Building a conceptual theory of anti-competition laws in public-private partnerships

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B.A., Kansas State University, 2017

A THESIS

Submitted in partial fulfillment of the requirements for the degree

MASTER OF ARTS

Department of Political Science

College of Arts and Sciences

KANSAS STATE UNIVERSITY

Manhattan, Kansas

2021

Approved by:

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Abstract

The growing economic presence of public-private partnerships in the market has led to an increased monopolization and subsequent reduction in competition in sectors such as infrastructure, utilities, and health services. Much of this can be contributed to the principal-agent problems that arise between the government and its constituents. Previous research has demonstrated the strain that anti-competitive practices place on the market, but little research on competition has been directed towards understanding how the active participation of public sector actors affect competition when in league with their private sector counterparts.

Using data from public-private infrastructure projects in the United States, a monte carlo test on public-private infrastructure expenditures, the data of which is then set into a cooperative game-theory to determine changes in the public actor's preferential outcome in the presence of increased risk. This quantitative analysis is then placed within a conceptual framework which demonstrates that many of the principal-agent problems can be overcome by the inclusion of anti-completion regulations.

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Chapter 1: Introduction and statement of problem

Introductory Statements

On a bitterly cold January day in 1900, the governor of New York state approached the lectern at the state house in Albany to give his second annual report to the assembled legislators. (Kearns, 2013) The governor standing before them was none other the future 26th president of the United States, Theodore Roosevelt, who, having risen meteorically thanks to his exploits in the Spanish-American War, was at the time, still formulating the trademark progressivism that would define his later presidential tenure. (Ibid) Thus, as Roosevelt began his remarks on January 3rd, 1900 it was telling one of the subjects of his speech would become defining for the man while still remaining relevant up to modern times. Wishing to burnish his reformer credos, Roosevelt was at beginning stages of formulating an intensely pointed opposition to the pro-business and laissez-faire mantra that has defined the United States since the end of the Civil War. (Ibid) "In our great cities there is plainly in evidence much wealth concentrated with much poverty and some of the wealth has been acquired or used in a manner for which there is no moral justification…wealth has been expended in multiplying and elaborating real comforts, or even pleasure which produce enjoyment at all proportionate to their costs will never excite serious indignation…We do not wish to destroy enterprise, we do not desire to destroy corporations; we do desire to put them fully at the service of the State and the people" (Ibid, 240). A century later, Theodore Roosevelt's words appear poignant once again. the U.S. government began a phased withdrawal from the world of in-house data maintenance. Instead, federal agencies would utilize third-party providers as a way of cutting an expected $20 billion in costs (Government Accountability and Transparency Board, 2011). Since the original announcement, Amazon Web Services (AWS) has vacuumed up government contracts relating to data management at an astonishing rate. One example is an AWS contract signed with the CIA for $600 million in 2013 (GOA, 2013). Another being the "JEDI" contract the pentagon was on the verge of signing with AWS worth $10 billion in 2020 (Burns 2020). However, as of late Amazon has found itself facing an increasingly hostile regulatory environment. Populist movements around the world are successfully lobbying national governments to act against anticompetitive business practices. Many political figures reckon that beating back the tentacular reach of Amazon provides the easiest way to appease them (European Commission, 2020).

Although such cases are currently rare, they are expected to increase in the near and long-term future (McLaughin 2021). The Biden administration has signaled that public-private partnerships are an important lynchpin of its operational strategy. In his "American Rescue Plan" for combatting CoVID-19, Biden establishes PPPs as the third leg of the recovery tripartite, proposing to: 1) "[Utilize] the DPA "to work with private industry to accelerate the making of materials needed to supply and administer the vaccine," having already purportedly "identified the suppliers who are prepared to work with our teams[.] 2) [Accelerate] efforts to make the vaccines available at local pharmacies and other retailers, an initiative endorsed by pharmacy executives and the National Association of Chain Drug Stores" (White House 2021). Thus answering critical questions about the how such public private partnerships should be treated in such situation quickly becomes a wicked problem. Although it could be argued that AWS and other PPP projects are simply a product bought by the government, other arrangements are not so cut and dry. Within the world of public governance, public private partnerships (PPP) are fast becoming a preferred vehicle for overcoming the twin issues of resource allocation and public return on investment. As PPPs have become increasingly prevalent complex questions both applied and conceptual have arisen regarding the line between the public and private sector. Interlaced within the fabric of PPPs are legal frameworks that serve to answer these questions using predictable and accountable methods. Such legal frameworks are inherently predicated on existing law and regulation. This leaves PPPs vulnerable to issues of unclear laws that could hurt the interest of both the public and private actor. A particularly grey area relating to PPP lies in the realm of anti-competitive behavior. This paper will seek to resolve this by proposing the application of a novel theory of anti-trust enforcement to public-private partnerships. Using a law and economics framework embedded in a grounded theory methodology, this paper will demonstrate that the public economic benefits create a legal scenario that necessitates the imposition of legal culpability for anti-trust actions.

Statement of problem

The transfer of federal executive authority has rarely been wholly amicable. However, recently there has been an increasingly worrisome trend of legislative and legal whiplash resulting from the incoming administrations bonanza of policy revocations aimed squarely at rolling back the work of the previous executive. In light of this there are ever decreasing areas of policy that remain stable. One of the rare examples of policy that tends to flow from one administration to another, however, is increasing hostility towards anti-competitive behavior (Antitrust institute 2020).

Figure 1

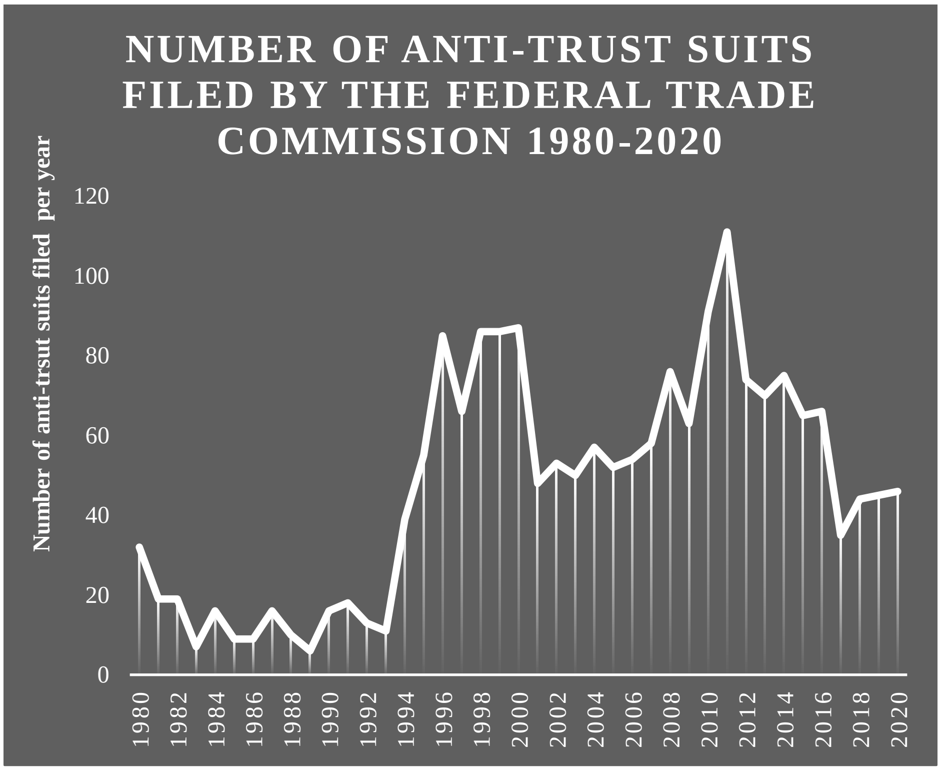
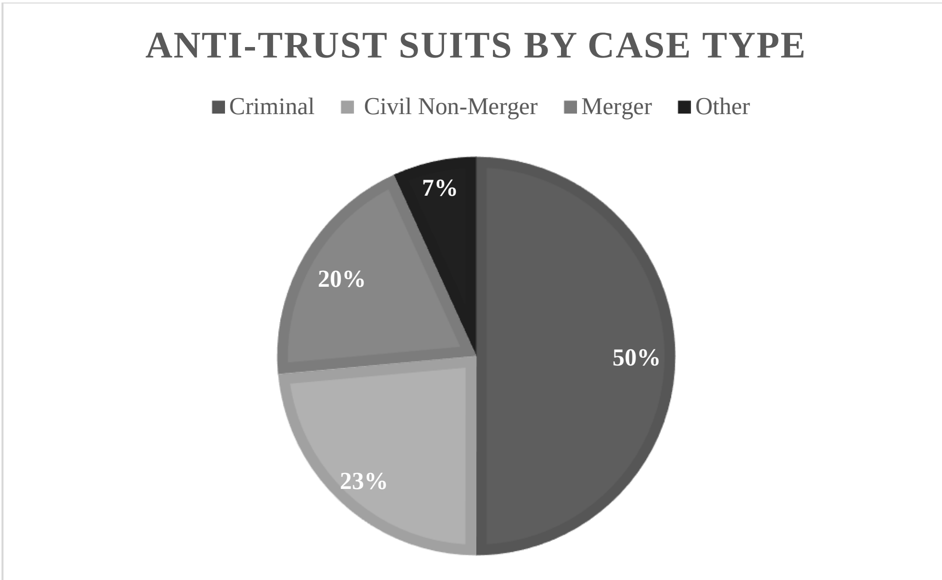


Figure 2



[1][2]

Figure 1 demonstrates that there has been an increasing number of anti-trust cases since 1980. Although there is an expected decrease in enforcement during Republican administrations (1981-1989; 2001-2009; and 2017-2021), there is still a noticeable increase over time. Figure 2 shows that criminal enforcement constitutes half of all enforcements, while merger and civil non-merger account for another 43%. The new presidential administration has already signaled it will continue enforcement, which is expected based on historical trends (Bloomberg 2021). As Reinhart (2021), explain:

"Conventional wisdom is that Republican administrations tend to enforce the U.S. antitrust laws somewhat less rigorously than Democratic administrations. That wisdom was contradicted in several ways by the Trump administration: Over the past four years, the Department of Justice (DOJ) Antitrust Division and the Federal Trade Commission (FTC) applied novel theories to increase scrutiny of vertical mergers or acquisitions of potential or nascent competitors,

[1] Data collected from https://www.justice.gov/atr/antitrust-case-filings
[2] See Appendix A. for full data

particularly in the technology sector. In doing so, they paved the way for continued aggressive enforcement by the Biden administration."

