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Xuetao Wang April 9, 2019

# Measurement of Federal Agency's Performance: Using the Case of Thirteen Agencies under Department of Agriculture

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An abstract of
a thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
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Bachelor of Arts with Honors

Political Science

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Abstract

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How to evaluate the performance of federal agencies? This question has been investigated by extensive literature. However, these literatures had three types of problems. First, some of existing literature tried to use a universal set of criteria to evaluate the agency's performance but ignored the distinctive nature of each agency. Second, most literature used survey methods to gauge the opinion of employees as indicators of the agency's performance. This method relied on the opinion of employees, which was not always reliable. Third, it was hard to balance the theoretical argument and empirical analysis. Most studies only emphasized on one aspect but was relatively weak on the other aspect. This study proposed two models to deal with the problem. The graph algebra model could help us understand what variables will influence the performance of agencies and provide a theoretical argument explaining how those variables contribute to the agencies' performance. The interaction variable regression model paved the way to compare the performance of agencies with respect to utilizing each resources variable and overcoming the negative constraints. The agencies' performance would be decided by how well it utilizes their resources and overcomes the negative constraints to maximize their output. The main contribution of this study was: 1. proposed a new performance evaluating method; 2. identified the factors which might influence the performance of the agency and offered theoretical argument for each variable; 3. utilized a model to compare the performance across agencies. The study found out that agency size and employees' working experience could help explain the agency's performance, and agencies have efficiency difference in utilizing the budgetary resources.

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Acknowledgements

My sincere thanks to Professor Courtney Brown. I will never forget these months when I come to your office every Tuesday and Thursday at 6:50 pm. It is one of the most memorable parts in my college life. I also want to thank Professor Alexander Bolton and Professor Zhongjian Lin, whose expertise I always relied on.

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## Introduction

How should we measure the performance of federal agencies? Given the distinctive nature of agencies' missions and resources, most studies rely on survey methods to gauge the perception of employees and consumers as an indicator of performance. This study proposes a different measurement strategy and argues that federal agencies' performance could be defined as how they utilize their resources and overcome negative constraints to maximize their productivity. The study analyzes the resources and negative constraints faced by thirteen agencies under the Department of Agriculture. This study looks at how well those agencies utilize their resources and overcome negative constraints to produce regulations.

The performance or effectiveness of government agencies has been an interesting research subject for many scholars since the 20th Century. Many existing studies delve into the question of how to measure the performance of federal agencies. Yet, due to the complexity of the phenomenon, there is a huge debate surrounding how to measure the agencies' performance. some scholars suggested ways to measure the performance while others argue that it is impossible to have a legitimate measurement. Among those researchers who have proposed their own measurement strategies, they cannot agree on measuring criteria, model's generalizability and evaluating method. Moreover, the existing models proposed in studies contain different kinds of problems such as relying on survey data, overgeneralization, and the lack of normative theory behind the model or empirical evidence backing up the choices of criteria. Therefore, the conceptualization and operationalization of performance measuring is important both in academic field and reality. On the one hand, it will provide us with some innovative ideas about performance as a concept and understand the term better, although it is hard to come up with an idea to accurately conceptualize agencies' performance. On the other hand, it helps us to adjust

our expectations about the output of the agency, provides means to monitor progress, inform priorities, and identify improvement areas (Cassidy and Kendis 2011).

First, how can we conceptualize the idea of performance, or what criteria could be used to define it? Some studies emphasize the productivity aspect, namely the level of output in the sense of achieving the result for which the agency is designed (Georgopoulos and Tannenbaum 1957; Mott 1972; Chakraborty et al 2001). Some studies propose to look at the morale of the employees, which can be measure through the level of internal strain and the ability of the organization to preserve its human and material resources (Georgopoulos and Tannenbaum 1957; Price 1968). Besides these two dominant criteria, some other criteria include growth ability, adaptability, and creativity (Katz and Kahn 1966; Bennis 1962; Schein 1970). These criteria are not mutually exclusive; on the contrary, many studies use a multivariate system to incorporate more than one criterion. Studies with more criteria will be more comprehensive and better at capturing the variance in performance (Steers 1975).

However, due to the difference in the agencies' missions and resources, it is hard to use a set of criteria to indicate the performance of all agencies, especially since different agencies might have different goals. Gross (1969) examined how to measure the goals of American universities and proposed five goals of agencies: output, adaption, management, motivation and position. Output refers to the goals that could deliver immediate product, service or skills. Adaptation goals reflect the need of the university to come to terms with the environment in which it is located. The university should adapt to changes in the preferences of students and parents. Management goals refer to the ability to run the university well. The university needs to handle conflict and make a reasonable priority list. Motivation goals reflect the need to attract students and faculties to stay in the university and gain satisfaction from it. Last, positional goals

serve to help the university to maintain its position relative to other universities. It requires the university to maintain the educational quality, a healthy relation between students and faculties, and keep up to date. To achieve each goal, the university is required to fulfill different set of criteria. If we want to measure the degree to which universities reach their goals, we need to specify which goal to look at. In order to find out the goal of a university, the study proposed to look at some specific information like the policy on research, the emphasis on academic research versus professional and vocational performance, and the percentage of total enrollment in graduate school. That information could help us to identify the main goal of the university.

Similarly, the study on federal agencies performance should also specify which goal to investigate. To narrow our scope, I examine the output goal, which indicates the productivity of the agencies. The output can be indicated by the agencies' published regulations. I choose output as the main goal to analyze because agencies' outputs impact the public directly. The Congress enacts laws, and the agencies publish regulations to specify and clarify the law. By publishing and enforcing regulations, the agencies use their resources and authorities to impact the society.

Second, some studies used survey methods to gauge the perception of employees and customers (Wolf 1993; Radin 2009). It is difficult to conclude if employee surveys or consumer surveys are good indicators of agencies' performance, despite the fact that many studies used them to measure performance. These surveys are subject to individual opinions and partisanship. As a result, it may not be standardized and consistent (Lewis 2007; Radin 2009)

The George W. Bush administration established the Program Assessment Rating Tool (PART) to evaluate the performance of federal programs. The PART system is a grading scheme used by the Office of Management and Budget (OMB) to evaluate the performance of federal programs numerically. The OMB sent out questionnaires to employees asking them 25 questions

about their opinions on the performance of their agencies, using four categories including program purpose and design, strategic planning, program management, program results and accountability. After collecting the responses, the PART system generates an overall score to indicate the program's performance. It would further rate the program's performance under four categories, "effective", "moderately effective", "adequate" and "ineffective".

Questions about program purpose and design assess whether the program's purpose and design are clear and sound (Brown Dustin, 2008). A typical question asks "is the program purpose clear? (OMB's PART Questions)" Strategic planning questions measure whether the program has valid long-term and annual measures and targets (Brown Dustin, 2008). This section often asks "does the program have a limited number of specific long-term performance measures that focus on outcomes and meaningfully reflect the purpose of the program? (OMB's PART Questions)" Program management questions rate the program's management, including financial oversight and program improvement efforts (Brown Dustin, 2008). The questions include "does the agency regularly collect timely and credible performance information, including information from key program partners, and use it to manage the program and improve performance? (OMB's PART Questions)" Program results and accountability rates program performance on measures and targets reviewed in the strategic planning section and through other evaluations (Brown Dustin, 2008). It includes questions such as "has the program demonstrated adequate progress in achieving its long-term performance goals? (OMB's PART Questions)"

However, as indicated by Gallo and Lewis (2011), the PART scores are subject to the influence of partisanship. Gallo and Lewis compared the performance of federal programs administered by Bush's appointees from the campaign or party against programs run by other

appointees or career professionals. Gallo and Lewis measured the ideology of agencies and labeled them as conservative or liberal. They found out conservative programs receive higher PART scores systematically. The PART score is established by the Bush Administration. As a consequence, if the scoring system is biased, conservative program might receive a higher score overall. Although it is hard to conclude whether the PART scoring system is biased toward conservative programs or conservative programs generally perform better than liberal programs, ideology and partisanship might be a factor influencing the validity of performance measurement.

Some studies try to create an index combining a variety of variables to indicate the performance strength (Cassidy and Kendis 2011; Negandhi 1973). Cassidy and Kendis (2011) proposed to use a Performance Measurement Index in multiple management levels to indicate the overall performance of the agency. The Performance Measurement Index is formulated through a step-down methodology based on the agency's strategic planning process, from the mission statement to specific project areas. In addition to a single mission-level score, agencies can calculate scores at the priority goal, strategic goal, strategic objective, and project levels. Cassidy and Kendis (2011) reported that this method follows such steps: 1. understand the goal and mission of the agency; 2. develop outcome-based priority goals and design measurements regarding each goal; 3. prioritize and weight performance measure based on importance and relevance; 4. determine performance targets for each performance measure; 5. calculate and report index scores. An index is straightforward and enables the principals and public to track progress. However, the index method has disadvantage of low generalizability. According to the index method proposed by Cassidy and Kendis, we have to create an index for each agency based on its mission and priority. We cannot apply the same measurement standard across

agencies. Furthermore, the index has little utility in comparing performance across agencies. If we designed distinctive measuring criteria for each agency, then it will be meaningless to compare the performance across agencies based on the index. I cope with the problem by narrowing my focus on the ability of the agency to produce regulations and make my model applicable to a variety of agencies.

