger households. Researchers speculated that perhaps farmers feel more attachment to land if they see it being passed on to their children

(assuming larger households means a higher likelihood of an heir) (Featherstone and Goodwin 1993). An alternative explanation is that these larger families have more hands to do work around the farm, making conservation practices more affordable.

Family Tradition. A similar, family emphasis was strongly observed in British farmers, with the desire to look after the farm for future generations being rated more highly than any other value in explaining their farming practices. In addition, farmers living on old, family farms were more likely to adopt conservation measures than relative newcomers to the field (Wilson 1996). This same factor was found to be the highest rated reason for joining nature conservancies in a study of Michigan farmers (Ryan, Erickson, and DeYoung 2003). Although not statistically significant, a similar study in North Dakota revealed that all farmers surveyed using conservation practices believed that they would be farming in the future, as compared to 92 percent of conventional farmers and 95.8 percent of mixed-type farmers (Jacobsen, et al. 1991).

Age. Younger farmers were more likely than older farmers to engage in conservation activities. Results were shown across the United States, with farmers in Kansas (Featherstone and Goodwin 1993), North Dakota (Jacobsen, et al. 1991), and Iowa (Bultena and P. Nowak 1981).

Education. Farmers with more education are more likely to adopt new technologies or join conservation efforts (Gould, Saupe, and Klemme 1989).

A General Note about the Reliability of Available Research

All research contained in this report is based on peer reviewed reports, and/or information from research organizations. However, much of the data is becoming increasingly outdated. Prior to 2005, U.S. agricultural policies had created a farming culture that is significantly different than the culture today. Market prices for corn were kept extremely low due to large subsidies being granted to farmers. Because of these low corn prices, farmers were forced to produce as much corn as possible in order to get some return on investment, forcing many small farmers to expand or sell their farms. In 2005, new policies such as the New Renewable Fuel Standard, which encouraged using corn for ethanol, dramatically increased demand for corn, raising corn prices. Farmers were suddenly incentivized to continue producing as much corn as possible, changing their motivations from a desire to simply stay in business to a desire to make a large profit. An acre of land set aside for conservation, even with the existence of economic incentives for sustainability initiatives, was suddenly much more costly to farmers than it had been before the 2005 fuel standards were passed.

It is likely that with this change in farmer motivation, farmer attitudes and opinions will change as well. Much of the public opinion research available was done prior to 2005 and may no longer reflect farmer opinion. In addition, research done on farmers outside of the United States, who were not subject to changing subsidies and requirements, may be equally unreflective of Mississippi River Basin farmers. This underscores the need for current research on this demographic.

Methodology

Bluestem Communications (formally Biodiversity Project), an environmental outreach organization based in Chicago, is the nonprofit organization that instigated this research. The organization recently completed similar research with the general public, looking at what values people generally hold with regards to the Mississippi River, in the hopes that an outreach campaign geared towards meeting public interests would be more effective than a campaign geared to meet the needs of a subset of environmentalists.

This first round of research was not complete, however, due to a lack of farmer input. Frequently cited by environmentalists as being responsible for the bulk of what is currently creating the Dead Zone or oxygen depletion in the Gulf of Mexico, farmers are an indispensable part of both the problem and the solution. In the present study, the original Bluestem Communications survey was modified from a telephone survey to a paper survey with questions that pertained directly to farmers, to determine why farmers make the conservation choices they do and how they value the land and waterways.

300 addresses were randomly selected to receive a paper copy of the survey from a list of 600 farmers in the Illinois region who participated in the Conservation Stewardship Program, which was obtained from an environmental organization that was part of Bluestem Communications's Mississippi River Network. Of these, 102 surveys were returned either fully or partially completed, with two returned as incorrect addresses. This was a response rate of 34 percent, a high response rate for mail surveys, especially for a general population with no incentives and no follow.¹ The information was collected by a University of Michigan graduate student, in association with Bluestem Communications and their Mississippi River Network.

The variables in the dataset include a listing of conservation activities and basic demographics, as well as a set of responses meant to measure certain viewpoints with regards to the environment. These include questions about agreement with certain statements and environmental arguments, as well as their support for potential conservation initiatives, and how threatening they perceive certain activities to be to the Mississippi River.

Data was collected in six parts: 1.) Conservation information, 2.) Reasons for conservation choices, 3.) Opinions about the Mississippi River, 4.) Beliefs about possible threats to the Mississippi River, 5.) Support for proposed corrective measures with regards to Mississippi River maintenance, and 6.) Judgments about reasons for valuing the river in a particular way. All data was collected using Likert scales, with the exception of demographic information and the conservation choices section, which was collected using a binomial, yes or no, system.

The data was collected using two different surveys, called Survey A (46 percent of respondents) and Survey B (54 percent of respondents). While these surveys had many of the same questions, 20 of 63 questions were altered slightly to determine if the use of certain language affects farmer agreement with environmental sentiments. With one exception (discussed in results), there was no statistical difference between the responses to identical questions between the surveys.

¹ For comparison works, see up (Kaplowitz, Hadlock, and Levine 2004), (Cobanoglu, Warde, and Moreo 2001), (Greenlaw and Brown-Welty 2009), (Church 1993), (Kephart and Bressler 1958)

Many of the variables in the survey are categorical variables (i.e. religious affiliation), which means Chi-squared tests were used. Because a great deal of the data was collected using a Likert scale, Chi-squared tests were especially useful when comparing Likert scale results with categorical responses, such as looking at whether the strength of certain values is associated with political affiliation. Although the direction of relationship cannot be empirically determined using Chi-squared tests, statistical independence can be determined.

T-tests were used to determine whether associations exist between the different variables. Some of the data (total number of conservation measures, for example) is continuous, but many variables are dichotomous (i.e. “Do you use no-till or minimal till farming? Yes or no.”), which means that this research focuses on proportion data. T-tests were conducted to examine the reliability of the differences between Survey A and Survey B.

Descriptive Statistics

One hundred and two farmers responded to the survey. Comparisons between key demographic information revealed no significant differences between the respondents of Survey A and Survey B, indicating that randomization was successful. Table 1 below shows the results, with standard errors in parentheses.

Table 1. Means for Survey A and Survey B Respondents and Associated p-values.

Variables	Survey A	Survey B	p-value	Overall
Self-Identified Church Goers (%)	70	71	0.84	71
Average Schooling (%)	3.63 (2.14)	3.16 (2.18)	0.29	3.37 (2.17)
Average Age (%)	58.8 (9.35)	57.3 (11.13)	0.47	58.0 (10.34)
Average % of Income Based on Farming	73 (28.48)	75 (30.26)	0.63	74 (29.36)
Average % of Farmed Land Owned	63 (59.82)	52 (37.80)	0.27	57 (49.19)
Average # of Years Spent Farming	33.9 (12.77)	34.2 (12.67)	0.90	34.0 (12.65)
Average # of Acres	1114 (1332)	1009 (891)	0.64	1055 (1104)
Average # of Conservation Techniques Used	5.3 (1.58)	5.0 (1.96)	0.34	5.1 (1.80)

The above data also reveals that the targeted population responded to the surveys. The respondents were primarily farmers, with an average of 74 percent of their annual income dependent on farming (84 percent of respondents reported at least 50 percent of their income dependent on farming). The farmers both owned and rented the land they worked, with the average farmer owning 57 percent of the land worked. Most respondents were also long term farmers, working the land for an average of 34 years, and they owned large tracts of land, with an average of 1055 acres, although the removal of an outlier who owned almost 5,000 acres more than the next largest landowner puts this number at approximately 980 acres (standard deviation 820.40). Finally, the farmers displayed an interest in implementing conservation measures, with the average farmer

having at least five conservation techniques employed on her or his land at the time the survey was taken.

Based on available data, the demographic data collected closely resembles the national average data in areas like age and differs in a few key characteristics. The USDA's 2012 Census of Agriculture reported the average age of Illinois farmers to be 57.8 (versus the study's finding of 57.99), and found that 82 percent of farmers had been farming for 10 years or more. The key difference is farm size: the average Illinois farmer farms 359 acres—significantly smaller than the survey average, whether determined with or without the outlier (US Department of Agriculture 2014). Because the survey creators were hoping to gather information on large scale farmers, this difference provides evidence that the target population was reached.

Many demographics measured in the questionnaire are not measured through government surveys (such as religious practices and schooling). Other traditional demographic variables, such as sex and race, were not collected, although this would be a very interesting extension of this work. In this instance, the small sample size would make it difficult to identify statistically significant differences between these demographics (which are not evenly represented in the United States large scale farming community), and with limited space, other demographic information was determined to be more important.

Data Analysis

Conservation Practices

Ninety-nine percent of farmers report using some sort of conservation practices, with a mean of five conservation practices overall. The most popular practice is No Till/Minimal Till farming, which provides not only conservation benefits in terms of water and soil retention, but also provides gains in time and labor costs from a business perspective, making it an obvious choice for many farmers. Crop rotation is also extremely popular, as it allows productive use of the land for agriculture, while also providing some environmental benefits. The least popular method of conservation is wetland restoration, which takes up a great deal of space and has few obvious economic benefits for the farmer, despite requiring a great deal of restoration work. Strip-cropping is almost equally unpopular, as the practice requires alternating different types of crops on the same land, making harvesting more difficult.

Table 2. Percent of Farmers Using Conservation Practices.

Conservation Practice	Percentage of Farmers Using
Any Conservation Practices	99
No Till/Minimal Till	90
Crop Rotation	86
Waterways	81
Buffer Strips	59
Field Borders	43
Cover Crops	39
Terracing	32
Strip-cropping	14
Wetland Restoration	13

Of the demographic characteristics measures, two displayed significant relationships, as determined through standard regression, although both were relatively small effects. Age and conservation use were positively correlated ($p = 0.043$). Each decade of farming experience is associated with an increase of 0.3 conservation practices used. In addition, another positive correlation was found for conservation use and farming-based income ($p = 0.002$). Each 10 percent increase in farming-based income is associated with an increase of 0.2 conservation practices used. There was no significant relationship between conservation usage and farm size, owning versus renting, frequency of church attendance, or schooling.

Additional analyses were conducted to determine whether demographic information played a role in total conservation measures used. A chi-squared test was run to look at the correlation between political affiliation and the total number of conservation measures used. The variable for “total conservation measures used” was broken down into two categories, “Few conservation measures used”, denoted as five practices or less, and “Many conservation measures used”, denoted as six practices or more. Political affiliation included Republicans, Democrats, and Independents. The results are displayed on Table 3 below.

Table 3. Total Implemented Conservation Practices by Political Affiliation.

Political Affiliation	0-5	6+	Total
Democrat	9	0	9
Independent	9	13	22
Republican	33	25	58
Total	51	38	89

The chi-squared test revealed that the association between party affiliation and conservation practices is significant ($p=0.0104$). This result was confirmed using the Fisher’s Exact Test for small sample size (with the category of “Independent” removed in order to achieve the two-by-two matrix

required for the test), which found the same p -value as the chi-squared test in a one-tailed variation, and a value of 0.021 in a two-tailed test, both significant values.

Conservation Measures: Farmer Decision Making

This analysis raised questions as to why farmers belonging to one political affiliation chose to implement specific conservation measures over those belonging to another. An analysis was run with a breakdown of responses by political party, as shown in Table 4 below.

Table 4. Percentage of farmers who responded with “Agree” to the following statements.

Measured Values	Political Affiliation			Overall
	Democrat	Independent	Republican	
“Participation in conservation initiatives...”				
Benefits me economically (All)	33	86	83	79
Puts me at a competitive disadvantage relative to other farmers in the area, who aren’t implementing these measures. (All)	0	9	5	6
Is important because other farmers will look poorly on my farm if I don’t participate. (All)	0	0	5	3
Helps to maintain the quality of my land and soils, so that I can use the land for longer. (Survey A)	100	100	100	100
Improves the health of my farmland, so I can use it more sustainably. (Survey B)	75	82	89	86
Helps clean up local waterways. (Survey A)	40*	82*	68*	68
Helps clean up the Mississippi River. (Survey B)	50	45	58	55
Is part of my responsibility as a farmer. (Survey A)	100	100	91	95
Makes me a good steward of the environment. (Survey B)	100	100	100	100
*Although these appear very different, the small sample sizes for each survey prevented a significant finding.				

From this data, only the first question on economic benefits displayed a significant difference, as determined by a chi-squared test ($p = 0.0021$) and corroborated by the Fischer's Exact Test ($p = 0.0025$), which indicates an interaction effect of this measure and political affiliation. While a large majority of both Republicans and Independents believed conservations measures have economic benefits, the majority of Democrats did not. The small sample size brings the significance into question, but party affiliation as it relates to conservation activities could be an area of further research, to try to understand if and why Democrats specifically are less likely to believe in the economic benefits of conservation.

Of note is that farmers were the least likely to agree with the idea that conservation measures put farmers at a competitive disadvantage (six percent) or believed that other farmers would disapprove if they chose not to implement conservation measures (three percent). As to this last question, further study may be warranted, as this finding contradicts previous research. Because this survey looked at conscious attitudes, however, it is possible that farmers do not notice the effect

of social pressures. The lack of subtlety of this question may have overshadowed underlying social forces.

Analysis of Differences Between Survey A and Survey B

In the survey, several questions were asked of only one half of the survey respondents, for two reasons: 1) to see if there were differences in reaction to slight variations in framing and 2) because the survey was short, and we needed to get as much information out of it as possible. For this reason, some comparisons between Survey A and Survey B make quite a lot of sense. In other instances, the comparison is less appropriate. For the purpose of this paper, only the questions posed differently between the surveys are analyzed.

Interchangeable Terminology

From a communication standpoint, understanding when word choice does not make a difference is just as important as understanding when it does. For this reason, a brief review of non-significant findings has been included.

In terms of language used, farmers did not readily differentiate between the terms "global warming" and "climate change," "state" and "region," or "cultural" versus "historical." In addition, farmers showed no difference in opinion when the term "steward" was used or not used, when a divine "God" was invoked versus not invoked, when the Mississippi was mentioned specifically rather than "waterways" generally, nor the mention of specific flooding events as opposed to general flooding.

Interestingly, the farmers showed equal concern for protecting wetlands as a form of flood control as they did as a form of wildlife habitat. This question was posed to determine farmer opinion changed towards wetlands when they considered it a detriment to themselves (flooding their land) versus a non-human, non-personal entity (wildlife). The farmer's unchanging concern for wetlands was demonstrated twice in the data, whether framing the issue of wetland destruction as a threat, or wetland protection as a benefit. In neither instance was the end concern shown by farmers statistically different, regardless of framing. This lack of opinion change with regards to human and nonhuman benefits was also echoed in the lack of a significant difference found between wanting to protect land beside rivers from development, versus protecting it for human use and enjoyment.