As explained by Wright and Portuese, much of the enforcement stems from an increase in protectionism as a result of an "Anti-trust populism" that taken hold across the United States (Wright). The current antitrust enforcement framework is built around three separate acts of the congress, these being the Sherman Antitrust Act of 1890 (15 U.S.C. §§ 1-38), The Clayton Act (15 U.S. Code § 12) of 1914, and The Federal Trade Commission Act of 1914 (15 U.S.C. 41 et seq.). With the core legal structure of anti-trust enforcement now over a century old there exists a large gap in substance and application that has required the implementation of a patchwork of law and regulation (McGinnis; Lamb). These issues in turn lead to the core issue of this paper, which is that there exists a principal-agent problem in the context of the public-private partnership. Principal agent theory posits that there are natural inefficiencies that exist as a result of the principal/agent hierarchy. Because the government is acting in as the agent of the larger citizenry, we can expect that issues of agency will arise. Namely issues of efficiency and outcome. This paper proposes that the introduction of anti-competition laws to public-private partnerships will create more room efficiency and help to solve some of the principal-agent problems that may arise. In order to accomplish this, the paper will conduct a literature review and prepare a conceptual framework for understanding the role of antitrust enforcement in PPPs. This paper will also use a quantitative monte carlo test to determine whether the imposition of anti-competition laws creates more efficiency in a PPP. What we are expected to see from the experiment is that efficiency will increase as the administrative costs of compliance increase. If this hypothesis is correct it will lend support to the conceptual anti-competition framework.

Research Question

The research questions for this paper are as follows:

***Q**$_1$*: Are public organizations in a PPP liable for anti-competitive behavior based on the behavior of their private counterparts?

***Q**$_2$*: Is it legal for public organizations to enter into public-private organizations if they risk being called into public suit? i.e. can the government enter into an agreement that could potentially create uncompetitive behavior and therefore be against the public good?

Objectives:

The long-term goal of the research is to develop a formal theory justification for the liability of government actors in anti-trust suits. The objective of the current study is to review the literature and legal status of public sector anti-trust vulnerability and make an affirmative case for the application of anti-trust laws to public sector organizations. The study will seek to provide a review of the scholarship and law pertaining to this public sector anti-trust applicability, develop an affirmative public economics justification for the theory, and develop a public theory justification for anti-trust application.

Chapter 2: Literature Review

Introduction

There is a large amount of literature that stretches over multiple disciplines which pertains to this paper's topic. It is therefore important to provide an overview of the major themes that this literature review will cover. For the purpose of clarity, this review will start with the broadest and most conceptual themes to then proceed to the more specific topics. First this review will cover the role and importance of the political economics field and how it sets the stage for the study of public-private partnerships. The review then discusses the specific economics of PPPs. Finally, the review will discuss the relevant literature within political economics that pertains solely to anti-competition enforcement in PPPs

Political Economy and the PPP

The term “political economy” is tricky to define, as it straddles a fine line between economic mathematics and the larger social and policy implications that stem from political science, public administration, and sociology (Caporaso, 1992). Further muddying the waters is the fact that prior to the late 19th century the fields of economics and political economy were considered one in the same. It was not until the application of formally rigorous methods that the two respective fields began to develop their own independent identities (Ibid). It is therefore important to have a strict definition of political economy in place that establishes the field independently and without concern for overlap into the field of pure economics. The first generations of modern economics thinkers paid no heed to the idea that political, social, and economics concerns could or should be isolated from one another (Marcuzzo, 2020). These first scholars made explicit overtures in their works aimed at drawing an overarching theme that covered what they considered to be intimately interwoven aspects of society. Each field, they believed, could be divorced from each other only at the risk of creating siloed realms of through that limited the ultimate benefit to society (Ibid). Political economy is one of the fundamental subjects that has faced inquiry since ancient times. However, as a dedicated field of intellectual study political economy is fairly new, the pioneers of the field being such famous thinkers as Adam Smith, David Hume, and François Quesnay (Ibid). Stemming from a general revulsion to the dominant economic system of mercantilism, these early proponents of political economy emphasized the secular nature of economics and its subsequent role as an independent arbiter of the wide market. Additionally, these proponents also went to pains to emphasize the role of the individual as a mechanism in the functioning of their new economic model. By introducing the role of the individual, the early economists were tapping into the enlightenment ideal of individual liberty that had been developed by Thomas Hobbes, John Locke, and other political philosophers of the era (Vinnicombe, 2002). Thus from the beginning there was an underlying theme of political liberty and societal concern undergirding the nascent field of economics. As the field developed, politics and the economy continued to be considered operably dependent on each other. David Ricardo and Jeremy Bentham brought emphasis away from the individual and place the economic burden on the larger society by emphasizing the power of utilitarian distributions in creating economic efficiency. Karl Marx brought the mixing of society and economics to its zenith by emphasizing the power of class struggle and economic liberation against the entrenched societal forces that prohibited larger societal progress.

Public Economics and PPP. Following a high period of political economic scholarship, the field was gradually formalized (Tétreault. 2003). As a result many scholars felt that the field had grown too expansive and methodologically diverse to exist as a single entity. Thus there was a general split of the field into what is known today as economics, political science, and sociology. These fields remain independent in the modern era, but increasingly rely on each other in interdisciplinary studies (Ibid). Thus definitions of political economy are highly dependent on the subject expertise of the particular scholar making the definition. As with many fields, the most popular definitions come from established "schools" of thought that jostle for preeminence. The view taught as standard in most university courses is known as the "neoclassical" view, something Kuhn (1970) refers to as the "textbook approach." Foley (2006) writes that just as Newtonian physics as become simply "physics," so neoclassical political economy is now just "economy." In his seminal paper The Political Economy of Benefits and Costs: A Neoclassical

Approach to Distributive Politics, Weingast (1981) uses neoclassical thought to show "how political institutions transform the economic basis of costs and benefits into political costs and benefits. The latter, and not their economic counterparts, define rational decisions for political actors." Neoclassical political economy focuses on the liberal tradition of economic thought, reasoning that reasonably independent markets will result in a distribution of capital and labor that allows for the most positive benefits of society (Rosen, 1997).

In opposition to the neoclassical line of thought is the Marxist school of political economy. Marxist scholars believe that the focus should lay not on the axis of production/capital but instead on what is collectively known as the "labor theory of value," (LVT) or what Marx refers to as the "law of value" (McNally, 1993). LTV holds that the value of production lies in the average societal time needed to produce an item. In a capital-based society there is a mismatch between the amount of value produced by the average worker and the amount of value received by the beneficiary of the workers produced value, who would be the capitalist (Ibid). While the Marxist and neoclassical schools dominated the field of political economy during the 20th century, recent scholarship has sought to bridge the gap between the two schools of thought while incorporating new methods and scholarships (Besley, 2007; Gamble, 1995). This approach is now known as New Political Economy (NPE) (Gamble, 1995). At its core, NPE seeks to solve inherent issues of endogeneity in the classical schools of political economic thought by integrating formal interdisciplinary social science and economic methods while still maintaining an adherence to applied policy and societal outcomes (Besley, 2007). A key concept within NPE is the application of public choice theory (PCT) (Congelton, 2018). First developed into a theory by Buchanan and Tullock in their book *The Calculus of Consent* (1962), public choice theory seeks to answer questions of politics, behavior, and public practice through the application of economic methods. Specifically, the book separated of the creation of constitutional voting systems and the implementation of government under the constitutional framework (Ibid). In doing so, Buchanan and Tullock sought to deemphasize the failure of the market while bringing focus instead to failures as a result of government limitations (Buchanan, 1962). Doing so required a reassignment of responsibility to the individual rather than the collective society, thus positing that the constituent aspects of political systems are individual decisions that inform a collective movement (Kim, 2020). This focus on the real-world public theory came to be known as the "Virginia" school of public choice theory. In 1962, William H. Riker, operating under the formalist paradigm known as the "Rochester" school of public choice, demonstrated that by using public choice theory combined with game theory it was possible to determine with more certainty the results of bargaining versus persuasion.

Economics of PPP's

The economics of public-private partnerships provides a rich seam of academic literature. The literature predominantly focuses on three main areas, these being 1) Bundling and risk transfer; 2) Private finance; 3) contracting. These three areas are closely linked together and often overlap when studied. Kwak et al. (2009) finds that private partners can share or shift risks and get access to public projects through the sharing of projects with the public sector. The public sector in turn gains access to capital, expertise, and cost saving mechanisms (Pinz et al., 2018). However, unique hurdles are raised in the partnership process. These hurdles can be minimized by risk sharing through proper contract construction. Contracting is critical for the success of a PPP. As Engel (2013) explains:

“The main characteristic of a PPP, compared with conventional provision, is that it bundles investment and service provision in a single long-term contract. For the duration of the contract, which typically lasts several decades, the concessionaire manages and controls the assets, usually in exchange for user fees and government transfers, which compensate for investment and other costs.”