Third, it is challenging for a study to balance the theoretical argument and empirical evidence. Some studies provide a strong empirical analysis while lacking theoretical argument, and some other studies propose theories but do not have substantive evidence to back up. For example, Mahoney and Weitzel (1969) analyzed the difference in performance measurement criteria between a "general business model" and a "research and development model". They analyzed the sets of criteria used in those two models. At the same time, they ran the regression using the two models and examined the explanatory ability of each model. However, the study did not provide a normative theoretical argument behind the difference. While some studies lack normative theory, the other studies often need more empirical analysis. Georgopoulos and Tannenbaum (1957) argued that the concepts of organizational effectiveness could be measured by organizational productivity, organizational flexibility and absence of intraorganizational strain. They proposed these measurement criteria which could be used to measure the performance of retail merchandise stations. They offered a normative theory to back up their choice of those criteria but did not provide empirical evidence to justify their choice. Therefore, studies might always face the trade-off between normative argument and empirical analysis. If we could focus on one criterion and analyze how different variables could contribute to the variation in performance, the study will be less vulnerable to theoretical counterargument while provide strong empirical evidence.

How to conceptualize the idea of performance and what methods could be employed to measure it pose substantial challenges. Given the different missions and resources of agencies, it is important to recognize the limited consistency and reliability of performance measuring tools (Radin 2009). I analyze and compare the performance of thirteen agencies under the Department of Agriculture. Their mission could be divided into six categories, namely "farm and foreign agricultural services", "rural development", "food, nutrition, and consumer services", "food safety", "natural resources and environment" and "marketing and regulatory programs". Although these agencies have distinctive missions and expectation, they are under the jurisdiction of the same department and their works are relatively more related. On the one hand, increasing the number of agencies under examination will inevitably undermine the accountability of comparison. On the other hand, narrowing the scope will seriously damage the generalizability and scholarly contribution of the study. Facing the trade-off, it seems to be a good strategy to look at the agencies under the same department whose works are related while having a relatively sound sample size.

I want to specifically measure and compare the performance of thirteen agencies under the Department of Agriculture in achieving the output goal, which could be indicated by their productivity. First, the outputs for those agencies are similar. Different goals require distinctive way to measure and compare (Gross 1969). If we compare the agencies' performance in achieving other goals than output, we might need other ceteris paribus conditions to make meaningful comparison. Second, productivity is one of the easiest goals to objectively measure. Productivity could be clearly defined. The number and content of regulations is observable. Third, those agencies' products would affect the food industry, farmers and forestry directly. The regulations tell the industry what to do and what guidance to follow. For example, the Foreign

Agricultural Service (FAS) links U.S. agriculture to the world to enhance export opportunities and global food security.

In analyzing and comparing the performance of thirteen agencies, this study proposes to measure the performance of federal agencies through a highly controlled context. I examine how those agencies utilize their resources and overcome negative constraints to maximize their outcomes.

## Unit of Analysis

I randomly choose Department of Agriculture out of the fifteen federal executive department as my target. Department of Agriculture contains a reasonable sample size of agencies. As a federal executive department, it directs many federal agencies which has representative values and has a strong stability, which gives us a better chance to analyze with certainty. The performance evaluating model could be applied to evaluating the performance of agencies under other executive departments. However, the model does not apply to some types of agencies like independent regulatory agencies who do not subject to the review of Office of Information and Regulatory Affairs (OIRA) and some agencies that are mainly doing research works and do not publish regulations like the Economic Research Agency under the Department of Agriculture.

Department of Agriculture is the U.S. federal executive department responsible for developing and executing federal laws related to farming, forestry, and food. It provides leadership on food, agriculture, natural resources, rural development, nutrition, and related issues based on public policy, the best available science, and effective management (USDA). There are seventeen agencies under its jurisdiction in total. I did not consider Agricultural Research

Service, Economic Research Service, and National Agricultural Statistics Service because their main missions are to conduct research and provide agricultural knowledge. Consequently, they produce a few regulations. Incorporating those agencies will not serve the purpose of this study which defines the output as the number of regulations published. Moreover, I did not consider executive office such as the Office of the Chief Information Officer, the Office of the Chief Economist and the Office of Small and Disadvantaged Business Utilization.

The agencies being investigated could be divided into six categories. First, farm and foreign agricultural services: the **Farm Service Agency (FSA)**, the **Risk Management Agency (RMA)** and the **Foreign Agricultural Service (FAS)**. Second, rural development: the **Rural Business-Cooperative Service (RBS)**, the **Rural Utilities Service (RUS)** and the **Rural Housing Service (RHS)**. Third, food, nutrition and consumer service: the **Food and Nutrition Service (FNS)** which works along with the Center for Nutrition Policy and Promotion (CNPP). Fourth, food safety: the **Food Safety and Inspection Service (FSIS).** Fifth, natural resources and environment: the **Natural Resources Conservation Service (NRCS)** and the **United States Forest Service (USFS)**. Sixth, marketing and regulatory programs: the **Animal and Plant Health Inspection Service (APHIS)**, the **Agricultural Marketing Service (AMS)**, the **Grain Inspection, Packers and Stockyards Administration (GIPSA)**.

My unit of analysis is "agency per year". I collect yearly data about those agencies from 2000 to 2017.

## Theory: The Conceptualization and Operationalization of Performance

This study argues that the agencies' performance can be measured by how well they utilize resources and overcome the negative constraints to maximize its productivity (Boyne

2003; Campbell et al 1974; Rainey and Steinbauer 1999). If the agency could utilize its resources and overcome the negative constraints to maximize its productivity, we could describe the agency as having good performance. On the contrary, if the agencies cannot utilize its resources to the optimal extent nor overcome the negative influence, then it fails to maximize its productivity and we would describe the agency as having poor performance.

An agency will always have a certain amount of resources including its budget, connection with the principles, and human resources (Marume et al 2016). Boyne (2003) identified the importance of resources in contributing to the output of the agency. A higher public expenditure could bring higher productivity and thus better performance.

At the same time, the agency also faces challenges and negative constraints. For example, it might face restraints and regulations from the principles, competition from other agencies or the private sector, and the inherent challenges from carrying out its missions (Boyne 2003). Boyne mentioned how regulation from external bodies might negatively influence the productivity of the agencies. The agencies are not free to choose their own processes and strategies but instead must subject to the constraints set by their authorities and principals (Hood et al. 1998). As a result, the agencies may not be able to exercise their expertise to the maximized degree given the constraints imposed by their principals. At the same time, if the agencies are influenced by multiple principals, it is hard for the agencies to fulfill all the expectations from their principals, especially when those principals have contradictory goals. Commands from multiple principals will demotivate and confuse the agency (Boyne 2003). The agencies have to overcome the negative constraints from the principles in order to have a better performance.

Federal agencies usually carry out a variety of jobs. Thus, the expectation and evaluation of the agency's performance will vary from agency to agency, and a comprehensive measurement strategy will inevitably consist of multiple criteria with distinctive weights. I propose to solely look at the productivity of the agency. Since the agencies' productivity attracts scholarly attention and is frequently mentioned in research papers about performance measurement (Steers 1975), this paper explore what factors might lead to higher output, and the measurement strategy I proposed relate the agencies' performance to their ultimate productivity.

Campbell et al (1974) argues that productivity has been measured at three levels: individual, group, and total organization and is usually defined as the quantity or volume of the major product or service that the organization provides and is generally measured by using organization records of some sort. The agencies I investigate all publish regulation as part of their missions. Therefore, the number of regulations published could be an objective indicator of the productivity of the agency. As a consequence, agencies' performance could be measured by how well they utilize the resources and overcome negative constraints to achieve high output.

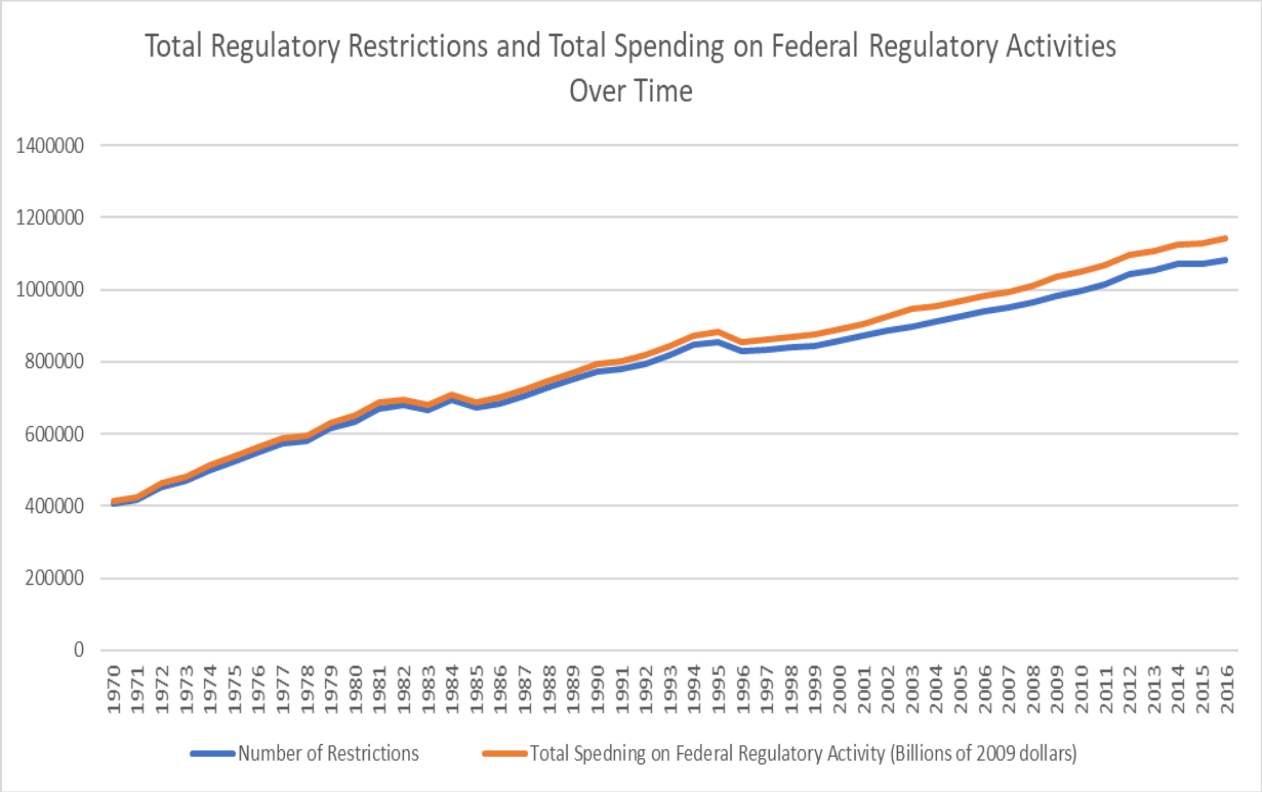
I set the output as the dependent variable, and the resources variables and negative constraint variables will be the independent variables. After running the regression and examining the coefficient in front of each independent variables, I conduct test to see if the coefficients for the variable between those two agencies are significantly different. If the coefficients are significantly different, then it is highly likely that one of agencies utilizes its resources better or worse than the other, or the agency is better at dealing with negative constraints than the other. For example, if the FSA's coefficient for budget is 1 and the FSIS's coefficient for budget is 0.5, it is possible that the FSA utilize its budgetary resources more