In order to increase sample size in the full analysis, the following non-significant variables have been combined into their respective single variables for the purpose of the full analysis:

- climate change and global warming
- historical and cultural
- region and state
- "God" mentioned versus not mentioned
- specific flooding events versus general ones

Non-Interchangeable Terminology

In several instances, farmers responded significantly differently to different phrasings. Farmers were more likely to agree with a statement that the Mississippi is "polluted," rather than "full of trash," for instance. This could be related to a sense that "trash" is a visible substance, whereas "pollution" can combine with the water to make it unsafe for human and ecosystem health without very visible signs of trash. In terms of curtailing non-visible pollution like fertilizer runoff, this distinction may be highly salient.

In addition, farmers who received Survey A unanimously agreed that conservation "improved the quality of their land," which allowed them to use it longer. However, there was less agreement as to whether these same activities resulted in "improved land health and sustainable use." These statements, which are arguably the same, received different reactions, indicating that farmers may respond more favorably to statements that do not directly use the words "sustainability" and/or "health."

Interestingly, farmers were more likely to agree that the Mississippi River is a "living ecosystem" rather than "full of life." This difference was chosen as two potential wordings for outreach materials, one representing a more scientific approach (the word "ecosystem") to river management and the other representing a more layperson language. The farmer response to the word "ecosystem" shows a familiarity with the more technical language used to describe natural environments, signaling that it might be useful to engage with farmers on a more technical level when it comes to river management. The difference in the survey results here could be because farmers were reminded in this survey that the Mississippi River is polluted, and were reluctant to say that it is "full of life" but did not have the same qualm about thinking about the river as an ecosystem. Whatever the reason, the difference is significant.

Farmers also responded differently to two different framings regarding restoration initiatives. One survey simply asked how much farmers were likely to support an "increase [in] public funding to clean up and restore the Mississippi." The second survey used exactly the same language, but with the phrase "supported by an increase in taxes" at the end. Farmers were less likely to support the statement if taxes were identified as the funding mechanism.

A difference was found between the views that the Mississippi is a "place of scenic beauty" rather than a "place to relax," with farmers rating "place of scenic beauty" more highly. One explanation for why farmer opinion seems to be slanted towards "scenic beauty" could be that farmers are more accustomed to seeing the river as a place to look at, but not necessarily interact with, as the phrase "a place to relax" implies.

There was one question which bordered on significance that should be mentioned. Farmers seemed to agree more to the statement that the Mississippi River is "vulnerable" than it being "threatened." This is an interesting differentiation, since "threatened" implies outside, aggressive forces, while "vulnerable" does not. It is possible that farmers are uncomfortable with the idea that the Mississippi River is being "threatened" as farmers themselves are often accused of doing harm to it. It is possible that "vulnerable" is more harmless, whereas "threatened" inspires defensive reactions. No variables with significant differences were aggregated.

Farmer as Residents of the Mississippi River Region

With one exception, there were no statistical differences between the surveys, indicating that in general, there were no serious interaction effects as a result of the slightly different wording. This one exception was farmer feelings about their own residency status with regards to the Mississippi River region.

The question posed was “I consider myself a resident of the Mississippi River region” with the options “Strongly Agree” to “Strongly Disagree” (1-5). Those who responded to Survey A were statistically more likely to consider themselves resident than those who responded to Survey B ($p = 0.0015$). It is possible that the assortment of questions in survey A vs. survey B may have inspired differences of thought around residency. It should be noted that there were no differences between the surveys on measures such as total conservation measures and it was confirmed through a regression that no linear relationship exists between the implementation of conservation measures and feelings about residency status. An association was uncovered between feelings of residency status and feelings of responsibility towards maintaining the Mississippi, although the link is tenuous due to an insufficient number of farmers rating this measure as unimportant to create an effective chi-squared test, even when numbers were combined to make larger categories. While of theoretical interest, this finding is of limited importance since neither measure correlates with increased use of conservation measures.

Limitations

While a random selection of all farmers would have been better than a random sample of farmers who are already associated with an environmental organization, this data was chosen for two reasons:

1. Farmer contact information is, quite understandably, private. An organization of some kind was required in order to gain access to farmer addresses.
2. The use of an environmental organization to gather this data had the potential to skew the data in favor of farmers that have already shown an interest in the environmental movement. However, analysis of survey respondent demographics indicated a wide range of responses, from those implementing one conservation measure to those implementing ten, and a wide range of environmental perspectives. Indeed, far more Republicans responded to the survey than Democrats, who are conventionally seen as more environmentally minded. While it is always possible that a population skew occurred, as well as potential for a nonresponse bias, the data analysis makes this unlikely.

The most obvious drawback of the data is that only 102 observations are available for analysis. Although the return rate for surveys was high, this may make it difficult to find more subtle difference between populations. The data collection was a relatively low budget operation and only 300 surveys were sent out initially. Further research in this area should focus on collecting information with more participants, to ensure that small effects (which are implied by the several instances in which effects approaching significance are found) are properly accounted for.

In addition, it should be made clear that the population is sampled from the Illinois region only. While Illinois is a big player in agricultural states and is traditionally considered to have a typical Midwestern culture, personal judgment (and hopefully further research) will need to determine whether the state is representative of the Midwest region or the country as a whole.

Discussion

Language

The analysis offers interesting insight into the values and thought processes of farmers. Many of the reasons that farmers put forth for why they make the decisions that they do are remarkably consistent with environmentalist thinking, despite not using environmentalist terminology. In some instances, use of classic environmentalist words such as “sustainability” seem to have reduced support for the idea (85 percent approval) while the concept itself, expressed as an issue of longevity and land quality, was unanimously accepted (100 percent approval).

The appreciation of the word “vulnerable” instead of “threatened” may be another example of farmers being extremely conscious of where they stand with regard to the Mississippi River’s health. This research seems to indicate that the tension that exists between the two groups, farmers and environmentalists, has spilled over into the language used to communicate ideas and concepts or vice versa.

In other instances, language seemed to play a much smaller role. Farmers overall had no change in response when the word environmental “steward” was used or omitted. Nor were farmers interested in “global warming” versus “climate change.” It seems likely that the subtle distinction between these terms and the concepts that they respectively represent may not be of great importance to farmers, whereas terminology frequently used by environmentalists, such as “sustainability,” or that seems to assign blame, such as “threatened,” may be seen as more meaningful.

Demographics

Often the demographic results raised more questions than it provided answers. Although the chi-squared tests are slightly suspect due to the limited number of Democrats in the subject pool, the statistically significant findings raise questions about what a large dataset might reveal given further study. As it stands, the data implies that Democratic farmers in Illinois engage in less conservation activities than Republicans or Independents, and that they are less likely than these other political affiliations to believe that such engagement in these measures will benefit them economically. These findings are counter to current intuition on the subject, but if true, would indicate a necessary change in communication patterns towards farmers, with more emphasis on environmental measures as sound business decisions and targeting Democratic farmers. More research with larger subject pools should be conducted before final conclusions are made.

Conclusion

In a great deal of conversations about American farming practices, large scale farmers are characterized as being uncommitted to conservation reform. Farmers who use conventional methods, as opposed to organic farming, are considered less environmentally conscious than those who do. This research provides evidence that when working with farmers directly, a strong commitment to sustainable land management is revealed as well as many values that mirror those of environmentalists. There is also a degree of sensitivity to words that take on an accusing tone, such as “threatened” instead of “vulnerable.” This suggests that the historic tensions between farmers and conservationists may have left an impact on farmer perception of river ecosystems, which should be acknowledged when working with the industry.

This research provides strong evidence that negative environmental perceptions about large scale farmers are not only wrong, but harmful to the cause of conservation. The farmers surveyed were reluctant to say that they engaged in conservation measures in order to use the land “more sustainably,” but they unanimously agreed that they wanted to use their land in a way that maintained the quality and longevity of the land and soil. These are arguably the same thing, and yet an environmentalist hoping to work with farmers to improve conservation could unintentionally alienate an audience through word choice. In the same conversation, environmentalists may feel a farmer is disagreeing with them if the farmer were to respond negatively to the word, even though the farmer may agree with sustainability in principle. Avoiding this sort of misunderstanding could help farmers and environmentalists be allies in their work. Farmers express a strong interest in implementing conservation measures that fit with their land, as well as an appreciation for sustainability that mirrors the views of environmentalists.

One of the most interesting findings of the research is the prevalence of farmers who see conservation work as a good business decision. Future research should look into why farmers see conservation practices as a business investment—and why some farmers do not. The difference between the business realities of daily farm work and the large scale implications of sustainable farming are often considered to be incompatible, but this work suggests that many farmers, who have been successfully running their farming business for an average of 34 years, have been able to strike a balance between the two. This is extremely valuable knowledge in the work towards more sustainable large scale farming and an area that requires a great deal more study and understanding.

Finally, it should also be noted that farm culture in America is changing. The farm size of the survey participants may seem large to those more used to urban gardens or community farms, but the reality is that a great deal of these “large” farms are being bought out by even larger farm owners, who then rent out the land to actual farmers and receive government price supports. Unfortunately, the predictions that this survey can make about the effects of this large scale farm “buy out” are limited. This survey included mainly farmers who worked the land personally, a very different demographic than a detached business owner. While this study found no significant relationship between farm size and use of conservation measures, this relationship may change when farm size increases drastically. More research should be done to determine what impact this large-scale buy out is having on conservation practices on Midwest farms.

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Six

Street-Level Bureaucrats Shirking to Success: An Application of Principal-Agent Theory to the Implementation of Florida's Third Grade Retention Policy

Rachel White

Abstract

Policymakers have aimed to increase early reading skills for decades, yet in recent years state governments have placed particular emphasis on the mastery of reading proficiency by the third grade – a pivotal year in a child's education since it is typically when students shift from learning to read to reading to learn (Hernandez 2011). Research provides mixed results as to whether retaining students based on the results of a state standardized test will benefit the student in the long run. This study utilizes principal-agent theory and street-level bureaucracy theory to better understand the ways in which school district teachers and administrators, as street-level bureaucrats, respond to a state-mandated test-based third grade retention policy in Florida. While both policymakers and practitioners may have the same end goal – to increase third grade reading proficiency rates – evidence from regression analyses suggest that street-level bureaucrats use their informational advantage to pursue means other than retention to achieve this end. For example, street-level bureaucrats may be able to shirk around the policy by providing students with exemptions from the state-mandated policy. Thus, while it appears as though a certain percent of students are proficient on the third grade reading exam, these statistics may distort the actual scenario and our understanding of the policy effects. By providing more students with good cause exemptions, these students' FCAT scores are not included in the interpretation of the increase in third grade reading proficiency levels.

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Introduction

In the American federal system, which divides elements of sovereignty between the central government and the states, the Tenth Amendment of the Constitution grants state governments full reign over their respective public education systems. However, governmental entities at every level of the American federalist system partake in the pursuit of achieving state and national education goals. The federalist structure of American government allows multiple layers of government to engage in public education policymaking. Unlike most other nations, the United States does not operate a national education system, and the federal government has historically taken a relatively decentralized approach to education policymaking. Schools in the United States have been, and remain, overwhelmingly a state and local responsibility.

Each government's level of influence over education policy has historically been a reflection of its funding contribution. According to the U.S. Department of Education, about 90 percent of the annual expenditures of education at all levels come from state, local, and private sources and just 10 percent from the federal government. As states governments have taken on a greater role in the funding of public schools, they have also taken on a greater role in education policymaking. Similarly, the increase in the share of education spending from the federal government has increased from less than 5 percent in the 1980s to 13 percent in 2010 (NCES 2013), and has coincided with an increasing focus on education policymaking at the federal level. Since the distribution of reports such as *A Nation at Risk* (National Commission on Excellence in Education 1983), *Why Johnny Can't Read* (Flesch 1955), and *Why Johnny Still Can't Read* (Flesch 1981), the federal government has taken an active role in increasing reading proficiency. For example, the federal government enacted a federal mandate requiring states to set targets for student performance consistent with national objectives around reading proficiency. The NCLB Act (2002) provided the federal government with a way to monitor adherence to the policy by requiring each state education agency to submit a regular "adequate yearly progress" report to the United States Department of Education.

Under the auspices of the federal government's NCLB provision, state governments and state education agencies require local education agencies (LEAs, i.e., school districts) to set targets for their own performance consistent with progress toward the goals determined on the state level. Similar to the federal-state monitoring process, most states require LEAs to submit a report to the state department of education with data documenting progress toward the state goals. Likewise, to be in compliance with federal and state law, local school district governing boards require school administrators and teachers to set targets for student performance and report progress towards these goals to the local education agency.

This paper will focus on the relationships between state and local education agencies during the implementation of education policy. While state governments typically treat each LEA as a single organization that must set targets for their own performance consistent with progress towards state objectives, they also treat each LEA as a self-managing entity, allowing school administrators and teachers to choose the processes and methods by which they will strive to reach district and, hence, state and national education objectives. These two arms of the education policy body – state government and local education agencies – can thus be perceived as a principal-agent relationship in

which the principal (i.e., state government) designs a contract with various incentive structures to facilitate control of the agent (i.e., LEAs), even when the agents may have different objectives and more information than the principal.

In this research study, I will apply principal-agent theory to the development and implementation of a Florida policy that mandates school districts to retain any third grade student who does not achieve “proficiency” on the annual third grade standardized reading exam. I will analyze Florida’s reading proficiency and retention data as well as data around student good-cause exemptions, and consider the relationship between the state government’s decision to implement a test-based grade retention policy and the decisions of school administrators and teachers around promotion and retention. I will then discuss the implications that state-mandated test-based retention policies may have on the decisions of administrators and teachers, who can be understood to be street-level bureaucrats, to include or exclude students in state standardized tests.

Review of Research on Reading Proficiency, Retention, and Student Success

Researchers and education practitioners alike have long recognized the importance of mastering reading by the end of third grade. This year is seen as a pivotal point in a child’s education since it is typically when students shift from learning to read to reading to learn (Hernandez 2011). Hernandez (2011) found that students who did not read proficiently by third grade were four times more likely to drop out of school than proficient readers. Lloyd (1978), too, found this result – that third-grade reading achievement was a strong predictor of student success – more than three decades ago. Lloyd (1978) also found, however, that retention in any of the first three grades is also a strong predictor of later school dropout.

Third Grade Reading Proficiency as a National Movement

While policy reforms have aimed to increase early reading skills for decades, the most recent nationwide effort – the No Child Left Behind Act of 2001 (NCLB 2002) – required states to test reading skills annually for all students beginning in third grade. The NCLB (2002) Act fully implemented President Bush’s “Reading First” initiative, underlying the President’s “unequivocal commitment to ensuring that every child can read by the end of third grade” (U.S. Department of Education 2002). This emphasis on third grade reading proficiency has continued into the current presidential administration; President Obama reiterated the importance of child literacy in his “Putting Reading First” blueprint for revising the Elementary and Secondary Education Act (ESEA, known in its most recent form as NCLB) when it was being considered for reauthorization (U.S. Department of Education 2010).