Rybnicek (2020) found that there are three main risks that arise from PPP contracting. These risks include negotiation, incompleteness, and contractual design. The consensus within the literature is that each risk should be itemized and then allocated according whichever party can best manage it. Irwin (2007) goes further by stating that “each risk should be allocated to maximize project value, taking account of moral hazard, adverse selection, and risk-bearing preferences.” The study of bundling and risk transfer is divided into two areas of thought. The first of which focuses on the role of property rights and asset ownership. Hart (2003) proposes a model where ownership is the only incentive. Hart envisions two kinds of investment (productive and unproductive) which may both reduce costs, but only the productive investment raises also benefits. Under traditional procurement, the builder cannot internalize the impact of his effort neither on benefits nor on costs (Iossa, 2012). He implements too little of the productive investment but the right amount of the unproductive one. Under PPP, the builder somewhat internalizes the impact of his productive investment whereas he also exerts too much of the unproductive one (Ibid). Under PPP, the builder somewhat internalizes the impact of his productive investment whereas he also exerts too much of the unproductive one. Francesconi (2011) and King (2001) considered the case of impure public goods and showed that shared authority can be optimal when the parties' investments are comparable. Bennett (2006) studied the desirability of bundling project phases and of giving ownership to the investor. Innovations are noncontractible ex ante but verifiable ex post. Ownership gives control right to the owner to decide whether to implement quality enhancing or cost-reducing innovations proposed by the investor. The hold-up problem is less severe under PPP, compared with traditional procurement, when there is a positive externality between the building and managing stages, and vice versa when the externality is negative. Public ownership acts as a commitment for the government to renegotiate and share with the investor the surplus from implementing the innovation. Private ownership is nevertheless optimal for generic facilities with high residual value. Chen (2010) extend Bennett and Iossa (2006) to the case of interdependent tasks and show that complementarity between tasks favors unbundling.

An important distinction in the literature is delineating what is a partnership and what is not. One such example is general contracting versus public-private partnership participation. In the former, the government acts as the consumer of the good produced as a representative agent of the public at large. In this scenario the private sector bids and competes to provide the public good in an open marketplace. In a PPP, the public and private sectors act in partnership in order to provide the public good. While a PPP relationship will maintain aspects of a contractual relationship such as the initial creation of the contract, the maintenance of pre- and post-award negotiations, etc., the public sector exhibits a much higher investment in the success of the PPP given the greater inlay of effort and resources (Cooper, 2003). In the same vein is the distinction between PPP's and privatization. A privatized organization is one in which the public sector divests wholesale from a previously public operation, thus forfeiting any returns beyond the proceeds from the sale or retaining a minimum stake through stock ownership. This removes the public actor from the competitive market and confines it to a regulatory role (Megginson, 2001).

That public administration is critical to the success of a PPP project is undeniable is a well-established fact. It takes a competent and dedicated public sector to build and maintain the contractual frameworks that constrain and guide the private actor towards creating a surplus public good. According to Grimsey and Lewis “PPPs reflect a unique relationship between the government and a private firm. While the government retains ultimate responsibility for the delivery of the good or service, it becomes a partner with the private sector in decision making and delivery” (Grimsey, 2004).

The literature expounding the role of the public sector in PPP’s tends to focus on cost-benefit analysis and accountability. Cost is a primary reason that the public sector enters into an agreement with a private actor. Government actors are by nature constrained in matters of budget. Being explicitly not-for-profit, the public sector has few avenues for raising revenue beyond taxation. Thus expense is by proxy passed onto the consumer of the public good, the citizen. Engaging a private actor allows the public sector to retain a majority of the benefit while doling out the risk. In return the private actor receives a portion of the goods produced. It therefore falls on the public administration to ensure that the cost-benefit ratio remains positive for the public sector. This is accomplished through the institution of accountability measures that fall upon both the private and public organization. To ensure public accountability, Goldsmith and Eggers (2004) propose four interconnected paradigms, these being 1) properly aligning the incentives; 2) routinely measuring performance; 3) building trust in the network; 4) and appropriately sharing risk. Forrer et al. (2010) propose six dimensions of accountability. These being 1) risk; 2) costs and benefits; 3) social and political impact; 4) expertise; 5) partnership collaboration; 6) and performance measurement.

Bundling is a complicated term simply because its definition changes in both inter- and intra-field. For the purposes of this paper there are two different fields that need to be reconciled. These being economics and public management. The economic definition is rooted in the subfield of organizational economics. According to Scott (2015), “Organizational economics is the application of economic logic and methods to understand the nature, design and performance of organizations, especially managed ones like business firms.” The study of organizational bundling is built on the foundations laid by Coase in his article *The Nature of the Firm* (1937). In the article, Coase poses the question of how large a company could feasibly grow to. His research ultimately found that firm size is correlated with higher efficiency but ultimately decreasing gains. This is because larger companies can better absorb the transaction costs associated with businesses. However a business cannot grow indefinitely because overhead costs inflate correspondingly, thus serving as an ever-larger drag until finally the company cannot operate efficiently. Thus individuals will move towards the formation of business partnerships and companies of larger scale, but growth will become more difficult as time goes on. Since that time organizational theory has focused on the three main areas of transaction costs theory (TCE), agent theory, and contract theory. TCE is a theory of how business transactions are structured in challenging decision environments. TCE is chiefly concerned with transactions that are complex in that they are recurring, subject to uncertainty, and involve commitments that are difficult to reverse without significant economic loss (Williamson, 1975; Williamson, 1985) TCE can be broken down along three separate axis, these being 1) theory of the firm; 2) theory of management; 3) theory of governance.

In 2012, the Organization for Economic Co-operation and Development (OECD) released a policy document called *Recommendation of the Council on Principles for Public*

Governance of Public-Private Partnerships. The document outlined twelve steps that developed nations should take to capitalize on the growth of public-private partnerships. There is a particular focus on the encouragement of competition. Recommendation 9 states the following: “Government should ensure there is sufficient competition in the market by a competitive tender process and by possibly structuring the Public-Private Partnerships program so that there is an ongoing functional market. Where market operators are few, governments should ensure a level playing field in the tendering process so that non-incumbent operators can enter the market” (OECD, 2012).

Review of the law

The current legal basis for PPP’s began with Parker v. Brown (1943). In Parker, SCOTUS debated whether the establishment of a proration board by the state of California for the purposes of stabilizing the sale of raisins was a violation of the Sherman Act. Specifically, the plaintiff argued that the states action had created an undue burden on his ability to participate in interstate commerce and thus was due compensation for damages. Having to weigh whether a state could be held liable for actions that violated the Sherman Act, the court found that the act was not intended to be applicable to individual states. Thus using the doctrine of legislative intent, the court formulated what became known as the Parker immunity doctrine, which held that as long states were exercising sovereign power they were immune to accusations of anti-competitive behavior. Here the court made an important distinction between the state exercising power as a sovereign versus “state action.” While the former is protected under the conditions of federalism and a desire to maintain the balance of power, violations in the latter camp fail to pass the muster. The test to differentiate between sovereignty and state action, laid out in California Retail Liquor Dealers Ass'n v. Midcal Aluminum, Inc., (1980) relies on a two-part analysis:

1) The challenged restraint must be one clearly articulated and affirmatively expressed as state policy;
2) The policy must be actively supervised by the State itself.

After Parker and Midcal, the law dictating the relationship between states and anti-competitive behavior continued to evolve. In Hallie v. Eau Claire (1985) the court held that actions by the state of Wisconsin to displace the competitive market in the name of regulation were protected under the state action doctrine as they were pursuant to the intended purpose of the original legislation. Additionally, the court held that municipalities can claim the same protections based on the argument that a municipality must conform to state law under the principle of preemption and therefore there is little risk of a municipality breaching antitrust statutes.

The most recent iteration of the Parker doctrine is found in Federal Trade Commission v. Phoebe Putney Health System, Inc. (2013). In 1941 Dougherty county, Georgia and the city of Albany established the Hospital Authority of Albany-Dougherty County. The group ran Phoebe Putney Memorial Hospital until 1990, after which it was leased to the private corporation Phoebe Putney Health System. In 2010 the Hospital Authority of Albany-Dougherty County began acquisition of another hospital, Palmyra, on behalf of Phoebe Putney Health System. Under the agreement the public group would buy the hospital using funds from the private group and subsequently lease back the hospital to the private group for $1 annually. In April 2011 the FTC moved to block the merger transaction. The court upheld the striking of the merger for two reasons. Firstly, the state's authority used to justify the merger was not expressly laid out "to act or regulate uncompetitively" and thus was insufficient for state-action immunity. Secondly, any anti-competitive behavior on the part of the state must be a logical, coherent, and ordinary expression of the relied upon statute (Ibid).

Finally, the federal government has practical mandate to pursue anti-competition charges in four scenarios. The first of these is any violation of the Sherman Act or the Clayton act. The second is a breach under the Administrative Procedures Act. The third is if any state feels they or their citizens have been harmed through anti-competitive practices they may bring suit under the Antitrust Improvement Act of 1976. Lastly, a private citizen may bring suit under the Sherman or Clayton acts.

Criminal v. Tort enforcement

A critical distinction to make is between criminal and tortious actions. As a primer, tortious activity occurs when a private party acts in a way that injurious or depriving to another private party in manner that merits remedy by the courts. Criminal activity on the other hand is the violation of statutes or laws established by the government. In summary, tort law concerns itself with private versus private party, while criminal deals with private versus public. From here there are a myriad of different combinations of tort and criminal actions. For example, a private party can institute a tort action against the federal government, or the federal government can bring suit against a state for non-compliance. When this is considered, enforcement against anti-competitive behavior became even more complicated. There is a good reason why the U.S. Department of Justice Antitrust Division maintains two offices, one for civil enforcement and another for criminal. Clarifying this distinction is important for this papers model. Within the model, should a public actor be held responsible or both criminal and tortious actions? To answer this requires analysis of both state and federal law. At the broadest level, state and federal government is protected under the 11^{th} amendment, which states:

“The Judicial power of the United States shall not be construed to extend to any suit in law or equity, commenced or prosecuted against one of the United States by Citizens of another State, or by Citizens or Subjects of any Foreign State.”