efficiently than the FSIS given the difference is statistically significant. Thus, the FSA performs better than the FSIS in utilizing its budgetary resources.

## Measuring Independent Variable: Budgetary Resources, Human Resources, Negative Constraints

### *Budgetary Resources*

It has been widely accepted that there is a relation between the budget the agency receives and its productivity (Boyne 2003). Researchers at Regulatory Studies Center at George Mason University merge data on annual regulatory restrictions produced by each federal regulatory agency with the agency's annual budget. In figure 1, we can observe a clear positive correlation between the total regulatory restrictions and total agency budget over time. The simple correlation between total of all regulatory restrictions and total of all agency budgets equals 0.91, which indicates a strong correlation (McLaughlin and Sherous, 2015).




(Figure 1: Total Regulatory Restrictions and Total Agency Budgets Over Time)

I utilize data on the outlay of the thirteen agencies at the Public Budget Database published by the OMB. The Public Budget Database contains detailed spending information on every account of each agency. After adding the spending from every account together, I get the total outlay for each agency. However, it is important to notice that the agency would not only spend on producing regulation, and different agencies might devote different portions of their budgets to producing regulations. Since I reduce the potential bias by only looking at the agencies whose main jobs includes making regulations, an overall capture of the outlay of the agency would be adequate to serve this study's propose.

*Human Resources*

Human resource refers to the total value or total worth of the individual members of an organization, in an accounting or balance sheet sense, to the organization (Campbell, 1974). The mission of the agency is carried out by its individual members. The quality of the agency's human resource will be an important determining factor of its performance. However, different agencies have sheer difference in total employee number. For example, the Forest Service has 36,439 employees in September 2017 while the Rural Utility Service only has 262 employees. Consequently, it might be more meaningful to compare the performance of those agencies using averages and control for the agency size. I measure the quality of human resources by looking at FedScope of the Office of Personnel Management (OPM), which contains information about the education level, salary level and length of service of each agency employee. The dataset captures all the employees who are in pay status at the end of each quarter. By calculating the average length of service in the agency, I could get an indicator of the competency of the agency's overall human resources. The length of service variable measures the number of years of Federal civilian employment, creditable military service, and other service made creditable by specific legislation. The data offered by OPM grouped the length of service by five-year intervals. I assigned values with respect to each categories of length of service level according to the following rule.

| | |
|---|---|
| Less than 1 year | 0 |
| 1-2 years | 1 |
| 3-4 years | 2 |
| 5-9 years | 3 |
| 10-14 years | 4 |
| 15-19 years | 5 |

| | |
|---|---|
| 20-24 years | 6 |
| 25-29 years | 7 |
| 30-34 years | 8 |
| 35 years or more | 9 |

*Agency Size*

The agency size could be counted as resources of the agency. Many researchers have explained the effects of agency size on the productivity. The size of agency will influence the budget it received and the management effectiveness. Goldman (1970) explained agency's large size could directly increase complexity of management and decrease commands' effectiveness overhead. Porter and Lawler (1965) found consistent evidence of a positive correlation between organization size and absenteeism, turnover, and number of labor disputes for blue collar workers. Blau (1970) presents a deductive theory describing the interrelationships of size, structural differentiation, and administrative overhead in bureaucratic organizations. From these existing literatures, we can assume the agency size will have effect on the performance. I examined the FedScope of OPM and found data on the total number of the agency's employees.

*Negative Constraints*

The agency faces constraints imposed by its principles. The President, by constitution, leads the executive branch. Congress, through the budget appropriation process, could also exert influence on the agency. I mainly look at the Office of Information and Regulatory Affairs (OIRA), since OIRA's review is observable and directly reflects the control of the President on the agencies' decision-making process. The OIRA was created by Congress as a result of the

1980 Paperwork Reduction Act. It reviews draft regulations developed by agencies, assesses plans to collect information, and oversees government-wide policies. The OIRA plays the role as the gatekeeper for agency regulations. After reviewing the submitted regulations, the OIRA could give three types of decision, namely "consistent without change", "consistent with change" and "withdrawn". The antiregulation mood of the country could provide support for the office to add additional obstacles to the rule-making process (Radin 2010). I examine the percentage of regulations that are labeled "withdrawn" or "consistent with change". If the OIRA is unsatisfied with the regulation published by the agency, it will ask the agency to make changes to it or completely withdraw it. As a result, the agency will earn no output if the regulation gets withdrawn, and it has to devote more resources to adjust the regulation if the OIRA request changes. Thus, the OIRA's decision might negatively influence the ability of the agency to publish regulations and thus influence its productivity.

## Measuring the Dependent Variable: The Output

*Regulation*

One of the main missions of all thirteen agencies is to produce regulations, and they publish regulations every year. I look at the number of regulations published by those agencies at Federal Register.

## Control Variables

This study compares the performances of thirteen agencies based on how the agency utilizes its resources and overcomes negative constraints to maximize its output, ceteris paribus. The strong ceteris paribus assumption in the formula is crucial because many literatures have

demonstrated that some other factors will influence the productivity of agencies, such as the agency size and agency's organization structure (Boyne 2003). These factors might have influence on the agencies' performance.

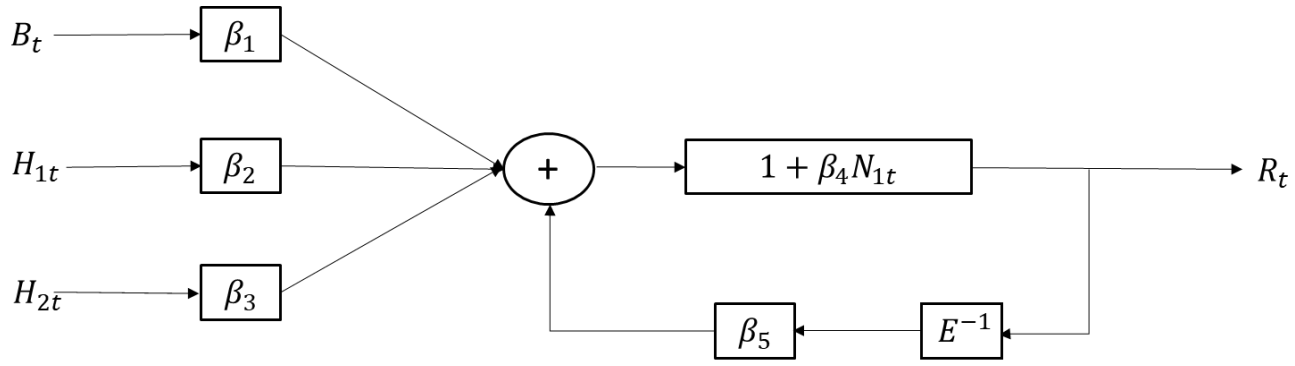
*Year*

The agency's number of regulations published depends not only on the performance of the agency, but also on the demand of regulation, and the demand for regulations varies from year to year. First, the demand of regulation depends on the election results, especially given that the government controlled by democratic party and republican party will have different policy goal. Second, a natural shock could happen in a certain year and strongly affect the demand for regulation. For example, if there is a disease outbreak, agencies have to make reaction and publish regulations to deal with the crisis. As a result, I will incorporate year as a fixed effect variable to control for the potential variation in demand of regulation.

## Methods

*Graph Algebra Model*

Using graph algebra, the initial model of the examined process is shown in figure 2 (Brown 2008, Cortés and Sprague 1974).



(Figure 2: A Graph Algebra Representation of the Regression Analysis of Regulations)

$B_t$: budgetary resources at year *t*

$H_{1t}$: agency size at year *t*

$H_{2t}$: staffs' average length of service at year *t*

$N_{1t}$: proportions of regulations that are labeled "Consistent with Change" by OIRA at year *t*

$R_t$: number of regulations at year *t*

I developed an equation to approximate the number of regulation variable:

(1) $$R_t = (\beta_1 B_t + \beta_2 H_{1t} + \beta_3 H_{2t} + \beta_6 R_{t-1})(1 + \beta_4 N_{1t})$$

After expanding the equation, we can get

(2) $$R_t = \beta_1 B_t + \beta_2 H_{1t} + \beta_3 H_{2t} + \beta_5 R_{t-1} + \beta_1\beta_4 B_t N_{1t} + \beta_2\beta_4 H_{1t} N_{1t} + \beta_3\beta_4 H_{2t} N_{1t} + \beta_4\beta_5 R_{t-1} N_{1t}$$

My theory anticipates a positive relationship between the resources the agency received and the output. If the agency receives a larger amount of budget, it will be able to devote more budgetary resources into doing researches about the agricultural industry and publish more regulations to tackle problems they identified during research.