Significant national attention has been placed on third grade reading proficiency as a signal of future academic access, compelling the federal government to address this issue through education legislation. States and some local school districts have also recognized the urgency to increase third graders’ reading proficiency levels. In fact, several states and some school districts have enacted policies requiring that third grade students who fail to demonstrate basic reading proficiency on the end-of-grade assessment be retained. Similar policies are under debate in

numerous state legislatures across the nation. While such policies have focused on reading proficiency, enacting mandatory third grade retention policies renewed a different longstanding debate: the consequences of retention on student achievement.

Return to the Retention Debate

Grade retention can be used with K-12 students who struggle in school. In today's test-based accountability environment, the term "struggle" often correlates with those students who have not met a state test performance standard. The intended objective of retaining a struggling student is to ensure the student learns the skills and knowledge necessary for success at the next grade level (Krier 2013). Policies of social promotion, on the other hand, allow struggling students to move on to the next grade level with their same-age peers.

Research around student retention and social promotion policies provide mixed results. Proponents of mandatory student retention policies often cite research that shows socially promoted students struggle academically in later grades. Although studies have found a slight gain in academic achievement directly after completing a retention year, the majority did not find long-term positive academic benefits (Moser, West and Hughes 2012; Schwerdt and West 2013; Roderick and Nagaoka 2005).

Opponents of student retention policies argue that grade retention produces more harm than good and that the benefits of keeping students with their age group outweigh the costs (Krier 2013). For instance, when it comes to motivation to learn and succeed – another strong indicator of success in both academic and professional life – numerous studies have found that retention has a negative effect on students (Pierson and Connell 1992). Retained students were found to have lower emotional health, self-esteem, academic self-concept, and homework completion than socially promoted students (Jimerson, Carlson, Rotert, Egeland and Sourfe 1997; Martin 2011). Moreover, elementary school students ranked academic retention as one of the top five most stressful things that could happen to them, just behind losing a parent, parental fighting, getting lost, and being caught stealing (Jimerson, Anderson and Whipple 2005).

State Policy Decisions to Increase Student Literacy

Given the conflicting lines of research around retention and reading proficiency, it seems incredibly challenging to conceive a policy solution to address the one-third of American third graders who are not proficient in the subject of reading, according to the National Assessment of Educational Progress (U.S. Department of Education 2013).¹ While policymakers are aware that third grade students not proficient in reading are at a greater risk for academic struggles in later grades, they also know that retained students are much more likely to drop out of school than those who are socially promoted. So, what decisions have policymakers made thus far?

A total of 32 states and the District of Columbia have enacted policies aimed at improving third grade reading proficiency (Rose 2012). Moreover, 14 states and the District of Columbia have recently enacted policies requiring that students who do not demonstrate basic reading proficiency at the end of third grade be retained and provided with remedial services (Rose 2012). Seven additional states require such students to be retained unless the student participates in an intervention, such as

mandatory summer school before starting fourth grade (Rose 2012). While some states (such as Florida and Ohio) have had laws in place for years that require no student be promoted without reaching the level of proficient on the state standardized third grade reading assessment, others (such as Indiana and North Carolina) implemented such policies within the last three years. In many other states (such as Iowa and Michigan), policy discussions around third grade test-based retention rates are occurring in state legislatures at this very moment.

Case Study: Test-Based Third Grade Retention Policy in Florida Retention Policy

Florida has one of the oldest and most frequently cited models of a strict third grade retention policy (Rose and Schimke 2012). Beginning in the 2002-03 school year, Florida legislative statute mandated retention of students whose reading deficiency was not remediated by the end of third grade, as demonstrated by scoring at Level 2 or higher on the third grade statewide reading assessment (Florida K-20 Education Code 2002). Florida was also one of the first states to include “good cause exemptions” by which students may be exempt from the mandatory retention policy. Good cause exemptions identified in the 2002 Florida K-20 Education Code include:

1. Limited English Proficient students who have had less than two years of instruction in an English for Speakers of Other Languages program;
2. Students with disabilities whose individual education plan (IEP) indicates that participation in the statewide assessment program is not appropriate;
3. Students who demonstrate an acceptable level of performance on an alternative standardized reading assessment approved by the State Board of Education;
4. Students who demonstrate, through a student portfolio, that the student is reading on grade level as evidenced by demonstration of mastery of the Sunshine State Standards in reading equal to at least a Level 2 performance on the Florida Comprehensive Assessment Test (FCAT);
5. Students with disabilities who participate in the FCAT and who have an IEP or a Section 504 plan that reflects that the student has received the intensive remediation in reading (as required in statute) for more than 2 years but still demonstrate a deficiency in reading and who were previously retained in kindergarten, first or second grade; and
6. Students who have received intensive remediating for two or more years but still demonstrate a deficiency in reading and who were previously retained for two years before entering third grade.

Two years after the law went into effect, the Florida Department of Education promulgated rules around the use of alternative standardized reading assessment and student portfolios for good cause promotion. The rules specify that students who score at Level 1 on the grade three reading FCAT may be promoted to grade four if the student scores at or above the 51st percentile on the grade three Norm Referenced Test portion of the reading FCAT *or* above the 51st percentile on a

parallel form of the SAT-9 alternative assessment. Moreover, good cause promotion under the student portfolio exemption requires evidence, collected by the student's teacher that shows an accurate picture of the student's ability and only includes student work that is independently produced in the classroom. The student portfolio must include evidence that the benchmarks assessed by the grade three reading FCAT are met, which includes multiple choice items and passages that are approximately 60 percent literary text and 40 percent information text, and that are between 100 and 700 words with an average of 350 words. Finally, for each Sunshine State Standard Benchmark for Language Arts assessed on the grade three reading FCAT, the teacher must collect at least five examples of mastery as demonstrated by a grade of "C" or above (Alternative Standardized Reading Assessment 2004).

The Florida Department of Education (FDE) administrative rule was amended twice more in 2008. The first set of amendments permitted the use of the SAT-10 as an alternative reading assessment and reduced the required student score percentile on any of the alternative reading assessments from the 51st to the 45th percentile. The second set of amendments allowed teachers to administer the SAT-9 or SAT-10 to a student two times, as compared to the previous rule that only allowed the student one try to achieve a proficient score on the SAT-9 or SAT-10 (Alternative Standardized Reading Assessment 2004, as amended in 2008).

One year later, in 2009, the rule underwent major reconstruction. Rather than limit the alternative standardized reading assessment to just the SAT-9 and SAT-10, the FDE permitted school districts to submit requests for approval of alternative standardized reading assessment that met certain criteria determined by FDE. Once an assessment was approved by FDE, it was also approved for statewide use. Moreover, the FDE was required to approve the percentile passing score for each approved alternative standardized reading assessment based on an analysis of Florida student achievement results (Alternative Standardized Reading Assessment 2004, as amended in 2009).

The latest FDE rule change occurred in 2011. The change removed the SAT-9 as an acceptable alternative assessment, increased the average number of words required in the passages included in a student portfolio from 350 to 500 words, decreased the number of examples of mastery included in a student's collection of evidence from five to three examples, and changed the definition of "mastery" for student portfolio work from a grade of "C" or above to a grade of 70 percent or above (Alternative Standardized Reading Assessment 2004, as amended in 2011).

Intervention Policy

Under the first iteration of the Florida test-based third grade retention legislation, school districts were only required to provide a retained student with supplemental instructional services and supports. In early 2004, however, the legislation was amended to include suggested interventions, including, but not limited to: small group instruction; reduced teacher-student ratios; more frequent progress monitoring; tutoring or mentoring; transition classes containing both third and fourth grade students; extended school day, week or year; and/or summer reading camps (Florida K-20 Education Code 2002, as amended in 2004). The 2004 amendments also required school districts to: (1) implement a policy for midyear promotion of any retained student who can demonstrate that he

or she is ready to be promoted to fourth grade; (2) provide retained students with a higher-performing teacher; and (3) provide parents of retained students with either supplemental tutoring options, a “Read at Home” plan outlined in a parental contract, or a mentor/tutor with specialized reading training (Florida K-20 Education Code 2002, as amended in 2004).

No amendments were made to the third grade test-based retention statute of the Florida K-20 Education Code between 2005 and 2012. In 2013, the legislature amended the statute to require school districts to provide retained third grade students with a school district summer reading camp (Florida K-20 Education Code 2002, as amended in 2013).

Policy Effects

In the 2002-03 school year, the first year of implementation, the number of third graders retained jumped from 3.3 percent (6,435 students) to 14.4 percent (27,713 students). The number of Florida students retained in third grade has fallen steadily over the last nine years, reaching 7.3 percent (15,098 students) in 2012 (Florida Department of Education Bureau of Education Information and Accountability Services). Schwerdt and West (2013) contend that this steady decline is primarily due to an increase in the number of students meeting the promotion standard, level 3 on the third grade FCAT reading assessment.

Theoretical Framework: Street-Level Bureaucrats and Principal-Agent Theory

In this study, I utilize two theories to develop a hypothesis about the relationship between state government and school district administrators and teachers in the implementation of the Florida test-based third grade retention policy: street-level bureaucracy theory and principal-agent theory. Lipsky’s (1969) theory of street-level bureaucracy identifies street-level bureaucrats as people employed by the government who are constantly called upon to interact with citizens in the regular course of their jobs; have significant independence in job decision-making; and potentially have extensive impact on the lives of their clients. Moreover, street-level bureaucrats’ work experiences are relatively strongly affected by three conditions: relative unavailability of resources, both personal and organizational; regular challenges to bureaucrats’ authority; and ambiguous, contradictory, and in some ways unattainable, role expectations (Lipsky 1969). Public school administrators and teachers are often referred to as street-level bureaucrats because they are employed by the school district and their work environment closely emulates that which is described by Lipsky (1969).

Principal-agent theory focuses on the dynamic process of interaction between principals and agents. Economists developed principal-agent theory in the 1960s and early 1970s in an effort to describe the so-called agency problem that occurs when cooperating parties have different goals and divisions of labor (e.g. Jensen and Meckling 1976; Ross 1973). The theory attempted to describe the relationship between a work-delegating party (the principal) and a work-performing party (the agent) using the metaphor of a contract (Jensen and Meckling 1976).

From an economic perspective, principal-agent theory is concerned with two dilemmas that occur in agency relationships: conflicting desires or goals of the principal and agent and oversight costs for the principal to verify what the agent is actually doing (Eisenhardt 1989). Given these two

dilemmas, the focus of the theory is on determining the most efficient contract governing the principal-agent relationship given assumptions about people (e.g., self-interest, bounded rationality, risk aversion), organizations (e.g., goal conflict among members), and information (e.g. commodification of information) (Eisenhardt 1989).

Applying Principal-Agent Theory to Education Policymakers and Street-Level Bureaucrats

In the 1980s, Terry Moe (1984; 1987) extended the principal-agent framework to relationships where a contract is implied rather than executed, particularly in the public sector context. Moreover, Matt McCubbins and colleagues (1987) adopted a distinct political approach to the goal conflict and information asymmetry dilemmas of principal-agent theory arguing “a system of rewards and punishments is unlikely to be a completely effective solution to the control problem” due to “the cost of monitoring, limitations in the range of rewards and punishments, and for the most meaningful forms of rewards and punishments, the cost to the principals of implementing them” (McCubbins et al. 1987, 251).

By the 1990s, the politically oriented principal-agent theory framework was expanded again, allowing for one to view public funding of government agencies as a “contract” (e.g., Boston 1991; Downs and Rocke 1994). Under this condition, an executive can be viewed as an agent of the public; while the public may be unable to monitor each and every action taken by the chief executive, they can readily monitor the success or failure of his decisions and take action (i.e., vote to remove or reelect) based upon the perceived success or failure of the chief executive’s policy (Downs and Rocke 1994).

Both the 1980s and 1990s principal-agent theory applications to political science can be applied to the American education policy arena. Moe’s (1984; 1987) conception of an implied contract can be applied to state government and LEAs. The state government, as the principal, needs certain tasks carried out, such as ensuring all third grade students achieve proficiency on the state standardized reading assessment. Because the state government lacks the time and expertise to personally carry out this task, it delegates the task to LEAs. Therefore, the state government enters into a contract with the LEAs in which the state government will allocate taxpayer dollars to pay for the cost of educating each student and, in return, the LEAs must provide education services to children that will ostensibly increase student reading proficiency levels.

At the heart of this principal-agent relationship is the question of how the state government can design the contract with various incentive structures to facilitate control of the LEAs when: (a) the objectives of the state government and LEA diverge, such as when street-level bureaucrats at the school district level see a different means – other than mandatory retention – to reach the end goal of all third graders reading proficiently; and (b) the LEA has an informational advantage over the state government. From this informational advantage, two dilemmas arise: adverse selection and moral hazard. For example, when the state government devolves much of the responsibility for educating students to the LEAs and when the school district level educators (i.e., school administrators and teachers) are embodiments of street-level bureaucrats, the LEA has a comparative advantage that stems from the information and expertise possessed by the street-level bureaucrats. In this situation, the problem of adverse selection arises if the state government is not

fully informed about the abilities of the school district level educators. Moreover, the problem of moral hazard arises when the contract between the principal and agent has been agreed to and the agent, realizing the principal's lack of information, pursues the agent's own objectives at the expense of the principal's interests.

In the next section, I will return to the Florida test-based third grade retention policy and utilize the theoretical frameworks of street level bureaucracy and principal-agent relationships to hypothesize how the enactment and implementation of the policy may be impacted by the aforementioned dilemmas that occur in principal-agent relationships.

Hypothesis

Drawing upon the previous discussion of principal-agent theory and street-level bureaucracy theory, I conjecture that the implementation of Florida's third grade test-based retention policy will lead street-level bureaucrats to (a) shirk in response to goal conflict and (b) define student interests in ways different from those of the state government and subsequently impose their own view of student interest due to the dilemma of asymmetric information.

Therefore, I hypothesize that because of agent shirking and the dilemma of asymmetric information, a positive change (in this case, a decrease) in the percentage of third grade students not proficient on the FCAT reading assessment will be associated with a positive change (in this case, an increase) in the percentage of students receiving good cause exemptions from the FCAT reading assessment.

Data and Methods

To test my hypothesis, I use data publicly provided by the Florida Department of Education. My rationale for including only data from Florida is based upon data availability and the policy implementation timeframe. Florida provides public access to school district level longitudinal data with data available at the grade level by year. Furthermore, no other states have had a test-based third grade retention policy in place for more than two years. Therefore, data from Florida allows for a longitudinal study of student achievement, retention, and good cause exemption after the test-based third grade retention policy was enacted. Appendix 1 outlines the sources of the data used in this study.