Since its inception in March of 1794, the 11^{th} amendment has been interpreted to be restrictive. Hans v. Louisiana (1890) extended the protection of the 11^{th} amendment to the states. However, the Congress and state legislatures have acted to waive immunity in certain circumstances. In 1948 the Congress passed the Federal Tort Claims Act (28 U.S.C.§2674), or FTCA. The law states that :

“The United States shall be liable, respecting the provisions of this title relating to tort claims, in the same manner and to the same extent as a private individual under like circumstances, but shall not be liable for interest prior to judgment or for punitive damages….With respect to any claim to which this section applies, the Tennessee Valley Authority shall be entitled to assert any defense which otherwise would have been available to the employee based upon judicial or legislative immunity, which otherwise would have been available to the employee of the Tennessee Valley Authority whose act or omission gave rise to the claim as well as any other defenses to which the Tennessee Valley Authority is entitled under this chapter.”

The context is important, given that the Tennessee Valley Authority was a large public works project with a large amount of private interaction.

States have also acted to impose constrains on sovereign immunity. Most states have passed some manner of tort claims act (TCA) modeled after the FTCA. Because anti-competition enforcement mainly lies in the jurisdiction of the federal government, this paper will focus on the ability of the federal government to enforce against its own PPP’s and those of the states.

Current legal scholarship on public good compliance

Within American jurisprudence there is no explicitly stated duty of care that the government owes to its citizens (Crowell, 2003) This stems from a widely held belief that accountability flows from the ballot box and thus an attempt to elucidate a principal of accountability beyond the confines of an election would risk moving the locus of control to the courts and away from the citizens. However, while there may not be an explicit statutory basis for a duty of care, there are laws on the periphery of the question that could serve as a basis for a duty of care argument. These include laws on ethics, business compliance, and tort law (McMillan, 1987).

Chapter 3: Development of anti-trust conceptual framework: Agency problems in a PPP

Introduction

The construction of the characteristics of anti-trust enforcement in the PPP have been established by the review of the literature and law on PPP through the lens of agency theory. This chapter will lay out the conceptual foundations that underline this papers proposed theory. First we will lay out important definitions that delineate the theoretical boundaries. Secondly we will establish that a principal-agent relationship exists between citizen and government. Thirdly we will review the problems that may arise as a result of this relationship. Finally we will conclude by laying out the conceptual theory in its entirety.

Definitions

Defining public private partnerships is critical for this paper. The reason for this being that this papers conceptual framework is based on the magnitude of cooperation between public and private. Therefore an objective definition is required in order to ensure an objective bright line beyond which a PPP can be held liable. However, defining the term is not simple. As Linder points out

"The points of reference defining the binary separation of public from private, in welfare economics and liberal political doctrine alike, have been confounded by complex, variegated views of multiple sectors, including civil, intimate, and dialogical realms, anchored to distinctive notions of social relations and political order. Use of the terms, public and private, now suggests any of a variety of social differentiations…" (Linder 39).

From here there are two diverging paths that could be used to define PPP. We could either hew to a predefined definition or strike out to carve out a novel definition uniquely defined to meet the needs of the conceptual framework. This paper will adhere to a predetermined definition for two reasons. Firstly, crafting a new definition would require a deeply involved ontological analysis regarding the relationship of the fundamental terms. Doing so is beyond the scope of this paper, especially in light of the rich academic literature that already exists. This paper will utilize the definition of PPP provided by Brinkenhoff. This definition is built on the twin fundamentals of mutuality and organizational identity. As they explain,

"mutuality refers to mutual dependence, and entails the respective rights and responsibilities of each actor vis-a-vis the others. Embedded in mutuality is a joint commitment to the partnership's goals, and their alignment to be consistent with each partner organization's mission and objectives. Mutuality also means some degree of equality in decision-making, as opposed to domination of one or more partners. All partners have an opportunity to influence their shared goals, processes, outcomes, and evaluation" (Brinkenhoff, 2011).

Further, organizational identity

“captures the distinctive competence and capabilities of the individual partner organizations. Organization identity can be examined at two levels. First, an individual organization has its own mission, values, and identified constituencies to which it is accountable and responsive…Second, from a broader institutional view, organization identity also refers to the maintenance of characteristics—particularly comparative advantages—reflective of the sector or organizational type from which the partner organization originates” (Ibid).

To Berkenhoff, a fully realized PPP will exhibit jointly determined goals, collaborative and consensus-based decision making, non-hierarchical and horizontal structures and processes. trust-based and informal as well as formalized relationships, synergistic interactions among partners, and shared accountability for outcomes and results (Ibid)

Non-competitive behavior must also be defined for the same reasons as PPP’s. Non-competitive behavior can be an ambiguous term and thus neglecting to define it would risk weakening the results of the paper. This paper will utilize the current U.S. government framework used to define anti-competitive behavior. This is beneficial in that it provides an established legal basis on which to build the argument. In doing so this paper avoids a potential *prima facia* issue that would render further studies on the subject moot. This issue being that any deviation from the already established definition would immediately fail to pass muster in any applied setting. The U.S. government bases its framework on three interconnected statutes. These being the Federal Trade Commission Act, the Sherman Act, and the Clayton Act. The prevailing course of action taken by the government is to enforce under 15 USC. Chapter 2 Sec. 45 subsection (n) standard of proof: public policy considerations:

“The Commission shall have no authority under this section or section 57a of this title to declare unlawful an act or practice on the grounds that such act or practice is unfair unless the act or practice causes or is likely to cause substantial injury to consumers which is not reasonably avoidable by consumers themselves and not outweighed by countervailing benefits to consumers or to competition. In determining whether an act or practice is unfair, the Commission may consider established public policies as evidence to be considered with all other evidence. Such public policy considerations may not serve as a primary basis for such determination."

Establishing the principal-agent relationship between the government and the citizen

The relationship between the citizen and government is a fundamental question of political philosophy. Even in ancient Greece, Plato centered virtually the entire *Republic* around establishing the role of the citizen and the state. As such, wading into an argument that has bedeviled political thinkers for millennia is beyond the scope of this paper. However, there is a rich seam of literature making the argument for the role of government and citizen.

The distribution of power is an underlying principle in the American constitution. The source of sovereignty was a commonly argued topic in enlightenment thought. Although thinkers such as Hobbes, Locke, Rousseau, and Mills proposed varying sources from which power was to flow, the essential aspect was that power did in fact flow from a specific source. In determining the role of power, the framers fell into two camps, one favoring a Millian utilitarian approach to power, and the other a more Lockean view based on natural rights (Hill, 2018; Doernberg, 1985). Mills understanding of liberty is based on the premise that interference by one person upon another person's liberty can solely be considered appropriate if there is threat to the former persons physical integrity. For Mills, utility is the goal. This contrasts with Locke, for whom rights are not progressive but instead based on the natural and fundamental rights that are inherent to every person and have been since the beginning of humankind. However, the ultimate goal of both Mills and Locke is the protection of the fundamental interest of the individual to their property and physical integrity (Crocker, 1985).

First it is important to establish the relationship between Mills views on liberty and utilitarianism. The first thing Mills does is to establish the individual as prime in the hierarchy (Brink, 2007). Additionally, Mills immediately establishes liberty as a priori. “No society in which…liberties are not, on the whole, respected, is free, whatever may be its form of government; and none is completely free in which they do not exist absolute and unqualified. The only freedom which deserves the name, is that of pursuing our own good in our own way, so long as we do not attempt to deprive others of theirs, or impede their efforts to obtain it. Each is the proper guardian of his own health, whether bodily, or mental and spiritual. Mankind are greater gainers by suffering each other to live as seems good to themselves, than by compelling each to live as seems good to the rest.” (Mills, 23) He does this for two reasons. The first is that individual rights exist independent of governments or social structures. Secondly, the role of governments is serving as the guardians of these rights. Therefore, by claiming liberty is a priori he liberates the individual from being subservient to the state (Brink, 2007). When this occurs the government is reduced to a tool for maximizing liberty. Thus like any tool, Mills argues that it should be used to the greatest extent possible. Mills additionally notes that individual rights are threatened continually by illiberal monarchs and aristocracies and thus treats them with circumspect skepticism. “But, without dwelling upon supposititious cases, there are, in our own day, gross usurpations upon the liberty of private life actually practiced, and still greater ones threatened with some expectation of success, and opinions proposed which assert an unlimited right in the public not only to prohibit by law everything which it thinks wrong, but in order to get at what it thinks wrong, to prohibit any number of things which it admits to be innocent”

(Mills, 167). Liberty in itself is an extension of the value of the individual and the individual is at the top of the hierarchy of concern.

Locke proposes a different paradigm for interpreting the origin of liberty. For Locke, rights do not exist as a tool for maximizing the freedom of the individual but rather stem from the existence of inalienable natural law that has existed for all time and will continue to exist as long as humanity persists. The first distinction that needs to be made is Locke carves out a special place for Christian revelation in his theory (Wardle, 2002). For Locke it was no issue that natural law could be discovered outside of divine inspiration. This could be an issue because it is axiomatic that natural law be discoverable by reason alone. Instead, he creates a justification by arguing that natural law is discoverable if and when the nature of divinity is also discoverable. To Locke natural law and God co-exist (Ibid). This contrasts with Mills utilitarianism because his theory holds no place for divine revelation (Carr, 1962). The theory that Mills posits instead is that liberty is an affirmative development stemming from human faculties.

The second distinction that needs to be made is where the natural rights stem from. Locke builds his argument from the concept of the state of nature. For Locke, the state of nature is governed by natural law and humanity exists in a permanent state of individual equality (Stanton, 2011). "A state also of equality, wherein all the power and jurisdiction is reciprocal, no one having more than another; there being nothing more evident, than that creatures of the same species and rank, promiscuously born to all the same advantages of nature, and the use of the same faculties, should also be equal one amongst another without subordination or subjection, unless the lord and master of them all should, by any manifest declaration of his will, set one above another, and confer on him, by an evident and clear appointment, an undoubted right to dominion and sovereignty." (Locke, Sect. 4) Because they are constrained only by the law of nature, which itself allows only for individuals to take actions against another if the latter has harmed the former (Stanton, 2011). Thus to Locke natural law is the base and ideal to strive for. Mills does not base his argument for liberty on a state of nature. Instead, Mills bases his argument on a sense of natural observation. Man develops a sense of liberty over time through the development and destruction of governments and societies. Humans learn what works and what does not work and create the laws and structures needed to protect their individual interest. In this way humans express a desire to create the most utility out of their governments (Dunn, 1968).