At the same time, if the agency has more competent staffs overall, it could utilize its budgetary resources more effectively. People who have been working in the agency for a long time will have more experience about the working procedure and potential problems. They might be able to contribute to producing a higher output. The number of employees will indicate the

Moreover, there is a negative relationship between the constraints put on the agency and the output. The OIRA's review of the agency's regulations will impose some obstacles to the regulation making process. The agency has to spend more time and resources on revising

regulations, which will limit the agency's ability to produce more regulations. If the proportion of regulations given "consistent with change" and the proportion of regulations given "withdrawn" increase, the output of the agency will decrease.

Last, the number of regulations published in the last year might have some correlation with next year's regulation published. It is possible that the affairs need to be regulated are limited. If the agency addresses one issue by publishing regulations in this year, it does not have to make another rule to deal with the same issue in the next year. On the other hand, the regulations published this year cause more chaos and the agency needs to revise its regulation by publishing more regulations. The regulations published in one year could have a long-term effect.

Thus, if the positive coefficient for budgetary resources, $\beta_1$, increases, we can assume the agency utilizes its budgetary resources more efficiently and will produce a higher output. If the positive coefficient for agency size and staff's average length of service, $\beta_2$ and $\beta_3$, increases, the agency has either a larger staff force to use or utilizes its human resources with a higher efficiency and produce a higher output holding other variables constant. On the contrary, if the negative coefficient for the proportions of regulations that are labeled "Consistent with Change" and "Withdrawn", $\beta_4$ and $\beta_5$, increases, the agency is more vulnerable to the constraints and will lower its productivity and produce less output. I will test to see if $\beta_1$, $\beta_2, \beta_3$ and $\beta_6$ is positive and nonzero, and if $\beta_4$ and $\beta_5$ is negative and nonzero.

Based on the theory outlined, I develop six hypotheses:

H1: If budgetary resources increase, the number of published regulations will increase.

H2: If agency size increase, the number of published regulations will increase.

H3: If staff's average length of service increase, the number of published regulations increase.

H4: If proportion of regulations labeled "consistent with change" increase, the number of published regulations will decrease.

H5: The number of regulations published in the previous year will exert a positive effect on the number of next year's regulations.

By testing the three hypotheses, I will be able to find out whether these three variables have effects on the output and the direction of the effects. Thus, it is possible to connect the agency's performance with the coefficient for each variable.

*Interaction Variable Regression Model*

An interaction variable regression model will enable me to test the difference in coefficients for one variable across agencies. I create a variable, $A_i$, to indicate which agency is associated with the variable.

I construct my regression equation as follows:

(3) $R_t = \beta_1 B + \beta_2 H_1 + \beta_3 H_2 + \beta_4 A_i + \beta_5 N_{1t} + \beta_6 B A_i + \beta_7 H_1 A_i + \beta_8 H_2 A_i + \beta_9 N_1 A_i$

According to the sequence of alphabetic order, Agricultural Marketing Service (AMS) will be the base agency, which will be excluded from $A_i$. When analyzing AMS, $A_i$ will turn to zero. When analyzing other agencies, it will assign value one to $A_i$. Through this interaction term, I will be able to compare the coefficient in front of one variable between AMS and other agencies. For example, I first run the regression with respect to the data under AMS and then add Farm Service Agency (FSA) as a dummy variable. The new data under FSA and the dummy variable will update the coefficient $\beta_6$, $\beta_7$, $\beta_8$, and $\beta_9$, which represents the difference of the

coefficients between AMS and FSA regarding budgetary resources, employee's length of service, agency size and the percentage of "Consistent with Change" ruling. If $\beta_6$, $\beta_7$, $\beta_8$, and $\beta_9$ are statistically significant, it is highly likely that the two agencies have performance difference in using their respective budgetary resources, the benefit from agency size and their employee's experience gained from length of service, and the oversight from the Office of Information and Regulatory Affairs (OIRA).

Based on the theory outlined:

H7: if $\beta_6$ is positive, then the comparing agency utilizes its budgetary resources better than the base agency.

H8: if $\beta_7$ is positive, the comparing agency utilize its employee's length of service better than the base agency.

H9: if $\beta_8$ is positive, the comparing agency utilize its agency size better than the base agency.

H10: if $\beta_9$ is positive, the comparing agency overcome less effectively the negative constraints posed by the oversight from OIRA.

Through testing these hypotheses, I will be able to evaluate any two agencies' performance in three aspects. However, the working range of the model is relatively limited. It only allows me to compare an agency with the base agency. If I want to compare the performance of two agencies other than AMS, the base agency in my model, I have to choose another agency and produce another table.

## Empirical Analysis

The theoretical argument and empirical expectation can be tested against evidence using the data collected. I run the regression with regard to each term in Equation (1) and report the results in the Appendix I. This model gives us an estimated effect of each independent variable on the number of regulations published. I perform an autocorrelation test to check for multicollinearity problem. I run the regressions with respect to the residuals to see if there is a linear pattern. I have not found any autocorrelation problems.

The results of the regression analysis target the number of regulations for each agency on their respective budgetary resources, agency sizes length of service, the number of regulations in the previous year, and the interactive term "consistent with change." Most of the coefficients are statistically insignificant, but there are several statistically significant regression results for the Farm Service Agency (FSA), the Rural Utility Service (RUS) and the Animal and Plant Health Inspection Service (APHIS).

The FSA is a relatively large agency under Department of Agriculture (DoA). Its annual outlay averages around $16 billion from 2000 to 2017 and it has 4680 employees in average. It also publishes more regulations than any other agencies under DoA, with an average 75 regulations per year. According to table 1, for the FSA, the agency size exerts a statistically significant positive effect on the number of regulations published. The regulations published in previous year, the agency size interacting with "consistent with change" and the regulations published in previous year interacting with "consistent with change" also produced statistically significant results but the p-value is higher than 5% but lower than 10%. The FSA's main mission is to help farmers, ranchers, and agricultural partners while protecting the environment. It relied on making regulations to design assistant programs to meet the need from farmers. It is possible that for large agencies which has many employees and high regulatory activism, their

agency size and published regulations will have a strong correlation with the ability and will to publish new regulations.

Table 1: The Regression of Regulations on Various Variables for Farm Service Agency

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 3.52×10+01 | 8.58×10+01 | 0.41 | 0.6923 |
| Budgetary Resources | -2.94×10-06 | 3.38×10-06 | -0.87 | 0.4095 |
| Agency Size | 6.33×10-02 | 2.42×10-02 | 2.613 | 0.0310 * |
| Length of Service | -2.36×10+01 | 2.37×10+01 | -0.996 | 0.3483 |
| lagged.R0 | -2.05 | 8.91×10-01 | -2.305 | 0.0501. |
| Budgetary Resources*Consistent with Change | 3.51×10-06 | 3.63×10-06 | 0.965 | 0.3626 |
| Agency Size*Consistent with Change | -5.17×10-02 | 2.70×10-02 | -1.913 | 0.0921. |
| Length of Service*Consistent with Change | 1.55×10+01 | 1.10×10+01 | 1.416 | 0.1945 |
| lagged.R0*Consistent with Change | 2.15×10+00 | 1.01×10+00 | 2.125 | 0.0663. |

Multiple R-squared: 0.838, Adjusted R-squared: 0.676, N = 18, df = 8

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \qquad \beta_1 = 0.21259,\ p - value = 0.431$

As for the RUS, the agency size and length of service terms produced statistically significant results as shown in table 2. Both of those variables have a strong positive correlation with the number of regulations published. Moreover, the intercept for the RUS is also statistically significant. The outlay for the RUS is -599 million per year according to the public budget database, which suggests that the RUS's income is higher than the outlay. However, the RUS employs a large number of employees, which averages 40456 from 2000 to 2017. The RUS administers programs that provide infrastructure or infrastructure improvements to rural

communities, including water and waste treatment, electric power and telecommunications services. It helps to increase access to telecommunications services, fund sustainable renewable energy development and conservation, finance reliable and affordable electric systems, work to integrate electric smart grid technologies and developing reliable and affordable rural water and wastewater systems (Rural Utility Service, 2019). Since it has a large employee group, the agency size and the quality of those employees will have a prominent impact on the ability of the agency to publish new regulations.

Table 2: The Regression of Regulations on Various Variables for Rural Utility Service

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -2.57×10+02 | 5.80×10+01 | -4.426 | 0.00221 ** |
| Budgetary Resources | 1.73×10-06 | 6.13×10-06 | 0.283 | 0.78449 |
| Agency Size | 3.14×10-03 | 1.06×10-03 | 2.954 | 0.01832 * |
| Length of Service | 3.61×10+01 | 1.24×10+01 | 2.921 | 0.01925 * |
| lagged.R0 | 2.55×10-01 | 1.67×10+00 | 0.153 | 0.88255 |
| Budgetary Resources*Consistent with Change | 1.11×10-06 | 6.43×10-06 | 0.173 | 0.867 |
| Agency Size*Consistent with Change | 4.27×10-04 | 9.27×10-04 | 0.461 | 0.65734 |
| Length of Service*Consistent with Change | -8.65×10-01 | 1.23×10+01 | -0.07 | 0.94563 |
| lagged.R0*Consistent with Change | -1.02×10+00 | 1.75×10+00 | -0.579 | 0.57827 |

Multiple R-squared: 0.8184, Adjusted R-squared: 0.6367, N = 18, df = 8

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \qquad \beta_1 = -0.25986,\ p - value = 0.361$

The APHIS has statistically significant results for some variables as well. I reported the results in table 3. The length of service has a significant positive effect while the regulations published in previous year interacting with “consistent with change” potentially has a negative

effect since the p-value falls in the range between 5% and 10%. The APHIS is a small agency with around 1 million outlay per year from 2000 to 2017, and its agency size is smaller than that of FSA and RUS, with only 770 employees in average, but its employees have a high average length of service. The average score for length of service is 4.4. The high average of length of service may contribute to explaining why the term is statistically significant.