I conduct simple descriptive analyses to examine trends in third grade student reading proficiency levels, third grade retention rates, and third grade good cause exemption rates. I also conduct bivariate regression analyses to understand how the implementation of the Florida test-based third grade retention policy impacted the percent of third grade students proficient on the third grade reading assessment. In the analysis, I also consider school district-level factors to examine whether changes in student proficiency rates are significantly related to school district-level characteristics such as a change in the percent of students receiving a good cause exemption; student population, stability, and demographics; and teacher expertise, education level, and salary.

Further, to understand the relationship between the change in the percentage of third grade students proficient on the FCAT reading assessment and the school district-level variables, I apply a production function that starts with the following general education production function: the change in the percent of third grade students proficient on the third grade reading assessment in school district j between 2002-2003 and 2010-2011 is a function of school district-level student characteristics, $StudChar$, school district-level teacher characteristics, $TeachChar$, and the change in the percentage of students receiving good cause exemptions from the FCAT reading assessment at the school district level, $\%Exempt$.

$$SchChange\%Prof_j = f(StudChar_j, TeachChar_j, \%Exempt_j) \quad (1)$$

From this production function, model 2 was developed. The log of school district enrollment, school district average level of teacher experience, and school district average teacher salary were used to improve model fit. Descriptions of the variables in model 2 are provided in Appendix 1.

$$\begin{aligned} SchChange\%Prof_j = & \alpha + \beta_1 \log(SchEnroll) + \beta_2 SchStabil + \beta_3 Sch\%White + \\ & \beta_4 Sch\%ELL + \beta_5 Sch\%FRPL + \beta_6 Sch\%SWD + \beta_7 Teach\%AdvDeg + \beta_8 \log(TeachAvgSal) + \\ & \beta_9 \log(TeachAvgExp) + \beta_{10} SchChange\%Exempt + \varepsilon \end{aligned} \quad (2)$$

Analysis and Discussion

Student Reading Proficiency and Retention

To understand whether the implementation of the Florida test-based third grade retention policy had an effect on student reading proficiency levels and student retention rates, I conducted an analysis of the trends of the third grade proficiency and retention rates before and after the policy was implemented.

The blue trend line in Figure 1 shows that the percent of students testing not proficient in reading decreased the first three years after the retention policy was enacted, as determined by the statewide assessment. This decrease was followed by a sharp increase in the percentage of students designated not proficient in reading. This dramatic shift occurred in the two school years following the FDE's promulgation of rules around the alternative standardized reading assessment and use of student portfolios for good cause promotion. This also marked the year that the Florida legislature amended the law to require school districts to: (1) implement a policy for midyear promotion of any retained student who can demonstrate that he or she is ready to be promoted to fourth grade; (2) provide retained students with a higher-performing teacher; and (3) provide parents of retained students with either supplemental tutoring options, a "Read at Home" plan outlined in a parental contract, or a mentor/tutor with specialized reading training. Since the 2007-08 school year, the percent of third grade students testing not proficient in reading has remained relatively steady at between 16 and 18 percent.

The red trend line in Figure 1 also shows that after the enactment of the retention policy, the percent of retained third graders more than tripled, from less than four percent to more than 14 percent. After the initial spike, however, the percent of retained third graders steadily declined for the next three years. Third grade student retention has remained at about seven percent since the 2007-08 school year.

Finally, the gap between the percentage of third grade students retained and the percentage of third grade students testing not proficient in reading as seen in Figure 1 narrowed after the enactment of the test-based third grade retention policy. Since the initial year of implementation, the difference between these two factors has remained relatively stable between 10 and 11 percent. A visible punctuation occurred during 2005-06 school year, which marks the year when both FDE and Florida legislature made substantial changes to the test-based third grade retention policy.

Figure 2 compares the distributions of school districts' percent of third graders who were not proficient in reading and the percent of non-promotions for each year after the implementation of the Florida retention policy. From this figure, two takeaways are evident: first, there is a stark shift between the distribution of the percent of third graders who are not proficient in reading and the distribution of the percent of third graders who are not promoted; second, the gap between these two distributions has widened over the last ten years.

Figure 1. Comparison of Percent of Third Grade Students in Florida Not Proficient on FCAT and Percent of Third Grade Students in Florida Retained in Third Grade, 2001-02 School Year to 2011-12 School Year.

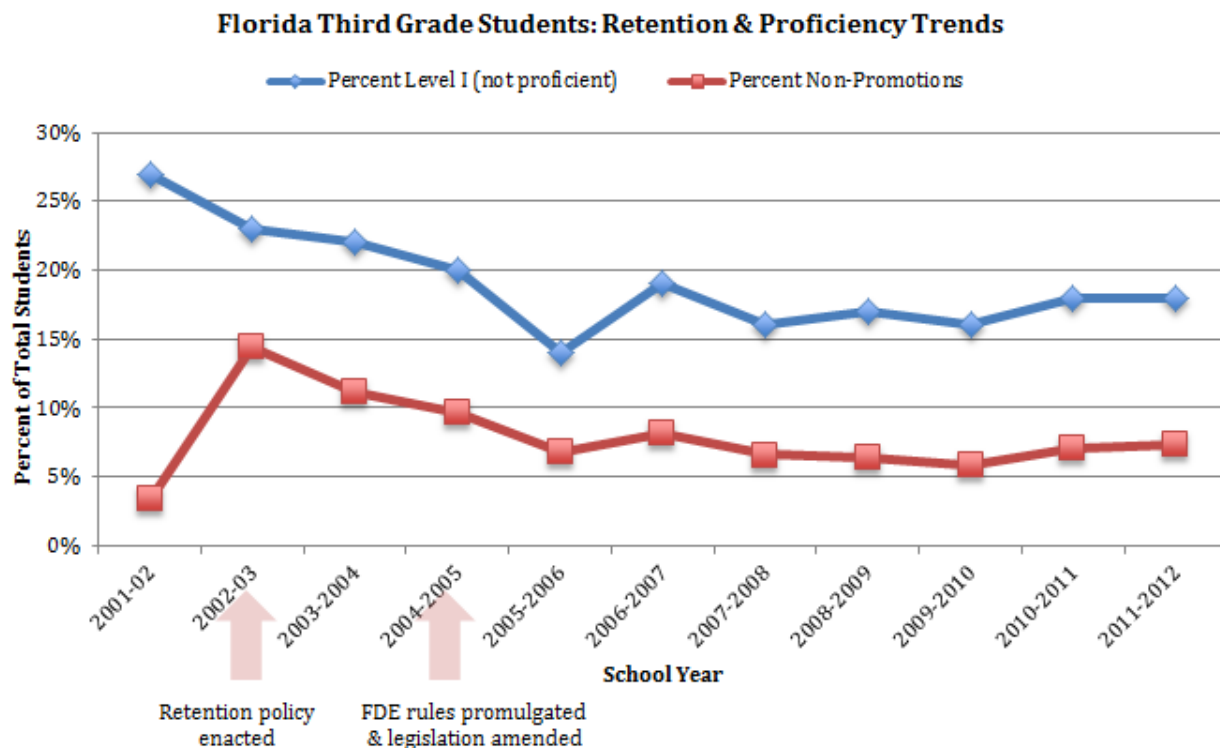
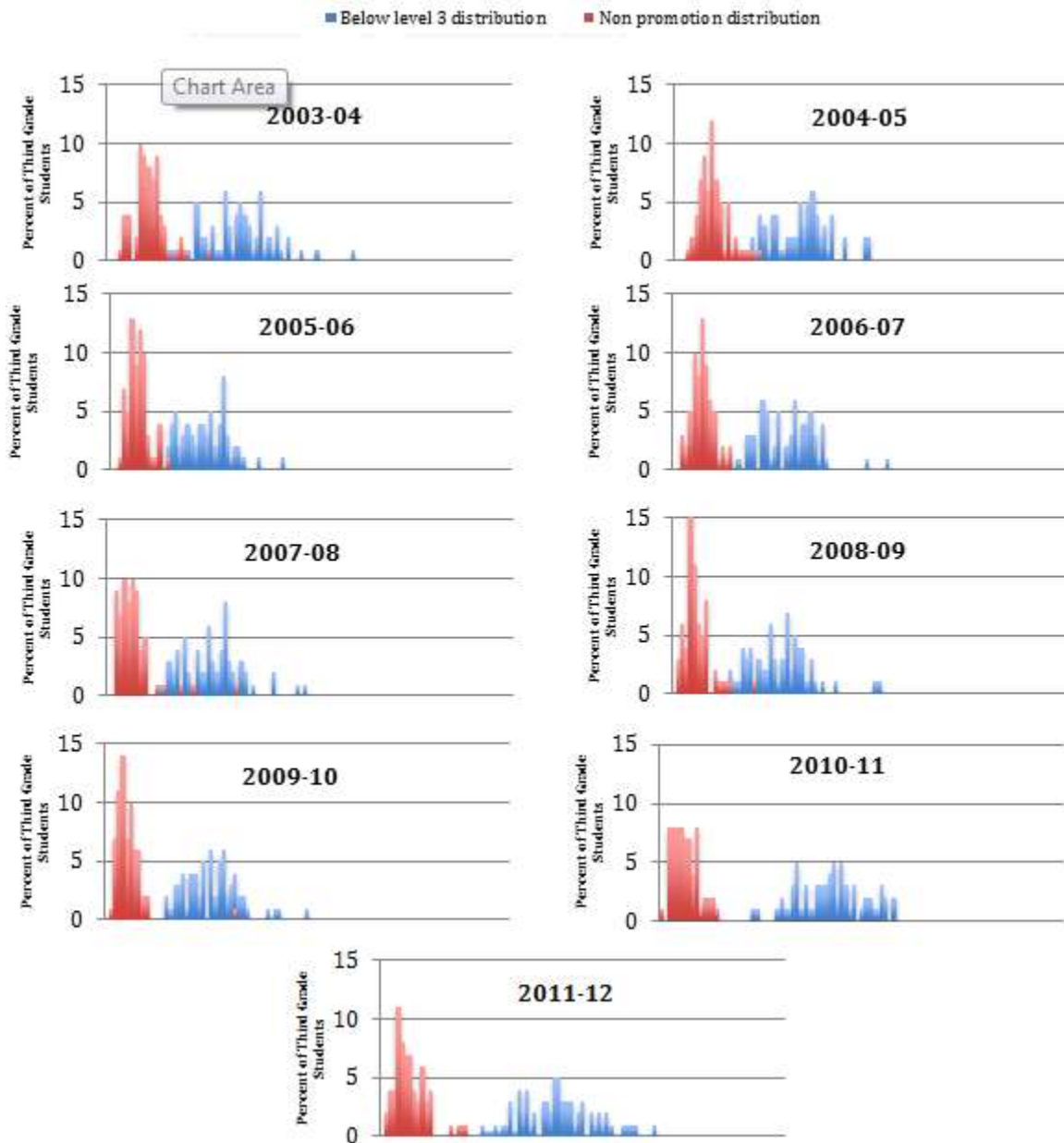


Figure 2. Comparison of Distribution of School Districts' Percent of Third Grade Students Not Proficient on FCAT and Percent of Third Grade Students in Florida Retained, 2001-02 School Year to 2011-12.



Reading Proficiency, Retention, Good Cause Exemption, and School District Level Factors

Table 1 presents the bivariate linear regression analyses with change in percent of third grade students proficient on the third grade reading FCAT as the dependent variable. Two significant relationships emerged from these bivariate analyses: first is a positive relationship between the change in percent of proficient students and the change in percent of students retained; second is a positive relationship between the change in percent of proficient students and the change in percent of students who receive a good cause exemption. The change in percent of proficient students and

change in percent of students who receive a good cause exemption were highly correlated and the analysis estimates that a one percent decrease in the percentage of third grade students scoring at Level 1 on the FCAT is associated with a 72.9 unit increase in the school district's percent of students receiving a good cause exemption. For example, if a school district were to decrease the percentage of third grade students scoring at Level 1 on the FCAT by 5 percent between 2003-04 and 2010-11 and the percent of students receiving a good cause exemption in 2003-04 was 4 percent, the bivariate linear regression estimates that the percent of students receiving a good cause exemption in 2010-11 would increase by 2.9 percent (72.9 percent of 4 percent) to 6.9 percent.

Table 1. Bivariate linear regression results with dependent variable, SchChange%Prof.

<i>Explanatory Variable</i>	β coefficient	R^2	Adjusted R^2	P-Value	Ho (5%) Rejected?
<i>School District level Students Characteristics</i>					
Log(SchEnroll)	0.005	0.004	-0.012	0.628	No
SchStabil	-0.125	0.004	-0.012	0.632	No
Sch%White	0.046	0.035	0.02	0.128	No
Sch%ELL	-0.15	0.037	0.022	0.118	No
Sch%FRPL	-0.064	0.026	0.011	0.196	No
Sch%SWD	0.295	0.035	0.02	0.13	No
SchChange%Retain	0.374	0.079	0.065	0.021	Yes
SchChange%Exempt	0.729	0.261	0.249	0.000	Yes
<i>School District level Teacher Characteristics</i>					
Log(TeachAvgExp)	0.065	0.007	-0.008	0.501	No
Log(TeachAvgSal)	-0.093	0.004	-0.011	0.607	No
Teach%AdvDeg	0.071	0.018	0.003	0.275	No

Table 2 presents an analysis using a relative change ordinary least squares regression model with change in percent of third grade students proficient on the third grade FCAT reading assessment as the dependent variable. The model in table 2 allows for an examination of the factors associated with a school district's decrease in the percent of third grade students performing below proficient on the FCAT reading assessment. Results from this analysis indicate that there is a significant, positive relationship between the change in the percent of students scoring at a level 1 on the FCAT reading assessment and the change in percent of third grade students receiving a good cause exemption. Holding all other school-level variables constant, a one unit increase in a school district's change in percent of students scoring at level 1 on the FCAT reading assessment is associated with a 39.5 unit increase in the school district's change in percent of third grade students receiving a good cause exemption. That is, a large decrease in the percent of students scoring non-proficient on the reading assessment is associated with a large increase in the percent of students receiving good cause exemptions. Using the same example above, if a school district were to decrease the percentage of third grade students scoring at level 1 on the FCAT by 5 percent between 2003-04 and 2010-11 and the percent of students receiving a good cause exemption in 2003-04 was 4 percent, the full model difference regression estimates that the 2010-11 percent of

students receiving a good cause exemption would increase from 1.6 percent (39.5 percent of 4 percent) to 5.6 percent.