Ultimately, the Lockean sense of natural rights won out and with it the belief that government sovereignty stems from the natural conditions of the individual. Since that time it has been axiomatic within American governance that the government is ultimately subordinate to the wishes of the American public. One can see this in the language used to describe the government. For example, to call a government employee a public servant is not considered derogatory, but simply a descriptor of the position. Thus, through an understanding of the political philosophy behind the subordination of the state to the citizen we have established a critical component of a this conceptual framework.

Agency theory framework

At its most basic level, agency theory seeks to understand and resolve issues that result from the existence of an owner-manager hierarchy. (Wasserman, 2006) Namely issues in communication, control, and liability. Agency theory came about as a response a response to the principal-agent problem, which has bedeviled the economics field since the time of Adam Smith.

The principal-agent problem occurs when a disconnect between owners and managers could lead the managers to not work in the best interest of their employers. More broadly, the principal-agent problem can be applied to any relationship between a primary stakeholder and the agent assigned to represent their interests. Berle and Means (1932) confirmed this issue when they analyzed large companies in the middle of the Great Depression. In the 1970s Ross (1973) and Mitnick (1975) proposed in two separate papers how to answer the issue of agency. Ross proposed that the agency problem arose due to a lack of incentives, while Mitnick pointed a finger at the broader picture by placing the impetus on institutional constraints. Jenson and Meckling in *Theory of the firm: Managerial behavior, agency costs and ownership structure* (1976) framed agency theory in the context of contracts between the principal and the agent. Because the relationship is solely contractual there is incentive for the agent to perform the bare minimum necessary under the contract thereby not always acting in the full interest of the primary.

Thus in public-private partnerships there is the potential for the rise agency problems between the government and the public. This is because when the government enters an agreement with a private company, they are becoming partners to varying degrees. Thus by proxy the citizen is also becoming a party to the partnership. Because the government agency is entering on behalf of the citizen as a whole, it the government is now acting as the agent and the citizen is now the primary. It therefore becomes imperative that the government act on the best interest of the primary, which is the citizen. Here we see potential agency problems in that the government may not act in the full interest of the primary. One way of doing so is the imposition of anti-competition laws. Panda (2017) summarized the basic categories that agency problems tend to fall into. These are 1) Separation of ownership from control; 2) Risk Preference; 3) Duration of involvement; 4) Limited earnings; 5) Decision making; 6) Information asymmetry; 7) Moral hazard; 8) Retention of earnings.

Separation of ownership from control

Separation of ownership from control was one of first agency issues identified by Jenson and Meckling (1976). Agency issues arise when the owner separates themselves from the role of manager. Fama and Jenson (1983) frame this as a separation of decision management from decision control. When the owner devolves power to a manager, this is a decrease in the consequences from poor decisions. Although the owner may remove the manager for these poor decisions, ultimately the owner's interests are most harmed. Mechanisms for controlling the issue of owner-manager separation range from internal mechanisms such as installing a board of directors, to external mechanisms such as government intervention and 3rd party monitoring (He, 2010). From a business perspective, separation of ownership most often concerns itself with the shareholder-manager relationship. Here we can draw some useful parallels between the separation of ownership from control in the public and private spheres. In a private firm, the principal has ultimate say over the organizational decisions and in turn has claim to any profit that might accrue. However, in a company owned by public shareholders the aspects of management and profit-claiming are divorced. This can be contributed to the inefficiencies that come about as a result of the inability of large groups to coordinate a consensus and the legal limitations placed on shareholders to manage the company. As such the role of principal and agent in public corporations is often centralized into top-level management. Additionally, the one mechanism of control available to shareholders is often less effective at reducing agency problems because voting is organized and results distributed via management channels, thus allowing top level management to indirectly influence shareholder voting outcomes.

While there are agency costs that arise from the separation of ownership and control, there are clear benefits to the structure that are strong enough bring about a general acceptance of the structuring in spite of the potential agency costs (Marks, 1999). The first of these benefits is that the introduction of a hierarchy of control has the potential to reduce transaction costs and improve marketability (Williamson, 1979). Secondly, a hierarchical approach greatly expands the availability and benefits of economies of scale. A single manager/owner is temporally and physically limited in their ability to run and grow a business. However, a corporation can harness the power of numbers to an almost exponential degree, being only limited by ballooning overhead costs and limited market space (Arrow, 1974). Lastly, the introduction of multiple shareholders allow an increasing level of mitigation by spreading the risk of investment over ever-larger numbers of owners. Thus separation of ownership from control allowed for investors that were not active in the company but still took on a portion of the risk of the company. Such behavior allows for corporations to ultimately take on more risk than would be allowed under a single owner/manager which increases the overall gain for the shareholders and the economy at large (Pitelis, 1986).

Risk Preference and duration of involvement

Risk preference is the tendency of managers to take on more or less risk than the principal desires. This is mainly a problem of communication in that the manager has less incentive to communicate the amount of risk taken on if they know that the principal has differing risk tolerance and thus will not conform with what the agent perceives as the best interest of the organization (Gormely, 2016). Duration of involvement concerns itself with the timeframe under which the manager operates. For example, a manager who does not intend to stay with the principal for an extended period of time might have less incentive to operate in the best interest of the principal since there will be less time for negative repercussions to come into play. On the other hand, an agent with a long timeframe might be inclined to seek a better outcome for the principal since the agent's investment in resources such as time and energy are higher (Panda, 2017).

Limited earnings and retention of earnings

Limited earnings and retention of earnings are categorically similar in that they both concern themselves with earning management. Earning management in the context of agency theory means the difference between how the principal desires organizational earnings to be handled, and the principal actually operates with the organizational earnings. An example of this is explained by Davidson, et al. (2004):

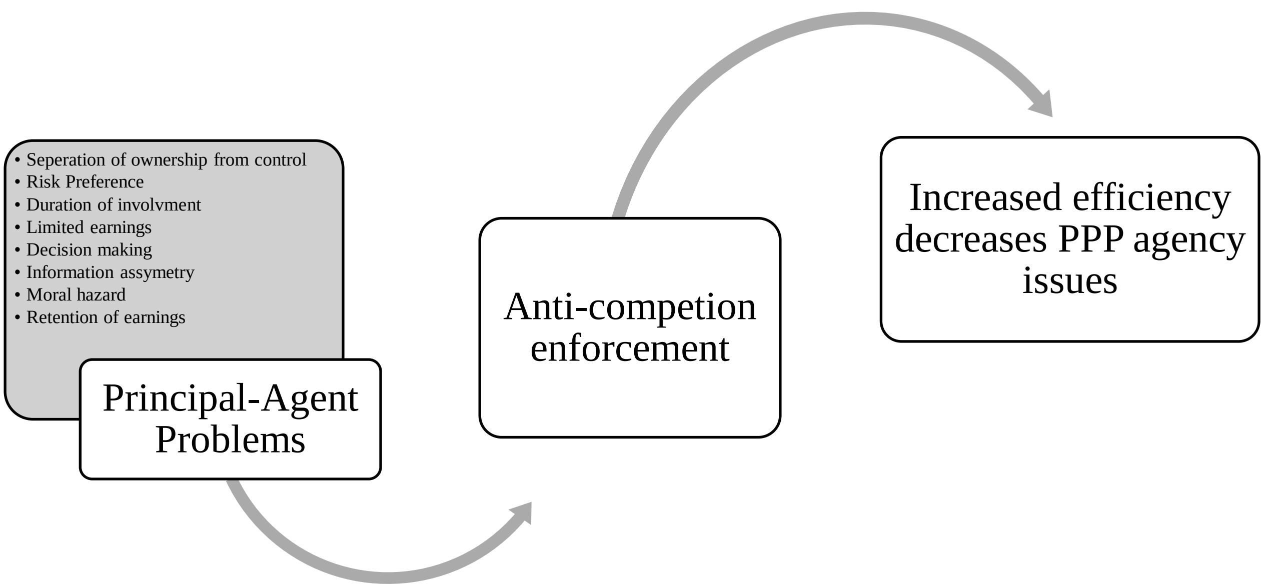
"Earnings management may be a type of agency cost if managers release financial reports that do not present an accurate economic picture of a firm and shareholders make nonoptimal invest ment decisions as a result. Thus, earnings management is related to agency theory because the former can create or exacerbate agency costs."

Decision making, information asymmetry, and moral hazard

Decision making and information asymmetry also can be paired categorically. Decision making issues and information asymmetry lie at the heart of the principal agent problem. This stems from a lack of information and communication and is an underlying cause of management not operating in the interest of the principal. The process begins by the devolution of power from the principal to the agent. Because the agent and principal do not share a conscience it is unreasonable to expect the agent to grasp with one hundred percent clarity the intentions of the principal. This can be compounded by a lack of understanding on the part of the principal. If the principal fails to understand the agent the principal could fail to frame the information being communicated in a manner that ensures the most information received (Laffont, 2002; Akerlof, 1970). Because information can never be communicated with full clarity, there will forever be an underlying inefficiency built into organizational design. This inefficiency is further magnified by the reality that action to mitigate information asymmetry can by costly and unproductive in itself. Information asymmetry in turn can lead to the formation of a moral hazard. A moral hazard occurs when the agent acts on behalf of the principal in a way that is deliberately contrary to desires of the principal. As Holmstrom (1979) explains,

"It has long been recognized that a problem of moral hazard may arise when individuals engage in risk sharing under conditions such that their privately taken actions affect the probability distribution of the outcome.' This situation is common in insurance, labor contracting, and the delegation of decision-making responsibility, to give a few examples. In these instances Pareto-optimal risk sharing is generally precluded because it will not induce proper incentives for taking correct actions. Instead, only a second-best solution, which trades off some of the risk-sharing benefits for provision of incentives, can be achieved. The source of this moral hazard or incentive problem is an asymmetry of information among individuals that results because individual actions cannot be observed and hence contracted upon" (Ibid, 74).