Table 3: The Regression of Regulations on Various Variables for Animal and Plant Health Inspection Service

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -2.88×10+00 | 1.64×10+01 | -0.176 | 0.8648 |
| Budgetary Resources | 9.70×10-07 | 2.08×10-06 | 0.467 | 0.6527 |
| Agency Size | -1.16×10-02 | 1.50×10-02 | -0.775 | 0.4608 |
| Length of Service | 3.09×10+00 | 1.26×10+00 | 2.446 | 0.0402 * |
| lagged.R0 | -1.34×10-01 | 2.50×10-01 | -0.537 | 0.6061 |
| Budgetary Resources*Consistent with Change | 3.04×10-06 | 3.78×10-06 | 0.804 | 0.4447 |
| Agency Size*Consistent with Change | 1.99×10-02 | 1.27×10-02 | 1.565 | 0.1562 |
| Length of Service*Consistent with Change | -2.71×10+00 | 1.59×10+00 | -1.703 | 0.1271 |
| lagged.R0*Consistent with Change | -1.02×10+00 | 4.74×10-01 | -2.145 | 0.0643 . |

Multiple R-squared: 0.7841, Adjusted R-squared: 0.5681, N = 18, df = 8

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \quad \beta_1 = -0.40704,\ p - value = 0.117$

Although we cannot conclude that agency size, length of service and the number of regulations published in previous year have positive effects on the agency's ability to publish regulations based on the results from three agencies, the empirical evidence demonstrate that

budgetary resource has no effects on the agency's ability to publish new regulations. The coefficient in front of budgetary resource is not statistically significant for all thirteen agencies.

After analyzed the results from the graph algebra model, the results from the interaction variable regression model are shown in Appendix II. The regression results report the estimated coefficient, standard error, and the p-value for the year's fixed effect, the agency's fixed effect, the natural log term of budgetary resources, the length of service, the natural log term of agency size and the percentage of "consistent with change" ruling given by ORIA.

I used negative binomial regression since the number of regulations is an over-dispersed count outcome variable. The coefficients in front of each variable represents that for each one-unit increase in the independent variable, the expected the number of regulations will change according to the coefficients. For example, the coefficient of the natural log term of budgetary resources for the base agency, the AMS, is -0.152. One percent increase in the outlay will lead to 0.152 less regulations. There is another type of coefficients which represent the performance difference between the comparing agencies and the base agency. For example, the intercept for the FNS is -1.920, which represents that the FNS will publish -1.920 less regulations than the AMS given one percent increase of budgetary resources for both agencies.

Since I used negative binomial regression, it is necessary to check whether the assumption for using the model is satisfied. Negative binomial model assumes that the conditional means are not equal to the conditional variances. UCLA's Institute for Digital Research and Education states that, "this inequality is captured by estimating a dispersion parameter that is held constant in a Poisson model. Thus, the Poisson model is actually nested in the negative binomial model. We can then use a likelihood ratio test to compare these two and test this model assumption. To do this, we will run our model as a Poisson (IDRE stats, 2019)."

The log of likelihood is 5.970026×10-12 with degree of freedom 64. The small likelihood suggests that the conditional means and conditional variance are unequal.

For the outlay term, I only find the Food Safety and Inspection Service (FSIS) yield statistically significant results. Given one-unit percentage increase in outlay, the FSIS will publish 4.699 more regulations than the AMS does. It is susceptible that the FSIS utilizes its budgetary resources better than the AMS.

Moreover, these is a strong variation of performance according to years. In year 2001, 2012, 2016 and 2017, I find a strong negative influence on the agency's number of regulations published. Compared with year 2000, year 2001 has 0.287 less regulations published, year 2012 has 0.716 less regulations published, year 2016 has 1.322 less regulations published and year 2017 sees 1.564 less regulations published overall.

I did not find any statistically significant difference for length of service, overcoming the negative constrains posed by the OIRA and the agency size. It is likely that all the agencies perform equally well in those two aspects.

## Conclusion

It is likely that different agencies' ability to produce regulation might be affected by different types of variables. For the FSA, the agency size and the number of regulations published in previous year had potential effects. The influencing factors are the agency size and the length of service for the RUS, and as for the APHIS, it is the length of service. Further studies could look at the difference between agencies as a factor to explain the effective range of

the model. It would be insightful if there is a way to categorize agencies such that it is possible to evaluate agency performance within a category.

Moreover, it is important to examine the reason why only these three agencies have statistically significant result. It could be a coincidence, since these three agencies are different from each other in their missions, outlays, and agency sizes. Nevertheless, a possible explanation might be their reliance on human resources. The FSA and RUS have numerous employees, while the length of service of APHIS's employees is relatively longer. To make regulations, these three agencies have to contact with farmers and do extensive field works. Consequently, the agency size and employee's length of service will have a more direct impact on their capacity of publishing new regulations. Further studies could examine human resources' importance to each agency and see if some types of agency will be more likely to have large agency sizes, and its employees have longer length of services.

The frequency of agency size and length of service showing up demonstrates that the agency size and length of service have a higher chance of being positively correlated with the ability of the agency to publish new regulations. Since I measure the performance of the agency using the number of regulations, it is possible that the agency size, employee's length of service could be used in evaluating the performance of the agency.

The agency size will influence the capacity of the agency to publish new regulation since it affects the management difficulty. I find evidence from the analysis with respect to FSA and RUS showing that agency size is positively correlated with the number of regulations published. The large agency size might increase management difficulty, but at the same time, increase the chance of finding relevant experts in making certain regulations within the agency. A large agency will have many employees who are diversified in expertise. When the agency tackles a

problem by designing regulations, it could find the person who possesses knowledge on that issue from the large employee pool. Nonetheless, if the agency is relatively small, it will have a harder time in finding the right person to do the job. It is also likely that one person has to do multiple works, which decreased his or her level of expertise on a specific issue.

The length of service is positively correlated with the number of regulations published as shown by the analysis regarding APHIS and RUS. The employee's length of service should have a direct effect on the ability of those employees. Since the process of making regulations is highly involved with research and relevant expertise, the length of service is expected to be a crucial factor in predicting the number of regulations published. However, this study only finds two statistically significant cases. Part of the problem might lie in the coding process. The dataset of Office of Personnel Management (OPM) did not give the exact number of every employees' length of service but categorize it using five-year intervals. When I code every category with a number and then calculate the average based on the coding numbers, the average does not represent the exact average length of service. Further researches could attempt to collect data on the exact years of each employee's length of service, which might render more significant results.

The fact that some variables do not have statistically significant results for any agencies suggests the potentiality of lack of clear correlation between budgetary resources, "consistent with change," the regulation published in previous year and the number of regulations published in this year.

I did not find statistically significant results for the coefficient of budgetary resources in any agencies or models. It is possible that the budgetary resources will not exert a strong effect on the performance of the agency. Nevertheless, the budgetary resources are usually used in a

variety of tasks, and the part spent on producing regulations might be relatively small. The effect of budgetary resources could be substantial, but it is dissipated as I have only examined the gross outlays rather than the regulatory budget which is specifically devoted to producing regulations. Future researchers could focus on looking at those regulatory agencies and their respective regulatory budgets, which might increase the effect of budgetary resources on the ability of the agency to make regulations.

Furthermore, the oversight from the Office of Information and Regulatory Affairs (OIRA) does not seems to be an influential factor on the agency's ability to publish new regulations. The OIRA only reviews a relatively small portion of the agency's regulations. It is possible that it will be more likely to review those regulations that are termed as economically significant. The predisposition of the OIRA's working mechanism could bias this study. Further studies could identify more direct and consistent oversights from principle or checks on the agency's rule-making process.

Through analyzing the interaction variable regression model, I find that some agencies perform differently regarding utilizing outlays. However, I only test for one base agencies, the AMS. I could choose a different base agency and test if other agencies perform different from it.

I find a strong fixed effect of years. Five years out of 17 (except the base year) have significant effects on the number of regulations published. Probably the demand for regulation will vary from year to year, which caused the difference. Future researches could look more into the yearly fixed effects and investigate the potential cause.

My study contains several problems waiting to be solved. My model might have overlooked some variables which could explain further the difference in agency performance, or these nuance variations cannot be captured easily. For example, the organization culture could

influence the agency's performance, but the organization culture and the employee's morale to some degree depend on the manager's personality. It is possible that a more active and caring manager will motivate his or her subordinates to perform better. However, the effect cannot be easily captured by data, and it varies along with the switch of managers. Future researches could look for other variables which might affect the performance of the agency and fill in gap.

Second, the mission of the agency plays a part in determining the number of regulations it is supposed to publish each year. Some agencies are regulatory agencies and their work required them to publish new regulations to regulate the agricultural affairs. Other agencies might be service agency or oversight agency. They have less incentive to publish new regulations but focus on other works.

At the same time, I find some agencies perform better than the AMS in utilizing the budgetary resources and the employee's length of service. However, the margin is too small to be practically significant. Since the AMS's regression of the independent variables on the number of regulations yields statistically insignificant results, when we use the AMS as the base agency, the subsequent comparing results may not be meaningful. Further studies could take more controls and pick a better base agency to do the comparison.