Results from this analysis also indicate that there is a significant, positive relationship between the change in the percent of students scoring at a level 1 on the FCAT reading assessment and the change in percent of third grade students with disabilities. That is, a decrease in the percent of students scoring non-proficient on the reading assessment is associated with an increase in the percent of students identified as a student with a disability within the school district. While these results do not suggest that such an increase in the percent of students with a disability within a school district could cause the decrease in the percent change of students proficient on the FCAT assessment, they do suggest that school districts that experience an increase in the percent of students with a disability may also experience a decrease in the percent of students not proficient on the test. One possible explanation for this is that the students with disabilities may be exempt from taking the FCAT assessment and, instead, take an alternative assessment or complete a reading portfolio; thus, the scores that these students would have received on the FCAT reading assessment are not taken into account.

Table 2. Full model differenced regression results with dependent variable, SchChange%Prof.

Independent Variable	Coefficient (Standard Error)
Intercept	0.431(0.984)
<i>School District level Student Characteristics</i>	
Log(SchEnroll)	0.018(0.015)
SchStabil	0.02(0.275)
Sch%White	0.035(0.043)
Sch%ELL	0.009(0.136)
Sch%FRPL	-0.034(0.063)
SCh%SWD	0.505(0.203)**
SchChange%Exempt	0.764(0.16)***
<i>School District level Teacher Characteristics</i>	
Log(TeachAvgExp)	0.005(0.089)
Log(TeachAvgSal)	-0.147(0.206)
Teach%AdvDeg	-0.02(0.064)
R^2	0.387
Adjusted R^2	0.278
Sample Size	67

^o $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Shirking Student Success?

These analyses provide evidence that student proficiency levels increased and student retention levels decreased after the initial enactment of the Florida test-based third grade retention policy. This offers some evidence that the policy was successful and that school districts have emphasized the importance of increasing the number of students who are proficient in reading by the end of third grade.

However, my analyses also support the hypothesis that school districts that experienced a positive change (i.e., a decrease) in the percentage of non-proficient students on the FCAT reading assessment also experienced a positive change (i.e., an increase) in the percentage of students receiving good cause promotions. Since the Florida law provides teachers and, ultimately, school administrators with the authority to decide which students receive a good cause exemption, these results suggest that street-level bureaucrats take advantage of the asymmetric information dilemma in the principal-agent relationship. The results indicate that perhaps one of the reasons a school district experienced a decrease in the percent of students scoring at level 1 on the FCAT reading assessment is because school administrators and teachers provided more students with good cause exemptions (e.g., determining that the student will take an alternative assessment or the teacher will complete a reading portfolio for the student). School district bureaucrats may do this for a variety of reasons. For example, they may provide more students with good cause exemptions so that certain students who may put the school district at risk for lower FCAT scores will, instead, take the alternative assessment or complete a reading portfolio. Alternatively, street-level bureaucrats may not agree with the objectives of the state government's mandated policy and, instead, believe that social promotion is best for their students; therefore, the bureaucrats may provide more students with good cause exemptions so that they can be promoted with the rest of their grade level cohort.

At the heart of this principal-agent relationship is the question of how the state government can design a contract with LEAs to increase third grade reading proficiency levels when the objectives of the state government and LEAs may diverge and when the LEA has an informational advantage over the state government. These two dilemmas are deeply intertwined in the development and implementation of any test-based third grade retention policy. The state government realizes it is being held accountable by the public to do *something* about the large number of third graders with dismal reading proficiency levels. In Florida, the state government responded to this call for action by implementing a test-based third grade student retention policy. While this study does not provide insight into how the Florida policymakers came to the final conclusion to enact a policy mandating retention of a third grader who does not score proficient on the state standardized reading assessment, the findings of this study indicate that street-level bureaucrats and policymakers may diverge in how to reach the end goal of increasing third grade reading proficiency. The LEAs' comparative advantage stemming from the information (e.g., student-specific circumstances) and expertise (e.g., research-based reading intervention strategies) possessed by the street-level bureaucrats may have led to agent shirking to provide more students with good cause exemptions.

Conclusion

In the case of Florida, policymakers enacted a test-based third grade retention policy with hopes of increasing third grade reading proficiency levels (as measured by standardized reading assessments) and, in the long term, student academic success. However, the results of this study suggest that street-level bureaucrats in school districts may shirk around the mandatory third grade retention policy, leading to an increasing number of students receiving good cause exemptions and, therefore, removing low-achieving students from the population whose scores are considered in the measure of third grade reading proficiency. The removal of certain students from taking the third grade FCAT reading assessment could overestimate the percentage of third grade students who are proficient in reading when the measure used by policymakers to monitor this education policy's success is the percent of students scoring at the proficient level on the third grade FCAT reading assessment. Furthermore, providing more students with good cause exemptions could exacerbate information asymmetry between the policymakers and street-level bureaucrats in the school districts since policymakers have provided relatively open-ended descriptions of the elements required in two of the most often used good cause exemptions: alternative assessments and student portfolios.

School districts are now allowed to submit a request for approval of any alternative standardized reading assessment to the Florida Department of Education. While FDE does require that the alternative assessments meet certain criteria, this may make it more difficult for the state to monitor whether students are reaching the perceived level of reading proficiency as measured by the state standardized assessment by the end of third grade. Similarly vague descriptions are given around the good cause exemption of a student reading portfolio. Florida Department of Education rules require just three examples of mastery included in a student's reading portfolio that are graded by the classroom teacher. Letting school districts complete such reading portfolios for their students may, again, make it more difficult for the state to monitor whether students are reaching the perceived level of reading proficiency by the end of third grade.

Policymakers are aware that students who are not proficient on a third grade reading assessment are at greater risk to struggle in later grades and drop out of school. They also know that students who are retained are much more likely to drop out of school than those who are socially promoted. In developing policy to increase third grade reading proficiency, policymakers across the United States are currently considering whether they want to prioritize reading proficiency at the expense of the potential negative effects of student retention. This study provides an examination of how street-level bureaucrats at the school district level in a principal-agent relationship with state government responded to a state's prioritization of reading proficiency over retention. It should be noted that the results by no means suggest that shirking by street-level bureaucrats is wrong; it may in fact be best for local administrators to make decisions about the students with whom they are in close contact. What this study does show, however, is that principal-agent theory and street level bureaucracy theory can help explain why ground-level results may deviate from initial policy goals. When the principal-agent relationship between government and LEAs includes a street-level bureaucrat as an agent, it seems that, despite their best efforts to control the agents, agents as street level bureaucrats take into account their context and use their expertise and in-depth knowledge of

the students in the on-the-ground implementation of the policy. Further research with student-level data is needed to understand whether the school street-level bureaucrats' decisions to provide more students with good cause exemptions in fact positively effects academic achievement in subsequent years.

Although the results drawn from this case study can tell us a great deal about the trends in third grade student retention and reading proficiency after the implementation of a mandatory test-based third grade retention policy, they cannot be generalized to other states with different reading assessments, different student populations, and different social, political, and economical environments. Once more longitudinal data is available, additional research of other states that have implemented test-based third grade student retention policies will be necessary to inform further case study work on the subject. Furthermore, findings from this research could be strengthened with qualitative research aimed at understanding the ways in which street-level bureaucrats interpret and implement test-based retention policies.

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Appendix 1. Variable Descriptions and Source

<i>Variable</i>	<i>Description</i>	<i>Source</i>
<i>SchChange%Retain</i>	The change in the percent of third grade students retained between 2003-2004 and 2010-2011, measured at the district level	Florida Department of Education Bureau of Education Information and Accountability Services (EISA)
<i>SchChange%Exempt</i>	The change in the percent of third grade students who receive a good cause exemption between 2003-2004 and 2010-2011, measured at the district level	Florida Department of Education Bureau of EISA (2004-05 to 2010-11); Florida Department of Education Bureau of Exceptional Education and Student Services (2003-04)
<i>SchChange%Prof</i>	The change in the percent of third grade students who score a proficiency level of 1 on the third grade FCAT reading assessment between 2003-2004 and 2010-2011, measured at the district level	Florida Department of Education District Reading Demographic Reports
<i>Log(SchEnroll)</i>	Logarithm (base 10) of total school district enrollment in the year 2010-2011	Florida Department of Education, Florida Student Indicators Report
<i>SchStabil</i>	Percentage of students in school district from October student count who are at the same school in February of the same school year for the year 2010-2011	Florida Department of Education, Florida Student Indicators Report
<i>Sch%White</i>	Percentage of school district's students whose race is identified as white for the year 2010-2011	Florida Department of Education, EIAS
<i>Sch%ELL</i>	Percentage of the school district's students who are ELL students served in English for Speakers of Other Languages Programs for the year 2010-2011	Florida Department of Education, EIAS
<i>Sch%FRPL</i>	Percentage of school district's students eligible for free or reduced-price lunch for the year 2010-2011	Florida Department of Education, EIAS
<i>Sch%SWD</i>	Percentage of students from October membership count in exceptional student education programs, excluding gifted students for the year 2010-2011	Florida Department of Education, EIAS
<i>Teach%AdvDeg</i>	Percentage of teachers in a school district with a master's degree or higher for the year 2010-2011 For the purposes of this indicator, teachers are defined as professionals who are paid on the	Florida Department of Education, EIAS

	instructional salary schedule negotiated by a Florida school district.	
<i>Log(TeachAvgSal)</i>	Logarithm (base 10) of average salary for all teachers within a school district for the year 2010-2011 For the purposes of this indicator, teachers are defined as professionals who are paid on the instructional salary schedule negotiated by a Florida school district.	Florida Department of Education, EIAS
<i>Log(TeachAvgExp)</i>	Logarithm (base 10) of average number of years of teaching experience for all teachers within a school district for the year 2010-2011. Both in-state and out-of-state experience is counted.	Florida Department of Education, EIAS

Note: ANOVA analyses were conducted to test the hypothesis that means of the following variables are equal across school years between 2001-02 and 2010-11, the year in which the most recent data was available: Log(SchEnroll), SchStabil, Sch%White, Sch%ELL, Sch%FRPL, Sch%SWD, Teach%AdvDeg, TeachAvgSal, and TeachAvg Exp. The ANOVA results indicated that there was no significant difference in any of the variables across school years. Therefore, I chose to include the most recent data in my analyses.

Seven

State Charter Law and Charter School Outcomes

Audrye Wong

Abstract

Despite federal initiatives encouraging the expansion of charter schools, there remains a limited understanding of the empirical relationship between state charter school laws and charter performance. In this study, I categorize state legislation across three dimensions – permissibility, autonomy, and accountability – and investigate each dimension’s statistical relationship with the number of schools as well as NAEP performance. Results suggest that a state’s legal environment may play a large and significant role in charter school students’ academic outcomes. Permissibility and autonomy are associated with a greater number of charter schools, while higher accountability standards may restrict and reverse growth. Although greater autonomy has some positive correlation with academic outcomes, the negative correlations of increased permissibility and increased accountability with student outcomes are greater in magnitude. These findings suggest that policymakers may want to consider tightening permissive charter laws and overhauling current accountability frameworks while encouraging a reasonable degree of autonomy. Furthermore, expanding charter school programs through permissive laws may adversely affect academic outcomes. Accountability standards seem to restrict charter school growth without necessarily improving student performance.

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Introduction

Background

Since 1991, when the first charter school law was passed in Minnesota, charter schools have been a growing feature of the U.S. education landscape. In the 2009-10 academic year, there were over 4,900 charter schools nationwide, serving more than 1.6 million students (Chen 2011). Charter schools were conceived as a means of revolutionizing public education through both competition and choice by introducing greater competition in quality with traditional public schools, and boosting student achievement along with parent satisfaction (Stillings 2005). Charter schools can be set up by parents, teachers, community organizations, or other groups, and are governed by a legislative contract with an authorizing body, such as the state or local school board. Such contracts, which are periodically reviewed after a certain number of years, are meant to articulate performance guidelines and hence maintain a certain degree of accountability.

Charter schools occupy an intermediary space between traditional public and private schools. Like public schools, they receive state tax dollars and are generally open enrollment. Charter schools also adopt features of private schools such as greater autonomy from regulations, increased operational and curriculum flexibility, expanded choice by parents and students, and a diminished teacher union presence (Miron and Nelson 2002; McNeal and Dotterweich 2007).

Because policymakers must try to manage the tension between local-level flexibility and macro-level accountability (Shober et al. 2006), and between private choice and public standards, charter school policy has inevitably become controversial. Detractors argue that the per-pupil funding redirected to charter schools has drained much-needed resources from public school districts without producing tangible success. Charter performance has been mixed and, despite some successful case studies, performance tends to be lower than that of traditional public schools (U.S. Department of Education 2006; CREDO 2009). A U.S. Department of Education study (2006) found that charter school students had, on average, lower mean reading and mathematics scores on the National Assessment of Educational Progress (NAEP) than students in traditional public schools. A 2009 study by Stanford University's Center for Research on Education Outcomes (CREDO) found significant state-by-state differences in charter school performance. A more recent CREDO 2013 study found some performance improvements but with high unevenness in quality between states and across schools.

Despite inconsistent results, the federal government is actively supporting charter school initiatives. The No Child Left Behind (NCLB) Act of 2001 included \$300 million of federal funding for charter schools. The Obama administration has also put considerable emphasis on expanding charter schools nationwide. For example, Race to the Top is a recent initiative seeking to spur local-level reform and innovation in education policies. In order to qualify for Race to the Top funding, states' applications must include initiatives for charter schools. Given such federal support, it becomes even more critical to evaluate the factors behind the successes and shortcomings of charter schools.

Each state implements its own set of charter laws. Because of such variation across states, legislation has considerable implications on the creation and operation of charter schools in

different states. Miron and Nelson (2002) describe legislation as creating “an opportunity space in which charter schools may experiment.” The authors highlight choice, deregulation, and accountability as broad structural variables that can act through legislation to influence school and student outcomes (Miron and Nelson 2002). Yet, there remains a limited understanding of the relationship between state charter school laws and student academic performance, especially one that is empirically based and at the national level.

This is in part because of the blanket ratings and classification of state charter laws that are widely used. For example, letter grades A through E and classifications such as “strong” or “weak” are subsumed into charter school policy discourse as a standard proxy for quality of charter legislation (Wong and Shen 2006). A “strong” law supporting the expansion of charter schools does not necessarily translate into quality outcomes and suggests a bias toward charter reform. Moreover, such ratings do not adequately capture different dimensions of state legislation that can have opposite effects on charter school presence and performance. Additionally, the complicated nature of charter school politics involves competing interests of multiple actors, such as education departments, traditional public schools, teacher unions, local politicians, parents, and citizens of various ideological stripes. This has given rise to legislative and regulatory “layering” (Wong 1999) in which laws are usually far from homogeneous. Wong and Shen (2006) have not only found variation across states but also variation in the degree of permissibility across provisions within a single state’s law.