Figure 3



Conclusion

To conclude this chapter, what we have done is establish a theoretical framework through which we can began to build an argument for why anti-competition laws could be applied to PPP's/ In the next section we will use a quantitative experiment to determine whether there is a corresponding difference in results if anti-competition laws are imposed, thus providing evidence

Chapter 4: Applied public theory

Overview

This paper argues the inclusion of anti-trust laws upon PPP's will create a scenario where the government has more incentive to innovate. To prove this, the paper will model a two round, bi-matrix game-theory scenario in a cooperative setting. The operation is cooperative because the government and the private firm will each the best outcome if they form a coalition, which is the PPP. The first will demonstrate the behavior of the government and the private firm in a non-ACL environment. The second will model the actors in an environment with ACL. What we expect to see is that when ACL are placed on the government, the governments favored outcome will change. This is because the transaction costs of doing business will shift as a result of complying with new regulations. Thus the outcomes that form the coalition will change as a result. It will in turn require higher payoffs to the government to convince them to form coalitions This shift in desired outcomes will result in the government favoring more efficiency in order to minimize cost thus leading to more efficient contracting in the initial stages.

Experimental framework

At the highest level of organization, this paper will use cooperative game theory. Cooperative is in opposition to non-cooperative games. The distinction lies in the ability of the players to interact. A cooperative game allows the creation of contracts and modes of cooperation. As Giles (2010) explains:

"[Cooperative game theory] changes the analysis and interpretation of a game radically. Indeed, if binding agreements can be written, all players collectively will pursue the maximization of the total wealth that can be generated within the social decision situation at hand. A binding contract then determines how this generated wealth is distributed among the various players in this interactive decision situation. Thus, the main objective of cooperative game theory is to determine a “just” or “well-supported” contract between all players to divide the total wealth generated collectively. Such a contract can be based on pure bargaining power or solely on fairness considerations or mixtures of both power and fairness.”

Having established a cooperative superstructure, we must now decide which representation form the game must take. The three possible options being extensive form, normal form, and characteristic function form. Extensive form is, as the name suggests, the most extensively mapped. It describes all possible outcomes in as much mathematical rigor as can be brought to bear. The normal form is a step down from extensive form in that it exchanges detail and rigor for simplicity and breadth. Finally, the characteristic form is the most basic form of gaming. Discarding virtually all non-vital details, the characteristic form instead considers only the wealth levels that can be assigned to the players and groups when interacting. Again Giles explains:

“[Characteristic form] is in fact the preferred game form to describe cooperative games in which binding agreements are investigated. Indeed, given that there are binding agreements, it is no longer of importance how these wealth levels are achieved, but only how these wealth levels are allocated to the players in the interactive decision situation. Hence, the selection of actions becomes irrelevant in favor of a description of the contract among the players in the game.”[3]

This paper will use the characteristic form for the following reasons: 1) Simplicity; 2)

Method: Testing how the imposition of anti-competition laws effects economic gains

This paper will utilize two avenues for exploring the implications of anti-competition laws on PPPs. The first of these will a monte carlo test, and the second will be a game theory Shapley value analysis. The monte carlo test will use a series of infrastructure projects to determine the

[3] Ibid

increased risk that comes from compliance. The results of the monte carlo test will then be plugged into game theory equations in order to determine whether optimal outcomes vis-à-vis participants in PPPs. Using these methods will provide a substantial statistical argument that demonstrates implications of the proposition and how it could effect public behaviors in the long run.

Monte Carlo Test

In order to quantify the risk, this paper will utilize a monte carlo statistical test. This will allow us to determine the distribution of risk prior to and after the imposition of anti-competition costs. A monte carlo simulation performs risk analysis by building models of possible results by substituting a range of values—a probability distribution—for any factor that has inherent uncertainty. It then calculates results over and over, each time using a different set of random values from the probability functions. Monte Carlo simulation produces distributions of possible outcome values (Ripley, 1987). To perform a monte carlo tests, the accepted procedure is to define a domain of possible inputs, generate inputs randomly from a probability distribution over the domain, perform a deterministic computation on the inputs, and aggregate the results Because a monte carlo test runs potentially thousands of tests, the use of computational software is required. Important to determine beforehand is the probability distribution the simulation will use. This simulation will use a triangular distribution by defining a lower limit, upper limit, and the mode. A triangular distribution is useful in that it provides clear results while relying on relatively simple math. According to central limit theorem, the resulting distribution will approximate a normal distribution. It also closely approximates a lognormal distribution.

Game Theory

Once we have completed the monte carlo test we perform our second test under game theory conditions. Our game theory model will be built around what is known as the Shapley value. The Shapley value stems from what is known as a cooperative game. In a cooperative game players are allowed to act cooperatively if it is in their best interest. This is opposed to non-cooperative games which do not allow cooperation. The goal of a cooperative game is to understand the coalition formation and the subsequent change in results. The Shapley value is used to determine how much of the end product each member of the coalition will receive if there is unequal amounts of input on the part of players. See appendix for a more detailed explanation of the Shapley value. For the analysis in this paper, I will insert the standardized outcomes of the monte carlo analysis with the addition of regulatory costs into the Shapley equations. These will be compared with a control set values that represent the outcome of a coalition without the imposition of regulatory costs. What I expect to see is that there will be a minor but statistically significant increase in the payoff that accrues to the public actor.

The basic unit of analysis within cooperative games are coalitions which have bargaining power and may leave negotiations at any time. The end goal of a cooperative agreement is that no coalition has any reason to object the agreement. Thus an equilibrium is reached.

Cooperative games are superadditive, which means that unions of coalitions result in greater wealth than coalitions individually.

$$v(S) + v(T) \leq v(S \cup T).$$

Cooperative games exhibit monotonicity. To be monotonic implies that the quantity is static and preserves the given order. additionally, a function is said to be monotonically increasing (or non-decreasing) if its values are only rising and never falling with increasing values of (with).

Likewise, it is said to be monotonically decreasing (or non-increasing) if its values are only falling and never rising (with).

A cooperative game is *constant sum* if:

$$v(S) + v(N \setminus S) = v(N)$$

The Shapley value in a cooperative game is defined from the idea that players should receive payoffs proportion to their marginal contributions to the ultimate outcome. Finding the Shapley value is notoriously difficult. Take this example by Jackson et. al.:

$$v(N) = 1 \; but \; v(s) = 0 \; if \; N \neq 1$$

which states that all parties must be present in any game otherwise all parties regardless of presence receive no payoff. Following that logic, all parties marginal value increases to 1, expressed as:

$$v(N) - v(N \{i\}) = 1$$

It therefore becomes imperative that contributions be weighted according their contributions to the group.

To overcome these issues, certain axioms have been adopted by field experts. These include

1) $For\ any\ v, if\ \ i\ and\ j\ are\ interchangable\ then\ \psi_i(N,v) = \psi_j(N,v)$

   What this translates to is that every interchangeable agent receives similar payouts

2) $For\ any\ v, if\ \ i\ is\ a\ dummy\ player\ then\ \psi_i(N,v) = 0$

   Contributions of O equate to a received outcome of nothing on the part of the non-contributing player

3) Additivity that if we re-model the setting as a single game in which each coalition S achieves a payoff of$\psi_i(N, v) + \psi_j(N, v)$, the agents' payments in each coalition should be the sum of the payments they would have achieved for that coalition under the two separate games.

$$For\ any\ two\ v1\ and\ v2, we\ have\ for\ any\ player\ i\ that$$

$$\psi i(N, v1\ +\ v2)\ =\ \psi i(N, v1)\ +\ \psi i(N, v2), where\ the\ game$$

$$(N, v1\ +\ v2)\ is\ defined\ by\ (v1\ +\ v2)(S)\ =\ v1(S)\ +\ v2(S)\ for\ every$$

$$coalition\ S.$$

With all this in mind, the standard form of a Shapley form is as follows:

$$\phi_i(N, v) = \frac{1}{N!} \sum_{S \subseteq N/\{i\}} |S|!\,(|N| - |S| - 1)!\,[v(S \cup \{i\}) - v\{s\}]$$

Theorem: $Given\ a\ coalitional\ game\ (N, v), there\ is\ a\ unique\ payoff\ division\ x(v) =$

$\phi(N, v) that\ divides\ the\ full\ payoff\ of\ the\ grand\ coalition\ and\ that\ satisfies\ the\ axioms\ of\ symmet$

A simple example of how the Shapley works will prove helpful. Let's say players *a* and *b* respectively form a partnership and wish to equitably divide the payoff. Player 1 contributes a value of 2, player 2 contributes a value of 1. Their new output becomes 4. The equation would look as follows

$$v(\{1\}) = 2, v(\{2\}) = 1, v(\{2,1\}) = 4$$

To find the distinct Shapley values we need to all possible combinations, which in the case of a two-player game is:

[4] See *A Course in Game Theory* by Osborne and Rubenstein for a full proof of the Shapley form

$$
\begin{array}{llll}
[1] & [1,2] & \therefore & v(1) = 2 \\
[2] & [1,2] & \therefore & v(1,2) - v(2) = 1
\end{array}
$$

Inserting $v(1)$ and $v(2)$ into the Shapley equation we find that player 1 should equitably receive a payout of 2.5 and player 2 a payout of 1.5.