Furthermore, future researches could redefine the output variable and specifically look at those regulations that have significant economic impact. According to Executive Order 12866 signed by President Clinton, "Significant regulatory action" means any regulatory action that is likely to result in a rule that may: "(1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy; (2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency; (3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations

of recipients thereof; or (4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in this Executive order" (Executive Order 12866 1993). Economically significant regulatory actions will bring more important political and social changes, and making these actions requires the agency to spend a large amount of resources on researching and political bargains. If the agency makes more significant regulatory actions, it is reasonable to assume that it exhibits greater productivity and produce greater output. I got relevant data from OIRA's regulatory review, which records the regulations submitted by each agency, and Federal Register provides information about which regulations are economically significant.

Lastly, every agency has multiple missions which interact with each other. On the one hand, agency has to allocate resources across different missions. The agency may not devote all its resources to making regulations. The coefficients in front of each resource variable only captured how well the agency utilizes the resources to produce regulations. Consequently, it may not be a valid indicator of the performance of agencies. On the other hand, agencies' missions may interact with each other. The number of regulations published may depend on the inspection activity of the agency. During the inspection activity, the agency could find out many problems within the agricultural industry and design more regulations to cope with the problem. The number of regulations would not be enough to indicate the whole picture. Although I pick many regulatory agencies and weed out research agencies, the problem still exists. It is important to design a way to control for the interaction with various missions of the agency.

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# Appendix I

Table 1: The Regression of Regulations on Various Variables for Farm Service Agency

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 3.52×10+01 | 8.58×10+01 | 0.41 | 0.6923 |
| Budgetary Resources | -2.94×10-06 | 3.38×10-06 | -0.87 | 0.4095 |
| Agency Size | 6.33×10-02 | 2.42×10-02 | 2.613 | 0.0310 * |

| | | | | |
|---|---|---|---|---|
| Length of Service | -2.36×10+01 | 2.37×10+01 | -0.996 | 0.3483 |
| lagged.R0 | -2.05×10+00 | 8.91×10-01 | -2.305 | 0.0501 . |
| Budgetary Resources*Consistent with Change | 3.51×10-06 | 3.63×10-06 | 0.965 | 0.3626 |
| Agency Size*Consistent with Change | -5.17×10-02 | 2.70×10-02 | -1.913 | 0.0921. |
| Length of Service*Consistent with Change | 1.55×10+01 | 1.10×10+01 | 1.416 | 0.1945 |
| lagged.R0*Consistent with Change | 2.15×10+00 | 1.01×10+00 | 2.125 | 0.0663. |

Multiple R-squared: 0.838, Adjusted R-squared: 0.676, N = 18, df = 8

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \quad \beta_1 = 0.21259,\ p - value = 0.431$

Table 2: The Regression of Regulations on Various Variables for Rural Utility Service

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -2.57×10+02 | 5.80×10+01 | -4.426 | 0.00221 ** |
| Budgetary Resources | 1.73×10-06 | 6.13×10-06 | 0.283 | 0.78449 |
| Agency Size | 3.14×10-03 | 1.06×10-03 | 2.954 | 0.01832 * |
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| Agency Size*Consistent with Change | 4.27×10-04 | 9.27×10-04 | 0.461 | 0.65734 |
| Length of Service*Consistent with Change | -8.65×10-01 | 1.23×10+01 | -0.07 | 0.94563 |
| lagged.R0*Consistent with Change | -1.02×10+00 | 1.75×10+00 | -0.579 | 0.57827 |

Multiple R-squared: 0.8184, Adjusted R-squared: 0.6367, N = 18, df = 8

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \quad \beta_1 = -0.25986,\ p - value = 0.361$

Table 3: The Regression of Regulations on Various Variables for Animal and Plant Health Inspection Service

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -2.88×10+00 | 1.64×10+01 | -0.176 | 0.8648 |
| Budgetary Resources | 9.70×10-07 | 2.08×10-06 | 0.467 | 0.6527 |
| Agency Size | -1.16×10-02 | 1.50×10-02 | -0.775 | 0.4608 |
| Length of Service | 3.09×10+00 | 1.26×10+00 | 2.446 | 0.0402 * |
| lagged.R0 | -1.34×10-01 | 2.50×10-01 | -0.537 | 0.6061 |
| Budgetary Resources*Consistent with Change | 3.04×10-06 | 3.78×10-06 | 0.804 | 0.4447 |
| Agency Size*Consistent with Change | 1.99×10-02 | 1.27×10-02 | 1.565 | 0.1562 |
| Length of Service*Consistent with Change | -2.71×10+00 | 1.59×10+00 | -1.703 | 0.1271 |
| lagged.R0*Consistent with Change | -1.02×10+00 | 4.74×10-01 | -2.145 | 0.0643 . |

Multiple R-squared: 0.7841, Adjusted R-squared: 0.5681, N = 18, df = 8

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \qquad \beta_1 = -0.40704,\ p - value = 0.117$

Table 4: The Regression of Regulations on Various Variables for Food Safety and Inspection

| | Estimate | Std.Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -2.99×10+01 | 5.96×10+01 | -0.501 | 0.630 |
| Budgetary Resources | 1.57×10-05 | 2.84×10-05 | 0.552 | 0.596 |
| Agency Size | 2.21×10-01 | 2.59×10-01 | 0.855 | 0.418 |
| Length of Service | 9.43×10-02 | 4.47×10+00 | 0.021 | 0.984 |

| | | | | |
|---|---|---|---|---|
| lagged.R0 | 1.54×10-01 | 8.91×10-01 | 0.173 | 0.867 |
| Budgetary Resources*Consistent with Change | 8.69×10-06 | 3.17×10-05 | 0.274 | 0.791 |
| Agency Size* Consistent with Change | 4.89×10-02 | 2.09×10-01 | 0.234 | 0.821 |
| Length of Service* Consistent with Change | -1.82×10+00 | 5.28×10+00 | -0.345 | 0.739 |
| lagged.R0* Consistent with Change | -2.38×10-01 | 1.12×10+00 | -0.213 | 0.837 |

Service

Multiple R-squared: 0.2416, Adjusted R-squared: -0.5169, N = 18, df=8

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \qquad \beta_1 = -0.02949,\ p - value = 0.921$

Table 5: The Regression of Regulations on Various Variables for U.S. Forest Service

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 556.4 | 354.6 | 1.569 | 0.161 |
| Budgetary Resources | -0.02876 | 0.05093 | -0.565 | 0.59 |
| Agency Size | -0.005991 | 0.03821 | -0.157 | 0.88 |
| Length of Service | -62.69 | 131.4 | -0.477 | 0.646 |
| lagged.R0 | 1.222 | 1.292 | 0.946 | 0.376 |
| Budgetary Resources*Consistent with Change | 0.02603 | 0.05186 | 0.502 | 0.631 |
| Agency Size*Consistent with Change | -7.171 | 0.09727 | -0.726 | 0.489 |
| Length of Service*Consistent with Change | -50.53 | 166.9 | -0.043 | 0.967 |
| lagged.R0*Consistent with Change | -1.238 | 1.431 | -0.865 | 0.416 |

Multiple R-squared: 0.8629, Adjusted R-squared: 0.7062, N = 18, DF = 7

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \qquad \beta_1 = -0.2183,\ p - value = 0.460$

Table 6: The Regression of Regulations on Various Variables for Risk Management Agency

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -5.20×10+01 | 9.91×10+01 | -0.525 | 0.6138 |
| Budgetary Resources | -4.04×10-07 | 1.32×10-06 | -0.307 | 0.7667 |
| Agency Size | -3.12×10-03 | 3.91×10-03 | -0.796 | 0.449 |
| Length of Service | 1.49×10+01 | 2.13×10+01 | 0.699 | 0.5045 |
| lagged.R0 | 7.93×10-01 | 3.84×10-01 | 2.067 | 0.0725 |
| Budgetary Resources*Consistent with Change | -2.16×10-07 | 2.14×10-06 | -0.101 | 0.922 |
| Agency Size*Consistent with Change | 1.67×10-03 | 6.91×10-03 | 0.242 | 0.8152 |
| Length of Service*Consistent with Change | 9.49×10-02 | 9.88×10+00 | 0.01 | 0.9926 |
| lagged.R0*Consistent with Change | -1.18×10+00 | 6.56×10-01 | -1.801 | 0.1094 |

Multiple R-squared: 0.4077, Adjusted R-squared: -0.1847, N =18, df = 8

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \qquad \beta_1 = 0.3432,\ p - value = 0.168$

Table 7: The Regression of Regulations on Various Variables for Foreign Agricultural Service

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -2.49×10+00 | 1.71×10+01 | -0.146 | 0.888 |
| Budgetary Resources | -5.96×10-09 | 8.59×10-07 | -0.007 | 0.995 |
| Agency Size | 6.01×10-03 | 9.09×10-03 | 0.66 | 0.528 |
| Length of Service | -5.79×10-01 | 2.46×10+00 | -0.235 | 0.82 |
| lagged.R0 | -3.25×10-01 | 6.57×10-01 | -0.495 | 0.634 |
| Budgetary Resources*Consistent with Change | -1.80×10-06 | 1.85×10-06 | -0.973 | 0.359 |
| Agency Size*Consistent with Change | -6.74×10-03 | 8.90×10-03 | -0.757 | 0.471 |

| | | | | |
|---|---|---|---|---|
| Length of Service*Consistent with Change | 2.24×10+00 | 1.81×10+00 | 1.236 | 0.252 |
| lagged.R0*Consistent with Change | 2.29×10-01 | 1.12×10+00 | 0.205 | 0.843 |