To better understand charter school legislation as it relates to charter school outcomes, my study decomposes state legislation into different clusters of provisions based on legal dimensions of permissibility, autonomy, and accountability. Wong and Shen (2006) describe a consensus that “evaluation of charter schools is not about, ‘Are charter schools working?’ but rather, ‘What makes some charters work and others falter?’” A better understanding and evaluation of the effects of charter school legislation is particularly relevant for pinpointing the circumstances that make charters effective and those that do not. This has crucial implications for the design and direction of existing and future charter law.

Literature Review

Through statistical analysis of clustered charter law provisions, Witte et al. (2003) concluded, “unexpected[ly],” that “increasing flexibility in creating and running charter schools is correlated with increasingly stringent state requirements for accountability of charter schools.” Subsequently, Wong and Shen (2006) highlighted the importance of studying links between charter law and charter outcomes and included a significant effort to kick-start the creation of a charter legislation database for the purposes of policy analysis. They described in detail a systematic procedure of coding state legislation, with the emphasis on individual provisions that were operationalized as objective, dichotomous variables for easy use in empirical work. While the authors outlined four broad categories of provisions (authorizing process; personnel policy flexibility; operation; and accountability, standards, and expectations), they only analyzed the link between these provisions and selected state-level factors, such as starting teacher salaries, size of state school system, and

Democratic Party strength, leaving unanswered the question of the relationship between charter law provisions and student academic outcomes.

Such a relationship with student outcomes was specifically examined in a 2007 conference paper by Watral, looking at fall-to-spring achievement gains in Northwest Education Assessment test scores for schools in that region. Watral (2007) found that guaranteed funding for charters had positive and significant effects on student achievement. Additionally, collective bargaining exemptions and automatic waivers produced significant negative effects. Watral (2006) concluded that there is no strong support for the impact of autonomy and flexibility on student achievement, despite the arguments of advocates. However, Watral's analysis was based on Center for Education Reform (CER) rankings, which may potentially reflect the bias of this pro-charter advocacy group.

A CREDO (2009) analysis found significant variation in charter school performance across 16 selected states (including the District of Columbia), and demonstrated a link between legislation and academic outcomes. These states, which had education department partnerships with Stanford, represented over 50 percent of K-12 students in the United States and over 70 percent of the country's charter school students. In particular, charter schools in states with either enrollment caps or multiple authorizers demonstrated significantly lower student growth in academic learning compared to traditional public schools. At the same time, states that provided an avenue for appeals on applications or renewals showed small but significant gains in learning. While the study's strength lies in its methodological selection of "twinned" students for comparison in charter versus traditional public schools, it also relies on value-added analysis using state test scores. This limits the ability to evaluate charter school performance between states as a function of legislation, since different test measures would potentially have varied parameters and standards of student achievement.

To take into account differences in education quality, the CREDO (2009) study also mapped charter school effects by state against the state's average performance on the 2007 National Assessment for Education Progress (NAEP). The study finds that charters were more positively associated with student performance gains in states with lower overall academic performance. Nonetheless, there remains an absence of research on a nationwide scale using national-level assessments as a common basis for comparison of legislation.

Methods and Data

Data and Methodology

Legal variables are based on individual state laws as reported in a 2004 study by CER. While the CER is admittedly a pro-charter organization, I only use the legal analysis and explanation provided for relevant individual provisions, in order to avoid any potential bias from CER's rankings of the state laws. I also refer to actual legal texts, legal databases and existing literature.¹ Charter school numbers by state were obtained from the National Alliance for Public Charter Schools (NAPCS) database and NAEP test scores were provided online by the National Center for Education Statistics (NCES) Data Explorer. There were fewer observations for charter NAEP scores, as some states did not meet NCES reporting requirements in some years; missing data were left out of subsequent

regression analyses. Data on poverty status and population size at the state level came from the Current Population Survey (CPS) Annual Social and Economic Supplement (U.S. Census Bureau). The above data were collected for four time points: 2005, 2007, 2009, and 2011. Because CPS data for 2011 were not yet available, 2010 figures were used instead. This is unlikely to significantly affect results since the relative change within a year would likely be limited. State government and citizen ideology scores are based on the most updated, commonly used measures by William Berry et al. (2010), using a scale of 0 to 100, with 100 being the most liberal.

I use state legislation in three dimensions: permissibility, autonomy, and accountability. Although previous studies code for a general “flexibility” dimension that encompasses the openness of authorization processes and freedom from general regulation, such a dimension actually encompasses both the ease of establishing and the freedom of operating charter schools. Thus, to better understand such factors, I chose to code more specific dimensions: permissibility, the legal ease of obtaining legal approval and setting up a charter school, and autonomy, the flexibility and freedom from usual district and state education regulations once a charter has been established. The third dimension, accountability, captures the public accountability and external monitoring standards imposed on charter schools.

Each legal dimension consists of several legal variables coded individually along a scale. I combine the variables’ scores to give each state three overall scores – one per dimension. Table 1 shows the breakdown of legal variables for each of the three dimensions. Instead of coding the entire body of legislation, I identify the legal variables after a thorough review of proposed model laws and the academic literature. Variables were coded on a scale of one to five, with a higher score indicating a greater level of permissibility, autonomy, or accountability. The overall dimension score for a state is equal to the sum of its individual variable scores. Because autonomy encompassed many individual variables, states’ overall scores in that dimension were scaled down proportionally to give the same maximum score of 15 as the other two dimensions.² Appendix 1 further elaborates on how these variables are defined.

Table 1. Breakdown of legal variables for each legal dimension.

Dimension	Legal Variable
Permissibility	No cap on the number of schools; if there is one, 90% of the cap is not reached
	Number and nature of authorizers
	Involvement of for-profit organizations
Autonomy	Automatic exemptions from most district and state regulations
	Waiver of teacher certification requirements
	Legal and operational autonomy
	Fiscal autonomy
	Guaranteed funding sources
Accountability	Defined academic and operational performance expectations
	Submission of annual performance reports to higher bodies
	Periodic formal evaluation of state charter school program

I study two main outcomes: the number of charter schools in each state and the academic performance of charter schools by state. I investigate the relationship between state charter law and each outcome using ordinary least squares (OLS) regression. To measure student performance, I use state-level mean charter scores from the National Assessment for Education Progress (NAEP) reading and writing tests for grades four and eight, starting from 2005, the first year a breakdown of scores according to charter and traditional public schools is available. I examine scores at four time points: 2005, 2007, 2009, and 2011.

While forty states and the District of Columbia passed charter laws by 2004, only 21 states are used because of the availability of NAEP charter school data. This approach assumes that state charter laws remained constant after 2004, which is not likely to be the case. Therefore, I presume that revisions would likely not be a determining factor of academic performance or school numbers. State legislative changes could primarily affect new charter schools, a relatively small proportion compared to the existing numbers, or would be phased in slowly to give current schools time to adjust their practices and hence taking legal effect after the studied time frame. Such laws also tend to produce effects observable only after a time lag. For example, more stringent accountability requirements may only lead to improved test scores after a few years, or may only be imposed during charter renewal. This is admittedly a potential weakness that will have to be addressed in future studies.

I use OLS regression models to understand how differences in charter law structure relate to point increases or decreases in NAEP test scores. Model 1 accounts for the number of charter schools by state (N) and Model 2 uses charter NAEP scores (T). The two equations follow:

Model 1

$$N = \alpha_1 + \beta_{perm1}L_{perm} + \beta_{auto1}L_{auto} + \beta_{acc1}L_{acc} + \lambda_1Pop_s + \omega_1Pov_s + \phi_1L_t + \varphi_1L_r + \theta_1I_{gov} + \varsigma_1I_{citi} + \varepsilon_1$$

Model 2

$$T = \alpha_2 + \beta_{perm2}L_{perm} + \beta_{auto2}L_{auto} + \beta_{acc2}L_{acc} + \gamma_2T_p + \lambda_2Pop_s + \omega_2Pov_s + \phi_2L_t + \varphi_2L_r + \varepsilon_2$$

Variables L_{perm} , L_{auto} and L_{acc} represent state permissibility, autonomy, and accountability scores, respectively. These are the main explanatory variables of interest. Constants are represented by α_1 and α_2 and ε_1 and ε_2 are error terms. Additional control variables include: state population (Pop_s); state poverty rate (Pov_s); time since the charter law first took effect (L_t); and, time since the last legal revision (L_r). I also include two other controls in Model 1: measures of government (I_{gov}) and citizen (I_{citi}) ideological leanings.

In Model 2, I incorporate the mean state-level NAEP scores for traditional public schools, T_p , as a covariate to take into account exogenous performance variations and education standards between the various states. By controlling for the mean performance of non-charter public school students in the same state, any remaining gaps in charter academic achievement across states as measured by β_c may more accurately be attributed to differences in state laws.

I also control for additional state-level factors that may influence charter law design as well as school numbers or performance. First, I use the percentage of the population under the poverty

line by state, Pov_s , as a proxy for the quality of the education system as a function of state resources. To the extent that charter schools are seen as a vehicle of school choice and a solution to increase the quality of traditional public schools through a competitive effect, states with more limited resources could be inclined to encourage the expansion of charter school programs by designing more permissive charter laws that grant greater autonomy without demanding high levels of accountability. To factor in large demographic disparities across the United States that affect the absolute number of charter schools per state, I include state population numbers (Pop_s) as a control. Larger states may also face greater demographic variation which may make it harder for states to implement or monitor higher education standards. Therefore, such difficulty may lead to variability in academic performance.

The two OLS models also factor in the number of years since a state's charter school law was first implemented and last revised. A combination of both variables could capture the potential time lag from any legal changes. The variable L_t refers to the age of the state charter law and is calculated by subtracting the year when the law was first implemented in that state from 2004 (the year for which state laws were coded). L_t is defined as the difference between the year in which the NAEP test was administered and the year of the most recent substantive revision to state law (until 2004). This information was obtained from prior research done by Shober et al. (2006). Additionally use the 2004 CER report for revisions after 2002 that were not included in the Shober et al. (2006) study.

Laws that were passed earlier would give charter schools more time to open and gain operational experience and this would plausibly facilitate improved academic performance. At the same time, legal amendments would likely occur over the years to meet changing needs, depending on whether the original law was regarded as too strict or too lax. Research has shown that state laws have often been revised to increase flexibility and decrease accountability requirements (Shober et al. 2006). Alternatively, amendments may tighten accountability standards because of experience from failed charter experiments or negative political or popular sentiment. For instance, a recent law proposed by the pro-charter National Alliance for Public Charter Schools (NAPCS) gave more attention to accountability and monitoring requirements.

Model 1 incorporates two variables on state government (I_{gov}) and citizen ideology (I_{citi}). Both variables are measured on a scale from 0 for the most conservative to 100 for the most liberal. Those with conservative leanings traditionally favor school choice and expansion of charter school programs. Therefore, I expect that states with a lower score will implement laws making it easier for charter schools to open.

Citizen ideology may also be related to state government ideology in that people tend to vote for political representatives with similar ideological leanings. Thus, ideology could influence charter school numbers directly through broader support or opposition at the grassroots level to the opening or closing of schools and indirectly, acting through the intermediary of state charter law. However, this is not included in Model 2 as it is less likely to be significant in terms of student academic performance. Finally, each state is weighted equally regardless of overall or charter student population size. This is because charter laws are developed by individual states and this study is focused on state-level comparisons rather than national aggregate effects.

Findings

Descriptive Results

This section presents a summary of the data used and descriptive trends of the two outcomes: number of charter schools and student academic outcomes. Figure 1 shows the geographic coding of state scores with darker regions reflecting higher scores. There is no clear pattern in the degree of autonomy but permissive laws and lower accountability standards tend to be prevalent in the West.

Figure 1. Permissibility, accountability, and autonomy ratings by state.