Having established the Shapley outcome as the breakdown of reward based on marginal contributions, it becomes important to determine how to define contribution. In order to do so we must look at the specific contracts that PPP's enter into. This paper will use the distribution of risk as the determinant of contribution in a PPP. The reason for this is because how end goal outcomes are defined vary widely among PPP contracts. Often the desired outcome cannot even be objectively defined other than as being a "public good," i.e. improving the flow of traffic, improving educational outcomes, etc. However, the mitigation and transfer of risk is universal among contracting partners. Determining risk allocation is a notoriously tricky business. As Yescombe (2007) explains:

"Risk transfer is at the heart of structuring a PPP project. Although the term 'risk-sharing' is often used in this context, PPPs do not generally involve risk-sharing in the sense of x% of the risk being taken by the Public Authority and (100 – x%) by the Project Company; risks are normally transferred fully to one side or the other (although there can be some limited exceptions to this—cf. §12.4.5, §15.2.5). There are only a limited number of ways in which any project risks can be handled…The default position, which may be set out in the PPP Contract, is that unless provided otherwise it is the Project Company's obligation to deliver the service as required, and bear or manage (by reallocation or otherwise) all risks accordingly."

Thus a PPP requires a thorough listing and distribution of risk during the initial contracting phase.[5] Because finding the Shapley value requires a numerically represented distribution of risk we must use a novel approach for determining risk. There is a rich literature on how to define and quantify risk. Chia (2006) compiled the common themes in the academic literature. These being 1) risk is a future event that may or may not occur; 2) A risk must also be an uncertain event or condition that, if it occurs, has an effect on, at least, one of the project objectives, such as scope, schedule, cost or quality; 3)The probability of the future event occurring must be greater than 0% but less than 100%. Future events that have a zero or 100% chance of occurrence are not risks; 4)The impact or consequence of the future event must be unexpected or unplanned for.

Data

For data, this paper will draw from five highway PPP projects from 2012 to 2019. This sampling of PPP's is advantageous for several reasons. Firstly, public-private infrastructure projects typically require higher investment inlays on the part of the public sector. Because of this there are higher levels of required disclosure meaning that data is more readily available and reliable. Secondly, the sample of PPP's displays high levels of categorical homogeneity but highly differing amounts within those categories. What this means is that the samples group their data similarly but because they are a wide range of differing sizes the real data they present spans the spectrum from very large to very small. Additionally there are differing levels of private participation within the projects. Some are publicly owned and privately operated, while others were built publicly and are now on a operate-to-own plan with the private sector. Both of these issues are dealt with within the model by analyzing on comparative level rather than as an

[5] See appendix C for sample risk allocation table

absolute. Another issue the way that the different PPPs organize their data. The issue is both external and internal. External because different organizations break out and compress data differently, and internal because how data is reported can change from year to year. This issue was dealt with by compressing the data into operational, maintenance, and administrative categories. These were chosen because they are representative of the data and can be applied universally across the sample. Testing with more or less categories confirmed that using three categories was the best way to balance significance and clarity. The uncompressed data can be found in the appendix.

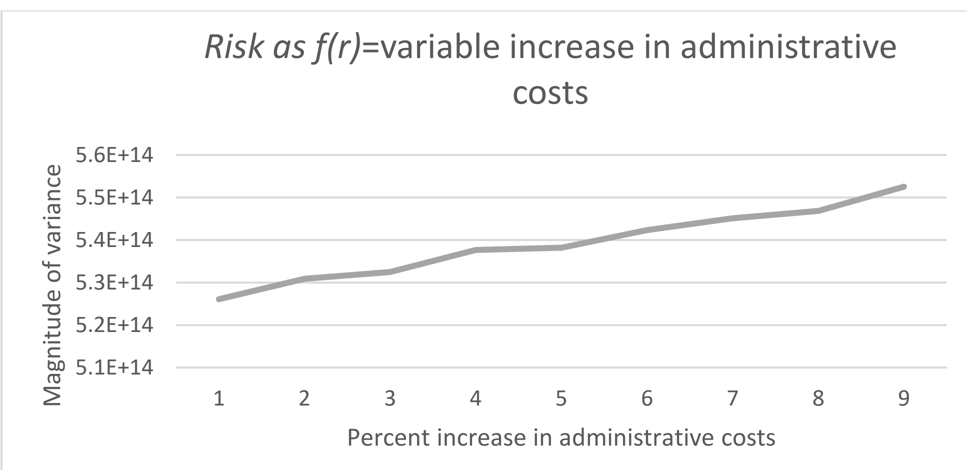
Table 1: Compressed data

Atlantic City-Brigantine Expressway	2019	2018	2017	2016	2015	2014	2013	2012	Mean	S.D.	Variance
Operations	$ 45,438,809.00	$ 46,621,831.00	$ 30,372,289.00	$ 27,731,327.00	$ 26,600,041.00	$ 28,609,201.00	$ 27,824,281.00	$ 28,254,087.00	$ 32,681,483.25	$ 8,312,475.60	6.90973E+13
Maintenance	$ 11,680,489.00	$ 11,404,558.00	$ 10,534,870.00	$ 9,783,785.00	$ 10,137,704.00	$ 8,139,506.00	$ 7,473,624.00	$ 7,089,919.00	$ 9,530,556.88	$ 1,760,608.42	3.09974E+12
Adminstrative	$ 14,160,377.00	$ 14,979,987.00	$ 13,428,079.00	$ 13,892,110.00	$ 16,440,049.00	$ 14,539,143.00	$ 15,644,151.00	$ 15,024,651.00	$ 14,763,568.38	$ 975,279.62	9.5117E+11
Total Costs	$ 71,279,675.00	$ 73,006,376.00	$ 54,335,238.00	$ 51,407,222.00	$ 53,177,794.00	$ 51,287,850.00	$ 50,942,056.00	$ 50,368,657.00	$ 56,975,608.50	$ 9,459,687.89	8.94857E+13
SR-91 Express lanes											
Operations	$ 6,556,033.00	$ 6,484,482.00	$ 8,268.00	$ 8,293.00	$ 8,083,194.00	$ 7,878,501.00	$ 7,504,955.00	$ 7,222,166.00	$ 5,468,236.50	$ 3,416,559.75	1.16729E+13
Maintenance	-	-	-	-	-	-	-	-			
Adminstrative	$ 11,853,577.00	$ 13,142,473.00	$ 26,429.00	$ 13,216.00	$ 11,626,069.00	$ 10,662,856.00	$ 9,461,831.00	$ 11,393,293.00	$ 8,522,468.00	$ 5,350,145.80	2.86241E+13
Total Costs	$ 18,409,610.00	$ 19,626,955.00	$ 34,697.00	$ 21,509.00	$ 19,709,263.00	$ 18,541,357.00	$ 16,966,786.00	$ 18,615,459.00	$ 13,990,704.50	$ 8,659,085.89	7.49798E+13
Florida Turnpike											
Operations	$ 357,160.00	$ 306,156.00	$ 288,172.00	$ 252,827.00	$ 235,018.00	$ 226,875.00	$ 244,334.00	$ 221,393.00	$ 266,491.88	$ 47,110.34	2219384268
Maintenance	-	-	-	-	-	-	-	-			
Adminstrative	$ 86,685.00	$ 85,015.00	$ 77,847.00	$ 53,574.00	$ 36,342.00	$ 37,066.00	$ 36,368.00	$ 33,714.00	$ 55,826.38	$ 23,583.86	556198530
Total Costs	$ 443,845.00	$ 391,171.00	$ 366,019.00	$ 306,401.00	$ 271,360.00	$ 263,941.00	$ 280,702.00	$ 255,107.00	$ 322,318.25	$ 69,617.81	4846639643
Maine Turnpike											
Operations	$ 26,970.00	$ 25,608.00	$ 24,716.00	$ 23,786.00	$ 22,424.00	$ 22,646.00	$ 21,605.00	$ 23,031.00	$ 23,848.25	$ 1,803.68	3253267.071
Maintenance	$ 13,796.00	$ 13,382.00	$ 13,519.00	$ 11,809.00	$ 11,595.00	$ 11,837.00	$ 10,556.00	$ 10,565.00	$ 12,132.38	$ 1,291.41	1667735.982
Adminstrative	$ 2,386.00	$ 2,414.00	$ 2,441.00	$ 2,491.00	$ 2,376.00	$ 2,184.00	$ 2,205.00	$ 2,399.00	$ 2,362.00	$ 109.58	12008.57143
Total Expenses	$ 43,152.00	$ 41,404.00	$ 40,676.00	$ 38,087.00	$ 36,395.00	$ 36,667.00	$ 34,366.00	$ 35,995.00	$ 38,342.75	$ 3,069.15	9419705.643
New York State Thruway											
Operations	$ 22,840,000.00	$ 23,910,000.00	$ 22,570,000.00	$ 9,040,000.00	$ 4,230,000.00	$ 4,380,000.00	$ 4,620,000.00	$ 7,970,000.00	$ 12,445,000.00	$ 9,003,162.94	8.10569E+13
Maintenance	$ 2,030,000.00	$ 1,660,000.00	$ 1,870,000.00	$ 1,080,000.00	$ 11,240,000.00	$ 11,470,000.00	$ 11,250,000.00	$ 10,920,000.00	$ 6,440,000.00	$ 5,119,408.45	2.62083E+13
Adminstrative	$ 10,230,000.00	$ 9,087,000.00	$ 10,150,000.00	$ 30,667,000.00	$ 12,326,000.00	$ 28,577,000.00	$ 17,338,000.00	$ 16,830,000.00	$ 16,900,625.00	$ 8,435,428.72	7.11565E+13
Total Expenses	$ 35,100,000.00	$ 34,657,000.00	$ 34,590,000.00	$ 40,787,000.00	$ 27,796,000.00	$ 44,427,000.00	$ 33,208,000.00	$ 35,720,000.00	$ 35,785,625.00	$ 4,976,273.33	2.47633E+13

Results and discussion

In order to test the hypothesis, this paper used a monte carlo simulation. Total simulations were n = 450,000, or n = 10,000 samplings per project per year. Assuming an α=0.05, this paper finds that across the entirety of the sample our p-value is consistently less than 0.05 thereby demonstrating significance and allowing us to reject the null hypothesis. See appendix for full test results. Most importantly, we find that variance increases in accordance with increased administration costs. Using the highway data, we find the risk increases as a function of variability. From here we can plug in these numbers into our shapley equations. As administrative costs increase as a result of anti-competitive regulation, the costs that will need to be borne by the public sector will increase. Therefore in light of our shapley equation the payoff allotted to the public sector within a cooperative game will also increase. Using the variance numbers from the analyzed data, we find that for every increase 1% increase in administrative costs there should be a corresponding 1±0.1% increase in the payout for the public sector.