Multiple R-squared: 0.3804, Adjusted R-squared: -0.2392, N = 18, df =8

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \quad \beta_1 = -0.13608,\ p - value = 0.603$

Table 8: The Regression of Regulations on Various Variables for Rural Housing Service

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -6.23×10+01 | 9.99×10+01 | -0.624 | 0.550 |
| Budgetary Resource | 5.92×10-06 | 6.51×10-06 | 0.909 | 0.390 |
| Agency Size | 2.45×10-01 | 2.32×10-01 | 1.056 | 0.322 |
| Length of Service | -5.00×10+00 | 1.64×10+01 | -0.305 | 0.768 |
| lagged.R0 | 1.37×10+00 | 1.71×10+00 | 0.8 | 0.447 |
| Budgetary Resources*Consistent with Change | -8.86×10-06 | 7.86×10-06 | -1.128 | 0.292 |
| Agency Size*Consistent with Change | -2.35×10-01 | 1.89×10-01 | -1.246 | 0.248 |
| Length of Service*Consistent with Change | 2.03×10+01 | 1.68×10+01 | 1.209 | 0.261 |
| lagged.R0*Consistent with Change | -1.51×10+00 | 1.82×10+00 | -0.832 | 0.429 |

Multiple R-squared: 0.3019, Adjusted R-squared: -0.3963, n = 18, DF =9

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \quad \beta_1 = -0.06102,\ p - value = 0.821$

Table 9: The Regression of Regulations on Various Variables for Rural Business-Cooperative Service

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 3.35×10+01 | 6.00×10+01 | 0.557 | 0.593 |

| | | | | |
|---|---|---|---|---|
| Budgetary Resources | -8.90×10-06 | 1.40×10-05 | -0.638 | 0.541 |
| Agency Size | 4.98×10-04 | 2.60×10-03 | 0.192 | 0.853 |
| Length of Service | -7.81×10+00 | 1.23×10+01 | -0.636 | 0.543 |
| lagged.R0 | -2.60×10-01 | 8.23×10-01 | -0.316 | 0.76 |
| Budgetary Resources*Consistent with Change | 1.30×10-05 | 1.81×10-05 | 0.719 | 0.493 |
| Agency Size*Consistent with Change | -2.66×10-04 | 2.80×10-03 | -0.095 | 0.927 |
| Length of Service*Consistent with Change | 4.42×10-01 | 7.43×10+00 | 0.059 | 0.954 |
| lagged.R0*Consistent with Change | 9.01×10-01 | 1.01×10+00 | 0.89 | 0.4 |

Multiple R-squared: 0.4583, Adjusted R-squared: -0.08344, N = 18, DF = 8

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \qquad \beta_1 = 0.001031,\ p - value = 0.997$

Table 10: The Regression of Regulations on Various Variables for Food and Nutrition Service

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 1.16×10+02 | 2.02×10+02 | 0.575 | 0.581 |
| Budgetary Resources | -7.97×10-07 | 4.99×10-07 | -1.598 | 0.149 |
| Agency Size | -1.15×10-02 | 9.03×10-02 | -0.127 | 0.902 |
| Length of Service | -1.76×10+01 | 2.71×10+01 | -0.649 | 0.535 |
| lagged.R0 | 4.63×10+00 | 3.03×10+00 | 1.527 | 0.165 |
| Budgetary Resources*Consistent with Change | 6.81×10-07 | 5.80×10-07 | 1.175 | 0.274 |
| Agency Size*Consistent with Change | -2.16×10-03 | 8.03×10-02 | -0.027 | 0.979 |
| Length of Service*Consistent with Change | 3.97×10+00 | 2.28×10+01 | 0.174 | 0.866 |
| lagged.R0*Consistent with Change | -5.34×10+00 | 3.16×10+00 | -1.692 | 0.129 |

Multiple R-squared: 0.5194, Adjusted R-squared: 0.0389, N = 18, DF = 8

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \qquad \beta_1 = -0.22557,\ p - value = 0.438$

Table 11: The Regression of Regulations on Various Variables for Agricultural Marketing Service

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -6.98×10+01 | 5.68×10+01 | -1.228 | 0.255 |
| Budgetary Resources | -6.25×10-06 | 4.23×10-05 | -0.148 | 0.886 |
| Agency Size | 1.49×10-02 | 3.14×10-02 | 0.474 | 0.648 |
| Length of Service | -1.81×10+01 | 6.91×10+01 | -0.262 | 0.8 |
| lagged.R0 | 7.32×10-01 | 2.03×10+00 | 0.36 | 0.728 |
| Budgetary Resources*Consistent with Change | 5.69×10-06 | 4.51×10-05 | 0.126 | 0.903 |
| Agency Size*Consistent with Change | -1.12×10-02 | 3.13×10-02 | -0.358 | 0.73 |
| Length of Service*Consistent with Change | 2.80×10+01 | 7.07×10+01 | 0.397 | 0.702 |
| lagged.R0*Consistent with Change | -6.59×10-01 | 2.72×10+00 | -0.242 | 0.815 |

Multiple R-squared: 0.335, Adjusted R-squared: -0.33, N = 18; df = 8

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \qquad \beta_1 = -0.1246,\ p - value = 0.644$

Table 12: The Regression of Regulations on Various Variables for Grain Inspection and Packers, and Stockyards Agency

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 1.13×10+02 | 7.58×10+01 | 1.493 | 0.174 |
| Budgetary Resources | -1.43×10-06 | 6.94×10-06 | -0.206 | 0.842 |
| Agency Size | 5.39×10-03 | 1.35×10-02 | 0.401 | 0.699 |
| Length of Service | -2.45×10+01 | 2.04×10+01 | -1.205 | 0.263 |
| lagged.R0 | -6.25×10-01 | 1.11×10+00 | -0.562 | 0.59 |

| | | | | |
|---|---|---|---|---|
| Budgetary Resources*Consistent with Change | -4.25×10-04 | 6.34×10-04 | -0.67 | 0.522 |
| Agency Size*Consistent with Change | -4.66×10-03 | 1.77×10-02 | -0.264 | 0.799 |
| Length of Service*Consistent with Change | 6.74×10+00 | 1.55×10+01 | 0.435 | 0.675 |
| lagged.R0*Consistent with Change | 9.29×10-01 | 1.61×10+00 | 0.578 | 0.579 |

Multiple R-squared: 0.587, Adjusted R-squared: 0.1741, N = 18 , DF = 8

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \quad \beta_1 = -0.4375,\ p - value = 0.104$

Table 13: The Regression of Regulations on Various Variables for National Resources Conservation Service

| | Estimate | Std. Error | t value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -7.94×10+01 | 3.64×10+01 | -2.184 | 0.0605 . |
| Budgetary Resources | 1.62×10-06 | 1.18×10-06 | 1.374 | 0.2066 |
| Agency Size | 9.60×10-02 | 4.87×10-02 | 1.969 | 0.0844 . |
| Length of Service | 5.73×10+00 | 4.29×10+00 | 1.338 | 0.2176 |
| lagged.R0 | -1.08×10-01 | 5.79×10-01 | -0.187 | 0.8566 |
| Budgetary Resources*Consistent with Change | 1.45×10-06 | 1.18×10-06 | 1.23 | 0.2538 |
| Agency Size*Consistent with Change | -3.49×10-02 | 4.95×10-02 | -0.704 | 0.5013 |
| Length of Service*Consistent with Change | 3.16×10+00 | 4.74×10+00 | 0.667 | 0.5234 |
| lagged.R0*Consistent with Change | 6.36×10-02 | 7.63×10-01 | 0.083 | 0.9356 |

Multiple R-squared: 0.6304, Adjusted R-squared: 0.2607, N = 18, df = 8

Autocorrelation: $error_{t+1} = \beta_0 + \beta_1 \times error_t \quad \beta_1 = -0.1317,\ p - value = 0.58$