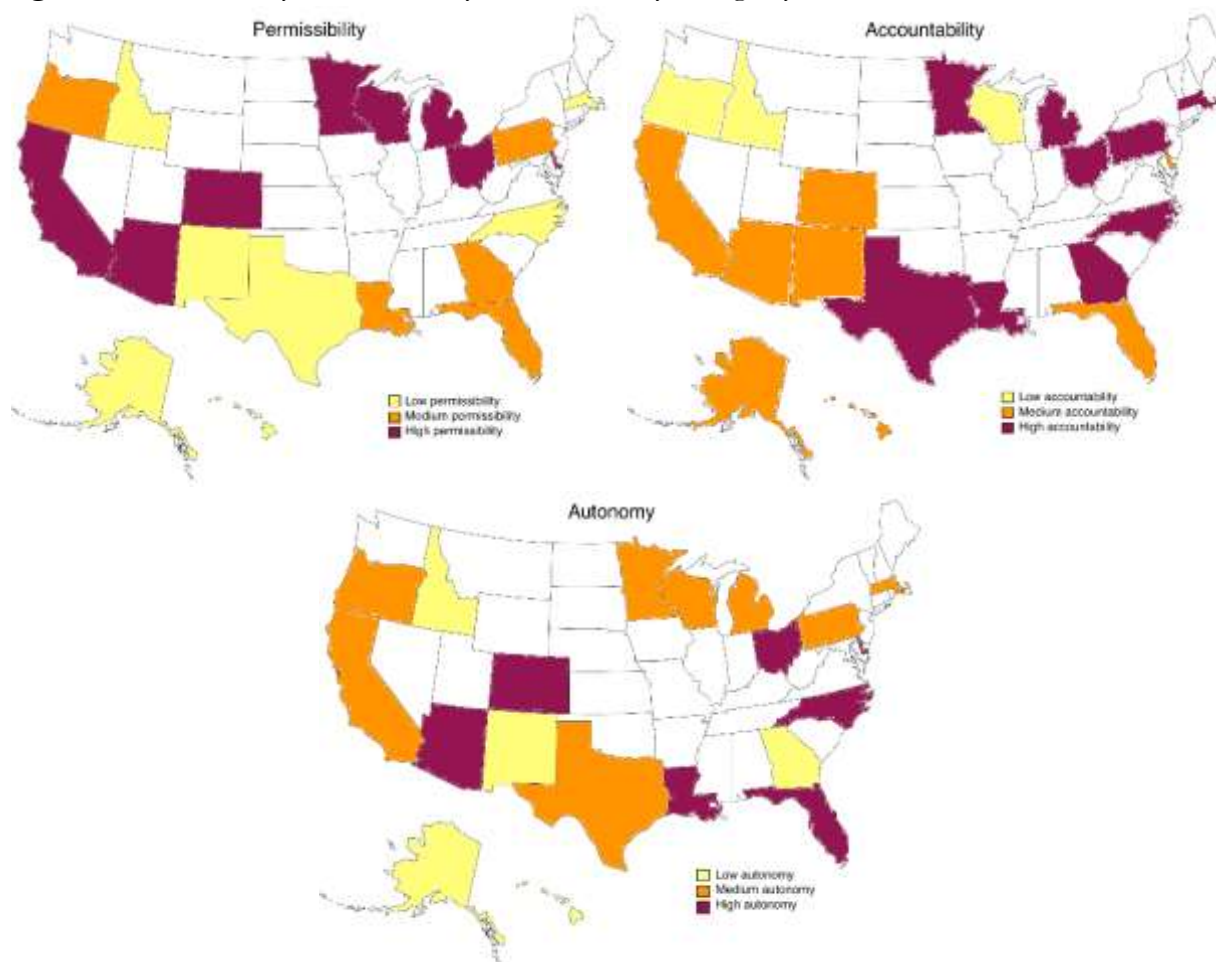
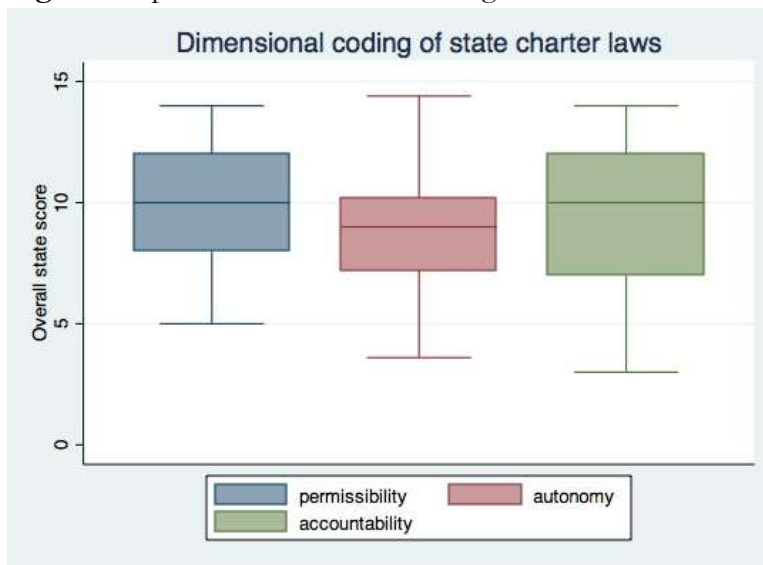
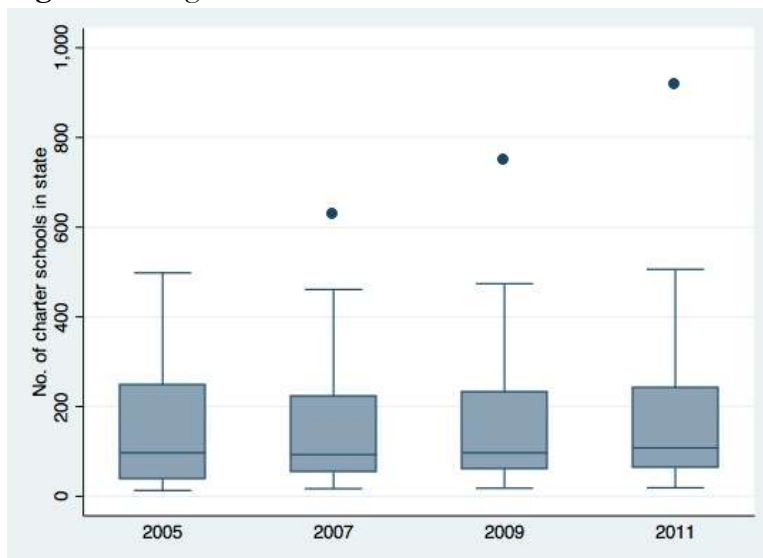


Figure 2 contains three box plots presenting the spread of scores for each legal dimension. State laws show greater variation in autonomy and accountability. The mean level of permissibility, 9.52, is slightly higher than those of the other dimensions. For accountability in particular, states that score below the median are more likely to have far less stringent standards than the average, as shown by the relatively large distance between the median and lower quartile lines. Although there is a large range of autonomy scores, most states are clustered around the median score of 9.

Figure 2. Spread of scores for each legal dimension.

The box plots in Figure 3 show the range in the number of charter schools for different states. Overall, states saw an expansion of charter schools over the years, although numbers varied greatly across states (which may also be a function of population size). While most states have fewer than 200 charter schools each, states with more schools than the median greatly exceed this median figure, indicating a positively skewed distribution. The dots that appear from 2007 onwards represent California as an outlier state.

Figure 3. Range in the number of charter schools for different states.

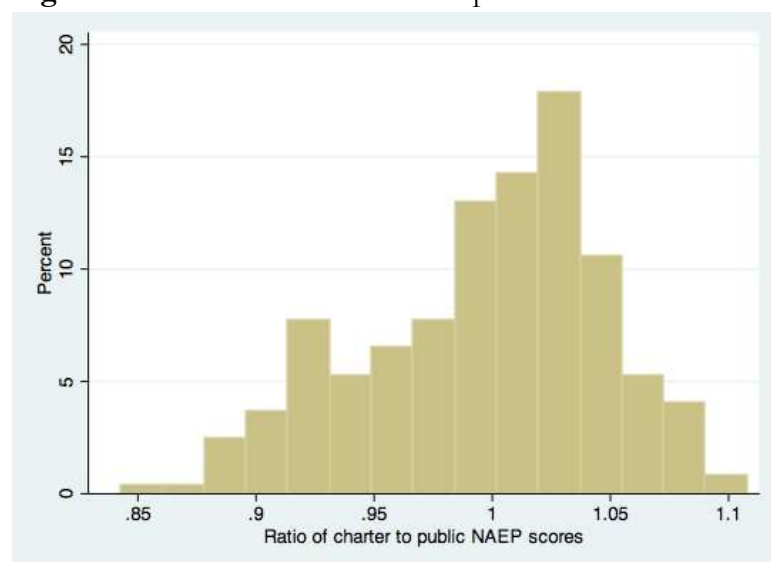
Mean state-level NAEP scores for charter and traditional public schools are almost the same and the mean ratio of charter to public school scores is very close to one (Table 2). However, the longer left tail of the histogram in Figure 4 suggests that charters that perform worse have a larger

achievement gap relative to traditional public schools in the same state and those that did better than state public schools produce relatively smaller improvement.

Table 2. Descriptive statistics of state laws.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Permissibility of state law	36	9.52	2.54	5	14
Autonomy of state law	36	8.91	3.09	.6	14.4
Accountability of state law	36	8.00	3.19	3	14
No. of charter schools in state (sum of the obs. across all 4 years)	36	168.96	176.26	3	917
2005	4	144.76	147.57	3	498
2007	4	158.14	159.64	7	627
2009	4	176.86	179.32	8	748
2011	4	196.10	210.85	9	917
Charter NAEP scores	46	248.08	26.42	88	311
Traditional Public School NAEP scores	36	249.10	24.99	90	299
Ratio of Charter NAEP scores to public school NAEP scores	46	.997	0.05	.84	1.11
Year state law was implemented	36	1994.91	2.09	991	1999
Year of latest revision to state law	36	2001	1.85	996	2003
Time in years between law implementation and 2004	36	9.10	2.09	5	13
Time in years between last revision of law and when test was taken	36	7.00	2.91	2	15
Citizen ideology rating by state	20	52.41	14.52	0.3	85.3
State government ideology rating	20	47.82	13.21	5.9	67.7

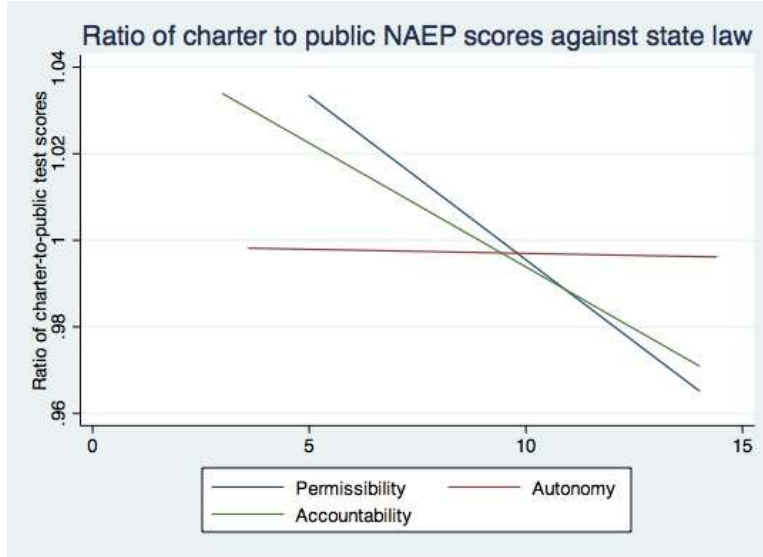
Figure 4. Distribution of charter-to-public NAEP score ratios.



The linear relationships of the three legal dimensions are plotted in Figure 5. Permissive state laws have a strong negative correlation with relative student achievement and, perhaps unexpectedly, laws that demand greater accountability also have a negative correlation with charters’

performance compared to traditional public schools. The degree of legislative autonomy has only a very small negative association with relative student achievement.

Figure 5. Ratio of charter to public NAEP scores against state law.



Regression Results

Based on my regressions, the influence of all three legal dimensions remained large and statistically significant even after adjusting for multiple controls. This demonstrates that legal environment may still have a major influence on the eventual number of operating charters (a joint F-test of all three dimensions provides a test statistic of $F(3, 310) = 102.02$ and a p-value of 0.0000).

I also test the three legal parameters of permissibility, autonomy, and accountability for correlation. The correlation coefficients are between 0.1 and 0.4 suggesting that individual analysis of each parameter (as well as in tandem) may be significant in predicting my outcome variables. Table 3 presents the results for the number of charter schools (Model 1) and Table 4 shows the results for charter NAEP scores (Model 2).

Table 3. Impact of the legal environment on the number of charter schools in each state (Model 1).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Permissive	26.64*** (3.504)			22.21*** (3.662)	13.02*** (2.024)	15.60*** (2.103)	11.00*** (2.056)	11.07*** (1.997)	7.135*** (1.934)
Autonomous		17.49*** (2.967)		12.71*** (3.077)	12.58*** (1.678)	10.37*** (1.749)	12.75*** (1.659)	12.75*** (1.611)	19.26*** (1.734)
Accountable			-1.740 (3.023)	-7.027** (2.809)	-12.69*** (1.545)	-12.39*** (1.518)	-13.67*** (1.423)	-13.73*** (1.382)	-16.97*** (1.354)
State population (in 100,000s)					1.577*** (0.0563)	1.524*** (0.0570)	1.484*** (0.0533)	1.380*** (0.0565)	1.266*** (0.0573)
State poverty rate						5.736*** (1.533)	6.612*** (1.431)	9.685*** (1.544)	12.52*** (1.636)
Age of law in 2004							16.38*** (2.260)	18.61*** (2.248)	22.99*** (2.333)
Time since last legal revision								-7.770*** (1.700)	-5.945*** (1.701)
Government ideology									-0.510 (0.414)
Citizen ideology									-0.615 (0.392)
Constant	-84.73** (34.53)	13.03 (27.99)	185.3*** (29.94)	-89.94** (41.15)	-78.15*** (22.45)	-158.2*** (30.71)	-280.9*** (33.20)	-279.4*** (32.24)	-285.3*** (33.70)
Observations	336	336	336	336	336	336	336	336	320
R-squared	0.148	0.094	0.001	0.195	0.761	0.771	0.803	0.814	0.844

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4. Impact of the legal environment on charter NAEP performance in each state (Model 2).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Permissive	-0.839 (0.688)			-0.619 (0.734)	-1.902*** (0.317)	-1.798*** (0.318)	-1.986*** (0.341)	-2.391*** (0.367)	-2.401*** (0.365)
Autonomous		-0.601 (0.525)		-0.421 (0.558)	0.599** (0.241)	0.560** (0.240)	0.714*** (0.261)	0.869*** (0.263)	0.901*** (0.262)
Accountable			-0.383 (0.593)	-0.243 (0.602)	-1.197*** (0.260)	-1.150*** (0.259)	-1.112*** (0.259)	-0.998*** (0.259)	-0.971*** (0.258)
Public school NAEP scores					0.975*** (0.0297)	0.974*** (0.0295)	0.969*** (0.0296)	0.972*** (0.0292)	0.969*** (0.0291)
State population (in 100,000s)						-0.0164** (0.00760)	-0.0134* (0.00784)	-0.0173** (0.00785)	-0.00953 (0.00875)
State poverty rate							-0.358 (0.239)	-0.292 (0.237)	-0.506* (0.260)
Age of law in 2004								1.203*** (0.432)	1.070** (0.435)
Time since last legal revision									0.530* (0.272)
Constant	256.3*** (6.942)	253.7*** (5.179)	251.7*** (5.842)	260.4*** (8.730)	29.73*** (7.967)	30.46*** (7.914)	36.35*** (8.824)	25.42*** (9.546)	25.34*** (9.491)
Observations	246	246	246	246	246	246	246	246	246
R-squared	0.006	0.005	0.002	0.009	0.819	0.822	0.824	0.829	0.832

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

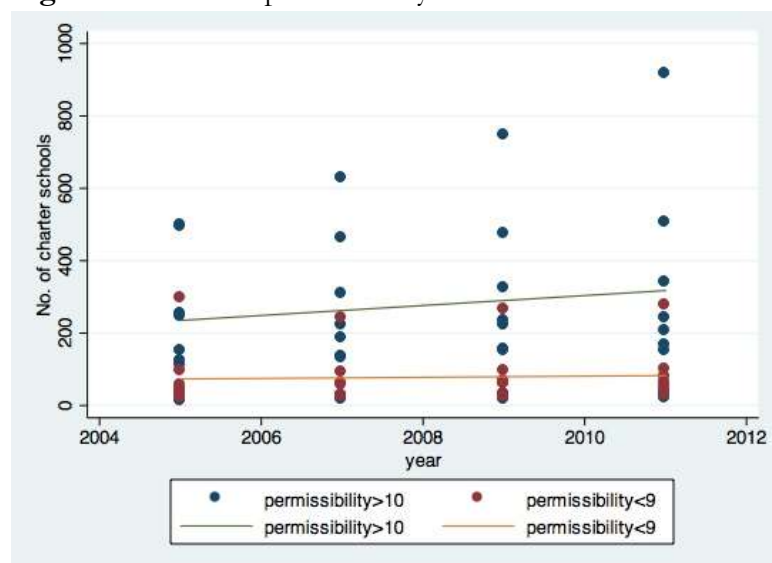
Model 1: Number of charter schools in state

Without controlling for other state factors, laws granting higher permissibility and autonomy significantly relate to a greater number of charter schools, while accountability is associated with fewer charter schools. Adding control variables reduces the apparent influence of permissive laws.