## Appendix II

**Fixed-effects negative binomial regression**

| Regulation | Coef. | St.Err. | t-value | p-value | [95% Conf | Interval] | Sig |
|---|---|---|---|---|---|---|---|
| Agricultural Marketing Service (AMS) | 0.000 | . | . | . | . | . | |
| Animal and Plant Health Inspection Service (APHIS) | 42.857 | 59.938 | 0.71 | 0.475 | -74.619 | 160.332 | |
| Farm Service Agency (FSA) | -15.662 | 48.518 | -0.32 | 0.747 | -110.756 | 79.431 | |
| Food Safety and Inspection Service (FSIS) | -72.696 | 59.859 | -1.21 | 0.225 | -190.016 | 44.625 | |
| Food and Nutrition Service (FNS) | 67.546 | 64.737 | 1.04 | 0.297 | -59.335 | 194.428 | |
| Foreign Agricultural Service (FAS) | -59.673 | 118.840 | -0.50 | 0.616 | -292.595 | 173.249 | |
| Grain Inspection, Packers and Stockyards Administration (GIPSA) | 13.531 | 49.316 | 0.27 | 0.784 | -83.127 | 110.188 | |
| Natural Resources Conservation Service (NRCS) | -68.022 | 54.566 | -1.25 | 0.213 | -174.969 | 38.925 | |
| Risk Management Agency (RMA) | 10.758 | 52.596 | 0.20 | 0.838 | -92.329 | 113.844 | |
| Rural Business-Cooperative Service (RBS) | -21.040 | 51.031 | -0.41 | 0.680 | -121.060 | 78.979 | |
| Rural Housing Service (RHS) | -14.876 | 50.263 | -0.30 | 0.767 | -113.391 | 83.638 | |
| U.S. Forest Service (USFS) | -9.617 | 59.426 | -0.16 | 0.871 | -126.090 | 106.856 | |
| lnBudgetaryResources | -0.152 | 0.571 | -0.27 | 0.789 | -1.271 | 0.966 | |
| Agricultural Marketing Service (AMS) | 0.000 | . | . | . | . | . | |
| Animal and Plant Health Inspection Service (APHIS) | -0.018 | 1.068 | -0.02 | 0.987 | -2.111 | 2.075 | |
| Farm Service Agency (FSA) | 0.562 | 0.633 | 0.89 | 0.375 | -0.679 | 1.803 | |
| Food Safety and Inspection Service (FSIS) | 4.699 | 1.795 | 2.62 | 0.009 | 1.182 | 8.217 | *** |
| Food and Nutrition Service (FNS) | -1.920 | 1.108 | -1.73 | 0.083 | -4.092 | 0.252 | * |
| Foreign Agricultural Service (FAS) | -0.196 | 1.805 | -0.11 | 0.913 | -3.734 | 3.341 | |
| Grain Inspection, Packers and Stockyards Administration (GIPSA) | -0.247 | 0.980 | -0.25 | 0.801 | -2.168 | 1.673 | |
| Natural Resources Conservation Service (NRCS) | 1.303 | 0.812 | 1.61 | 0.109 | -0.288 | 2.894 | |
| Risk Management Agency (RMA) | -0.391 | 0.776 | -0.50 | 0.614 | -1.912 | 1.130 | |
| Rural Business-Cooperative Service (RBS) | 0.569 | 0.625 | 0.91 | 0.363 | -0.656 | 1.794 | |
| Rural Housing Service (RHS) | 0.021 | 0.582 | 0.04 | 0.971 | -1.120 | 1.162 | |
| U.S. Forest Service (USFS) | -0.832 | 0.850 | -0.98 | 0.328 | -2.498 | 0.835 | |
| LengthofService | -1.627 | 1.677 | -0.97 | 0.332 | -4.914 | 1.660 | |
| Agricultural Marketing Service (AMS) | 0.000 | . | . | . | . | . | |
| Animal and Plant Health Inspection Service (APHIS) | 0.747 | 1.654 | 0.45 | 0.652 | -2.494 | 3.988 | |
| Farm Service Agency (FSA) | 1.527 | 1.701 | 0.90 | 0.369 | -1.807 | 4.861 | |
| Food Safety and Inspection Service (FSIS) | 1.540 | 1.687 | 0.91 | 0.361 | -1.766 | 4.846 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Food and Nutrition Service (FNS) | -1.598 | 1.950 | -0.82 | 0.412 | -5.420 | 2.224 |
| Foreign Agricultural Service (FAS) | 0.247 | 4.109 | 0.06 | 0.952 | -7.807 | 8.301 |
| Grain Inspection, Packers and Stockyards Administration (GIPSA) | -1.243 | 1.979 | -0.63 | 0.530 | -5.122 | 2.636 |
| Natural Resources Conservation Service (NRCS) | 2.325 | 1.806 | 1.29 | 0.198 | -1.215 | 5.864 |
| Risk Management Agency (RMA) | 1.550 | 2.164 | 0.72 | 0.474 | -2.692 | 5.791 |
| Rural Business-Cooperative Service (RBS) | 0.833 | 2.121 | 0.39 | 0.694 | -3.324 | 4.990 |
| Rural Housing Service (RHS) | 2.080 | 1.728 | 1.20 | 0.229 | -1.307 | 5.468 |
| U.S. Forest Service (USFS) | 1.260 | 1.954 | 0.65 | 0.519 | -2.570 | 5.090 |
| | | | | | | |
| lnAgencySize | -1.322 | 5.355 | -0.25 | 0.805 | -11.819 | 9.174 |
| Agricultural Marketing Service (AMS) | 0.000 | . | . | . | . | . |
| Animal and Plant Health Inspection Service (APHIS) | -7.479 | 6.703 | -1.12 | 0.265 | -20.617 | 5.660 |
| Farm Service Agency (FSA) | 0.687 | 4.951 | 0.14 | 0.890 | -9.017 | 10.391 |
| Food Safety and Inspection Service (FSIS) | 6.285 | 5.855 | 1.07 | 0.283 | -5.190 | 17.760 |
| Food and Nutrition Service (FNS) | -5.318 | 6.183 | -0.86 | 0.390 | -17.436 | 6.799 |
| Foreign Agricultural Service (FAS) | 7.990 | 15.467 | 0.52 | 0.605 | -22.324 | 38.304 |
| Grain Inspection, Packers and Stockyards Administration (GIPSA) | -0.633 | 4.953 | -0.13 | 0.898 | -10.341 | 9.074 |
| Natural Resources Conservation Service (NRCS) | 6.822 | 6.038 | 1.13 | 0.259 | -5.013 | 18.657 |
| Risk Management Agency (RMA) | -1.637 | 5.257 | -0.31 | 0.755 | -11.940 | 8.665 |
| Rural Business-Cooperative Service (RBS) | 1.458 | 5.199 | 0.28 | 0.779 | -8.732 | 11.648 |
| Rural Housing Service (RHS) | 0.263 | 5.119 | 0.05 | 0.959 | -9.771 | 10.296 |
| U.S. Forest Service (USFS) | 1.510 | 5.726 | 0.26 | 0.792 | -9.711 | 12.732 |
| | | | | | | |
| ConsistentwithChange | 0.393 | 0.480 | 0.82 | 0.413 | -0.548 | 1.333 |
| Agricultural Marketing Service (AMS) | 0.000 | . | . | . | . | . |
| Animal and Plant Health Inspection Service (APHIS) | 0.634 | 0.609 | 1.04 | 0.298 | -0.560 | 1.828 |
| Farm Service Agency (FSA) | -0.402 | 0.485 | -0.83 | 0.407 | -1.353 | 0.549 |
| Food Safety and Inspection Service (FSIS) | -0.479 | 0.588 | -0.81 | 0.415 | -1.631 | 0.674 |
| Food and Nutrition Service (FNS) | 0.116 | 0.747 | 0.16 | 0.876 | -1.348 | 1.580 |
| Foreign Agricultural Service (FAS) | 0.951 | 1.139 | 0.83 | 0.403 | -1.281 | 3.184 |
| Grain Inspection, Packers and Stockyards Administration (GIPSA) | -0.336 | 0.701 | -0.48 | 0.632 | -1.710 | 1.039 |
| Natural Resources Conservation Service (NRCS) | 0.691 | 0.660 | 1.05 | 0.295 | -0.602 | 1.984 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Risk Management Agency (RMA) | -0.509 | 0.556 | -0.91 | 0.360 | -1.599 | 0.581 | |
| Rural Business-Cooperative Service (RBS) | 1.213 | 0.779 | 1.56 | 0.119 | -0.314 | 2.740 | |
| Rural Housing Service (RHS) | 0.010 | 0.526 | 0.02 | 0.984 | -1.021 | 1.042 | |
| U.S. Forest Service (USFS) | -0.400 | 0.576 | -0.69 | 0.487 | -1.529 | 0.728 | |
| | 0.000 | . | . | . | . | . | |
| 2000b.Year | | | | | | | |
| 2001.Year | -0.287 | 0.138 | -2.08 | 0.038 | -0.558 | -0.017 | ** |
| 2002.Year | 0.234 | 0.172 | 1.36 | 0.173 | -0.103 | 0.570 | |
| 2003.Year | 0.107 | 0.155 | 0.69 | 0.490 | -0.197 | 0.412 | |
| 2004.Year | 0.226 | 0.188 | 1.21 | 0.227 | -0.141 | 0.594 | |
| 2005.Year | -0.006 | 0.165 | -0.03 | 0.973 | -0.329 | 0.318 | |
| 2006.Year | 0.041 | 0.177 | 0.23 | 0.818 | -0.306 | 0.387 | |
| 2007.Year | -0.012 | 0.211 | -0.06 | 0.956 | -0.425 | 0.402 | |
| 2008.Year | -0.311 | 0.229 | -1.35 | 0.176 | -0.760 | 0.139 | |
| 2009.Year | -0.226 | 0.252 | -0.90 | 0.370 | -0.720 | 0.268 | |
| 2010.Year | -0.498 | 0.258 | -1.93 | 0.054 | -1.004 | 0.008 | * |
| 2011.Year | -0.279 | 0.280 | -1.00 | 0.319 | -0.828 | 0.270 | |
| 2012.Year | -0.716 | 0.319 | -2.24 | 0.025 | -1.341 | -0.090 | ** |
| 2013.Year | -0.523 | 0.328 | -1.60 | 0.110 | -1.165 | 0.119 | |
| 2014.Year | -0.462 | 0.340 | -1.36 | 0.174 | -1.128 | 0.204 | |
| 2015.Year | -0.488 | 0.342 | -1.43 | 0.154 | -1.159 | 0.183 | |
| 2016.Year | -1.322 | 0.379 | -3.48 | 0.000 | -2.065 | -0.578 | *** |
| 2017.Year | -1.564 | 0.393 | -3.98 | 0.000 | -2.333 | -0.794 | *** |
| Constant | 22.571 | 52.227 | 0.43 | 0.666 | -79.793 | 124.935 | |
| Constant | 19.751 | 214.967 | .b | .b | -401.577 | 441.079 | |
| Constant | 19.106 | 214.967 | .b | .b | -402.222 | 440.434 | |

| | | | | |
|---|---|---|---|---|
| Mean dependent var | 15.712 | SD dependent var | 24.484 | |
| Number of obs | 215.000 | Chi-square | 2799.893 | |
| Prob > chi2 | 0.000 | Akaike crit. (AIC) | 1239.423 | |

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