As seen in Model 1, every point increase in permissibility of state law relates to seven more charter schools. In contrast, granting greater legislative autonomy has a larger positive correlation, while enhancing accountability requirements has a strong negative correlation. Each unit increase in the degree of legal autonomy is associated with an increase of over 19 charter schools, but the same increase in legal accountability correlates with almost 17 fewer charter schools.

Permissive laws – the lack of caps, having multiple authorizers, and allowing for-profit organizations – relate to an increase in charter schools. This suggests that permissive laws do make it easier or provide incentives for charters to be set up. Comparing states with high (score greater than 10) versus low permissibility (score less than 9), more permissive laws are associated with a faster rate of increase in the number of schools over time (Figure 6).

Figure 6. Effect of permissibility on the number of charter schools over time.



In terms of autonomy, fewer regulations, guaranteed funding, and more charter control over teacher certification and operational matters also appear to provide incentives to set up and maintain operation of charter schools. Freedom plausibly encourages innovation and hence more charter proposals. However, accountability standards in terms of performance expectations and monitoring requirements greatly limit growth, either by enforcing closures of schools or by reducing the incentive to open a school in the first place. A more daunting monitoring environment could deter potential applicants.

Model 2: Academic achievement of charter schools on NAEP tests

There is no significant correlation between charter school performance and any of the three legal parameters in the model without the covariate of traditional public school performance on NAEP. However, the corresponding coefficients are large and highly significant when mean scores of traditional public schools in the same state are considered. This underscores the large overall variability in academic achievement between states that could obscure any potential performance trends.

Without adding any other variables, permissibility and accountability have a negative influence on charter academic achievement, whereas autonomy has a slight positive effect. After controlling for other state-level variables, the model suggests greater negative influence of more permissive laws, and greater positive influence of greater legislative autonomy, alongside a smaller negative effect of accountability requirements. As shown in Table 3, a one-unit increase in the level of permissibility relates to a 2.4 point decrease on the NAEP. Increasing the degree of legal autonomy by one point correlates with a 0.9-point increase in NAEP score, while a similar increase in accountability is linked with a decrease of 0.97 points on the NAEP. A joint F-test of all three legal dimensions provides a test statistic of $F(3,237) = 22.57$ and a corresponding p-value of 0.0000. This further confirms the high significance of the overall legal environment and suggests good model fit.

Discussion

The regression results suggest potentially adverse implications for greater permissiveness in charter legislation. Charter school students in states with no caps on growth, multiple non-governmental authorizers, or laws that allow the involvement of for-profit organizations are far more likely to perform worse on NAEP tests. An unlimited number of possible charters would reduce authorizer oversight and incentive in screening for high-quality charter applications. At the same time, authorizers such as private non-profits or higher education institutions may have less stringent standards compared to state or local school boards who may be more demanding or even skeptical of charters because charters directly affect the operations of their public schools. The availability of multiple authorizers makes the approval process easier as applicants can work outside the usual governmental bodies to find an authorizer with less rigorous standards. Finally, for-profits could well have differing priorities when operating schools (charter or non-charter) and may be inclined to maximize revenue at the expense of quality, which in turn affects the academic learning opportunities of students.

The results do provide some empirical support to charter school advocates calling for increased operational and legal freedom, whether in terms of automatic exemptions from standard regulations, guaranteed funding, or even waivers of teacher certification requirements. This would be a means of spurring educational innovation and enhancing student outcomes without having to worry as much about fulfilling bureaucratic across-the-board regulations. States that have given more space for charter schools to operate and experiment appear to have attained higher NAEP scores. It is also plausible that increased autonomy could have even larger impacts if a broader definition of student outcomes was used to take into account specialized programs in music, art, language, or gifted education not usually captured in standardized reading and math tests. At the same time, it should be noted that this positive autonomy effect remains smaller than the size of the strongly negative permissibility factor. The different impacts of legislative permissiveness and autonomy underlines the potentially opposing effects of what is commonly called flexibility at different stages of charter school implementation (setting up versus operating the school).

Interestingly, greater accountability is associated with significantly lower test scores in charter schools (although the influence was less pronounced than with permissive laws). This influence was reduced in size but remained significant even after controlling for population, poverty, and law age. A possible reason could be omitted variable bias. Introducing a dummy variable that grouped states by census region, I also run a modified regression model (Table 5) with just the accountability parameter and eliminate state poverty and population controls to minimize collinearity. The accountability coefficient, however, remains negative. This could simply be because states with poorly performing charters have implemented accountability requirements as a remedial response with time lag limiting the influence of these more recent legal revisions.

Table 5. Impact of legal accountability on charter NAEP performance.

Variables	(1)	(2)
Accountable	-0.421*	-0.439*
	(0.238)	(0.238)
Public school NAEP scores	0.996***	0.996***
	(0.0241)	(0.0241)
Age of law in 2004		0.406
		(0.354)
Midwest region	-5.184*	-6.037*
	(3.005)	(3.093)
South region	11.23***	11.26***
	(2.864)	(2.862)
West region	17.67***	16.95***
	(3.036)	(3.098)
Constant	-5.794	-8.816
	(7.362)	(7.814)
Observations	246	246
R-squared	0.882	0.883

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

On the other hand, the results provide strong indication that existing accountability mechanisms are failing and suggest important implications for the improvement of charter school legislation and policy. For example, authorizers may not rigorously enforce accountability requirements prescribed by the law, and schools have little incentive to respond to such standards, especially when legal language is vague and permits are flexible. Furthermore, the illusion of having stringent accountability standards might lead to a perverse effect of laxer action in practice; monitoring bodies may be inclined to grant schools' requests for continued operation under supposedly consistent monitoring.

The coded variables for the accountability dimension also focused on reporting and monitoring requirements with no explicit link to upholding said accountability standards even if such performance standards may have been defined in the charter contract. Submission of annual performance reports or even state-level evaluation of the charter school program may not necessarily lead to rapid corrective action on poorly performing charters. State laws have largely been silent on requirements for sanctions, probation, or closure of failing charters. It may take years to complete follow-up action, given the possibility of an appeals process and schools may be allowed some time for self-improvement before stricter action is taken by authorizers or boards of education. In addition, the influence of interest groups and political pressure muddies the entire process. Thus, within the limited time period for which charter school NAEP scores are available, we may not be able to clearly determine the impacts of accountability requirements.

Moreover, the “ideal” definition of accountability standards has yet to be adequately captured in existing charter legislation across the country. Authorizers play an important role in upholding accountability, not just in granting “permissibility” during the initial stages of setting up a charter. Accountability standards should also encompass greater monitoring and intervention powers for authorizers, as well as specific reporting and performance mandates for authorizing bodies. This would provide important incentives for authorizers to maintain a quality portfolio of charter schools.

Several studies have found that authorizers face difficulties imposing accountability standards and implementing sanctions because of unclear laws, financial and logistical limitations, political pressure, and adverse impacts on reputation (Finnigan et al. 2004). However, such specific requirements are not traditionally emphasized in legal texts and public discourse. Only in recent years has this aspect started to receive more attention. Therefore, the true influence of accountability standards cannot yet be determined from data currently available for this study. This presents a broader challenge in evaluating the association of accountability standards across states. Future long-term studies will hopefully be better positioned for conclusive analyses.

Finally, methodological limitations may contribute to the negative association between accountability and charter school performance. The sample of states with charter school data available in NAEP is limited and not necessarily representative of the true population distribution of accountability scores. This limits conclusive interpretations of current results. For instance, several Northeastern states are not included in this study. Yet, the Northeast region tends to have higher accountability standards compared to the West and Midwest. The lack of a geographic region control variable in the model may also contribute to bias.

Conclusion

According to my analysis, states’ legal environments significantly shape the growth of charter school programs as well as charter academic performance. Different aspects of the law are working in varying directions. Permissibility and autonomy favor a greater number of charter schools while accountability restricts and reverses growth. In addition, although greater autonomy has some

positive association with student academic outcomes, it tends to be outweighed by the negative relationship between these outcomes and permissibility and accountability.

The results of this study suggest that different dimensions of charter laws may have conflicting influences on the expansion and quality of charter schools. It is thus important for policymakers to evaluate legislation at a finer level, by dimensions or even by individual provisions. Otherwise, legal policy may impede progress towards effective understanding and management of charter school programs. Charter school advocates consistently favor permissibility, autonomy, and, increasingly, accountability. However, this study indicates that blanket support for all three dimensions is detrimental to charter academic performance. While encouraging a reasonable degree of autonomy, policymakers need to tighten permissive laws and overhaul currently inadequate accountability frameworks. Just as with traditional public schools or any other system, charter schools (and charter laws) are not simply “good” or “bad.” Meaningful discourse needs to consider which aspects of policy and legislation are constructive and which ones are not. States that have implemented permissive laws as a means of expanding charter school programs tend to struggle with poor academic outcomes in these schools. On the other hand, accountability standards seem to be restricting growth without necessarily improving student performance. Given the relatively weak influence of autonomy, there is no clear-cut formula or combination of parameters that facilitate charter performance alongside growth. Thus, the best strategy in designing charter school law may be to first focus on ensuring academic quality through accountability reform and establishing adequate standards in a smaller group of schools prior to engaging in a state-wide expansion of charter schools. It would certainly be harder to belatedly rein in growth and enforce higher accountability standards on a large, heterogeneous, and poorly-regulated pool of schools.

Charter schools are a relatively recent initiative with mixed research results and there remains a paucity of reliable data. This study is limited by the number of years and states for which NAEP data for charters were available. This study also does not incorporate changes in state legislation after 2004, as governments respond to the growing interest (positive and negative) in charter schools. Nonetheless, this study provides groundwork for subsequent studies using more comprehensive coded legislation and larger datasets.

Future research might code state charter laws over time, especially after 2004, to analyze the dynamic influence of changes in permissibility, autonomy, or accountability. Research could also look into how various dimensions of charter school law correlate with variability in school performance within states. The legal environment may have varying influence on schools in rural, urban, or suburban settings, for instance, or depending on whether the charter school is virtual, newly set-up, or converted from a public or private school. It would thus be interesting to explore the legislative effects at the school or district level within a state.

¹ This included: the Education Commission of the States’ State Policies for Charter Schools Database, the Law, accessed Feb 23, 2012 at <http://www.ecs.org/html/IssueSection.asp?issueid=20&ands=What+States+Are+Doing>; Librarian’s Society of Washington DC Legislative Database, Wong and Shen (2006), Watral (2007), accessed Mar 18, 2012 at <http://www.llsdc.org/state-leg/>

² The summed score for permissibility as well as accountability, each consisting of three variables, was 15. Autonomy, which had five variables, had a total score of 25 – this was then adjusted to a 15-point scale, to facilitate easy comparison of dimension scores.

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Appendix 1. Definition of coded legal variables

Dimension	Legal Variable	Definition/Examples
Permissibility	No cap on the number of schools; if there is one, 90% of the cap is not reached	A cap limits the number of charter schools in a state, either through an absolute total or a cap on new schools per year e.g. in California, 550 schools were allowed in 2004, with the cap increased by 100 every year. Sometimes the cap can vary by the type of authorizing body, or by the type of charter (e.g. Florida imposed no limits on charters converted from existing public schools, but the number of new start-ups was limited by district size).
	Number and nature of authorizers	A state could designate the local or state school board of education as the sole authorizing body, or create a specialized statewide charter review board (as in Colorado). Alternatively, a more permissive state law could permit multiple authorizers, including higher education universities, non-profits, or other private organizations. At times, eligible authorizers may depend on the type or location of the proposed charter school. For example, in Wisconsin, charters in Milwaukee can be authorized by the local board, the city of Milwaukee, or the two universities; however, local school boards are the only legal authorizers outside of Milwaukee.
	Involvement of for-profit organizations	For-profit organizations can either directly operate charter schools (i.e. granted an approved charter), or indirectly be contracted for management and operational services. Statutory silence sometimes occurs, when a state's law does not explicitly permit or disallow the involvement of for-profits.
Autonomy	Automatic exemptions from most district and state regulations	Quite often, in the spirit of the original charter school concept, states automatically provide blanket waivers from most of the usual state and district education laws, regulations or policies, apart from those of health or safety for example. In some states, state- and district-level regulations are treated differently, or exemptions have to be negotiated on a case-by-case basis (e.g. in New Mexico).
	Waiver of teacher certification requirements	Teachers employed at charter schools in certain states may be exempted from the standard certification requirements for traditional public schools. Such waivers could also be for up to a certain percentage of teachers, or allow alternative levels of certification (e.g. Ohio), or depend on the type of teacher (e.g. Texas waives all requirements except for bilingual and special education teachers).

	Legal and operational autonomy	This measures the extent to which charter schools are allowed to be independent legal entities, versus remaining under district jurisdiction. Legally or operationally autonomous charter schools have more control over personnel, enrollment numbers, property ownership, and contracting for services, for instance. This could likely affect the level of charter school activity in the state. For example, charters in Washington DC enjoy high autonomy, while those in North Carolina have some autonomy with state and local board officials exercising additional oversight.
	Fiscal autonomy	Some states give charter schools complete control over budgets, while others leave funds in the hands of traditional school districts. This would have implications for the resources available for charters, as well as how they can spend funding, depending on the attitudes at the district and local levels. States such as California or Colorado allow negotiation with the sponsor district.
	Guaranteed funding sources	Generally, district and school budgets are affected by per-pupil funding, which automatically follows students to the schools where they are enrolled. In some cases, the law states that 100 percent of per-pupil funding goes to the charter school (e.g. Louisiana); while in other states, the amount is lower or has to be negotiated specifically with the district. In Hawaii, funding is determined annually and not guaranteed.
Accountability	Defined academic and operational performance expectations	These performance outcomes are usually defined in the charter contract, although the level of specificity varies by state. Such outcomes could include some or all of the following: academic achievement goals, assessment indicators, an imposed timeline and corrective action procedures if standards are not met.
	Submission of annual performance reports to higher bodies	This reflects whether the state requires schools or their authorizers to submit annual performance or progress reports that are available to the public, beyond the usual testing or reporting requirements for traditional public schools. Reports could cover student academic performance but also financial or other operational matters. Some states do not explicitly mandate regular accountability reports, or relax the annual requirement after a certain number of years; on the other end of the spectrum, Georgia has a state office of Charter School Compliance that prepares guidelines, contracts with third parties to evaluate schools, and compiles annual reports.
	Periodic formal evaluation of state charter school program	Some states require the state board of education or another entity (e.g. an independent consultant is commissioned by the secretary of education in Pennsylvania) to regularly report on and evaluate the overall performance of charter schools in the state. This may include academic progress, best practices, impacts on the districts, and policy recommendations.