Figure 4: Risk function based on data results



Chapter 5: Theory and conclusions

While the implications drawn from this paper are just scratching the surface of the application of private sector law to public sector policy, this thesis demonstrates that there is a lucrative amount applied and theoretical research waiting to be done on the subject. Chapter 2 discussed the purpose and value of performing dedicated research on the novel topic of anti-competition laws in the public sector. The chapter also established the methods, definitions, and frameworks that would be used to build the arguments in subsequent chapters. Chapter 2 also laid out the academic and literary foundations from which the key concepts and factual understandings would be drawn. Chapter 3 establishes the conceptual framework and the relationship between the enforcement of anti-competition provisions and agency theory. Chapter 4 provides an applied public theory argument that, using game theory and monte carlo analysis, demonstrates that risk increases as a function of variability in costs. Thus increases in administrative costs would result greater payoff for the public sector. Thus in conclusion, using monte carlo regression and game theory we can satisfactorily posit that the enforcement of anti-trust regulations on public-private partnerships would lead to an increase in economic efficiency and a higher return on investment for the public sector. In conclusion, based on the results of this paper we can reasonably argue that the evidence supports the theory that the imposition of anti-competition laws could be used to overcome some of the principal-agent problems that arise as a result of public-private partnerships.

Future research

A large amount of the value of this paper stems from the potential routes of research that can be inquired upon from it. Most importantly, this paper raises important questions about the link between public governance and the legality of its work as it continues to expand and professionalize. Such questions include whether the pairing of public and private creates a fundamental breach of the “veil of liability” that many government entities use as an affirmative defense against accusations of negligence or tortious liability. Another question being whether ethical norms, both *de facto* and *de jure*, for public servants interacting with private enterprises require greater oversight because of potential legal ramifications. In the broader scope of jurisprudence theory, this paper provides room to challenge the role of public and private in either a positive or negative fashion. A benefit of this paper and the larger framework it engages is that there is ample room for the use of novel or interdisciplinary methods from the social sciences and the legal field.

One potential avenue that could yield results is the use of data envelopment analysis. Data Envelopment Analysis (DEA) which is a non-parametric method that is increasingly used to measure efficiency in the public sector. DEA uses a 0-100 output to input ratio for each unit of analysis. To account for stochastic variables within PPPs a paper could utilize a stochastic DEA (SDEA), more specifically the chance constrained programming method developed by Land et al (1993). As laid out by Zbranek (2013), Data Envelopment Analysis (DEA) is a nonparametric approach to evaluate efficiency, using linear programming tools. It is a method that combines several inputs and outputs of decision-making units into a single comprehensive indicator, the level of technical efficiency of each DMU. The main goal of this method is to identify efficient decision-making units that produce the largest quantity of outputs using the least amount of inputs (Lotfi 2010). Since, the early 2000s, DEA has become a popular choice for determining the efficiency through programmatic experimentation. It is often used in evaluation of a relative performance of the set of companies that use the same inputs for the production of the same outputs, for example branches of banks, farms, hospitals, shops, and the like. Even individual employees of the organization might be evaluated units. Motivational factors that management of company uses to influence their performance may be regarded as inputs and job performance of employees may be considered as an output.

DEA provides several advantages for the analysis of efficiency in PPP systems. Firstly, It provides a comprehensive index, allowing an objective evaluation and comparison of employees, considering not only the outputs but also the inputs, plus it can handle multiple inputs and outputs simultaneously. Secondly, DEA responds to employees’ expectations about quantifying their shortcomings, overcoming the disadvantages of quality evaluation systems and is not dependent on the units of measurement. Since this is a non-parametric approach, DEA is not bound by the normal distribution of input and output variables (Manoharan, 2009).

A main disadvantage of DEA is that results are sensitive to the selection of inputs and outputs, so their relative importance needs to be analyzed prior to the calculation. However, there is no way to test their appropriateness. The number of efficient decision-making units (DMU) on the frontier tends to increase with the number of inputs and output variables (Berg, 2010). On the qualitative side, there is potential value in the use of case studies. Case studies would allow an author to explore the implications of legal liability in an applied sense. Although collecting data on case studies could potentially be complicated, the data could further build a case in an applied sense for the further study of public anti-competition laws.

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Appendix

Appendix A: FTC Data

Number of cases filed annually, categorized by Rep. (red) and Dem. (blue) Administrations									
1980	32	1989	6	1998	86	2007	58	2016	66
1981	19	1990	16	1999	86	2008	76	2017	35
1982	19	1991	18	2000	87	2009	63	2018	44
1983	7	1992	13	2001	48	2010	91	2019	45
1984	16	1993	11	2002	53	2011	111	2020	46
1985	9	1994	39	2003	50	2012	74		
1986	9	1995	55	2004	57	2013	70		
1987	16	1996	85	2005	52	2014	75		
1988	10	1997	66	2006	54	2015	65		

Anti-Competition cases by type	
Criminal	1116
Civil Non-Merger	525
Merger	438
Other	152

Appendix B: Key notations

N=finite set of players
S $\subset N$ A coalition
$\emptyset$ Empty coalition
$2^N = \{S \mid S \subset N\}$ Collection of all coalitions

G A game. (Chapter 1)

Γ A class of games. (Chapter 1)

Ω The outcomes of a game; where $G \in \Gamma$, then Ω_G is the set of possible outcomes of G. (Chapter 1)

$\sigma : \Gamma \to 2^{\Omega}$ A solution concept: for every game $G \in \Gamma$, identifies a set of outcomes $\sigma(G) \subseteq \Omega_G$ that are intuitively the "rational" outcomes of the game according to σ. (Chapter 1)

$N = \{1, \ldots, n\}$ The players in a game. (Chapter 2)

$C, C', C^1, C_1 \ldots$ Coalitions, i.e., subsets of players N. (Chapter 2)

$v : 2^N \to \mathbb{R}$ The characteristic function of a game: assigns a real number to every possible coalition, indicating the value that this coalition could obtain if they cooperated. (Chapter 2)

$G = (N, v)$ A characteristic function game; the basic model of cooperative games we use throughout the book. (Chapter 2)

$CS = \{C^1, \ldots, C^k\}$ A coalition structure: a partition of N into mutually disjoint coalitions, i.e., $C^1 \cup \cdots \cup C^k = N$, and $C^i \cap C^j = \emptyset$ for $i \neq j$. (Chapter 2)

$\mathcal{CS}_N$ The set of all coalition structures over N. (Chapter 2)

$v(CS)$ The social welfare of coalition structure CS: $v(CS) = \sum_{C \in CS} v(C)$. (Chapter 2)

$\mathbf{x} = (x_1, \ldots, x_n)$ A payoff vector: a distribution of payoffs to players in a game; x_i is the payoff received by player i. (Chapter 2)

$x(C)$ The total payoff of a coalition $C \subseteq N$ under $\mathbf{x}$, i.e. $x(C) = \sum_{i \in C} x_i$. (Chapter 2)

$\mathcal{I}(CS)$ The set of all imputations for a coalition structure CS. (Chapter 2)

$(CS, \mathbf{x})$ An outcome of a cooperative game: a coalition structure together with a payoff vector. (Chapter 2)

G^* The superadditive cover of game G. (Chapter 2)

Π_N The set of all permutations (possible orderings) of players N. (Chapter 2)

π An element of Π_N, i.e., a permutation of the players N. (Chapter 2)

$S_\pi(i)$ The set of players preceding player $i \in N$ in the ordering π. For example if $\pi = (3, 1, 2)$ then $S_\pi(1) = \{3\}$, $S_\pi(2) = \{1, 3\}$. (Chapter 2)

$\Delta_\pi^G(i)$ The marginal contribution that player i makes to the set of players preceding him in the ordering π in game G. (Chapter 2)

$\varphi_i(G)$ The Shapley value of player $i \in N$ in game G. (Chapter 2)

$\beta_i(G)$ The Banzhaf index of player $i \in N$ in game G. (Chapter 2)

$\eta_i(G)$ The normalized Banzhaf index of player $i \in N$ in game G. (Chapter 2)

$\mathcal{C}(G)$ The core of G. (Chapter 2)

$d(\mathbf{x}, C)$ The deficit of C with respect to $\mathbf{x}$, i.e., the amount that C could gain by deviating from $\mathbf{x}$: $d(\mathbf{x}, C) = v(C) - x(C)$. (Chapter 2)

$\mathbf{d}(\mathbf{x})$ The deficit vector of $\mathbf{x}$. (Chapter 2)

$\mathcal{N}(G)$ The nucleolus of game G. (Chapter 2)

$S_{i,j}(\mathbf{x})$ The surplus of player i over player j with respect to payoff vector $\mathbf{x}$. (Chapter 2)

$\mathcal{K}(G)$ The kernel of game G. (Chapter 2)

$\mathcal{B}(G)$ The bargaining set of game G. (Chapter 2)

$G = [N; \mathbf{w}; q]$ A weighted voting game with players N, weights $\mathbf{w} = (w_1, \dots, w_n) \in \mathbb{R}^n$, and quota $q \in \mathbb{R}$. (Chapter 4)

$w(C)$ The total weight of coalition C in a weighted voting game: $w(C) = \sum_{i \in C} w_i$. (Chapter 4)

$w_{\max}$ The largest weight of any player in a given weighted voting game. (Chapter 4)

$\dim(G)$ The dimension of vector weighted voting game G. (Chapter 4)

$\Lambda = \{\lambda_1, \dots\}$ The set of choices in an NTU game. (Chapter 5)

$\succeq_i \ \subseteq \Lambda \times \Lambda$ Preference relation for player $i \in N$ over choices Λ; the relation is required to be complete, reflexive, and transitive. (Chapter 5)

$\mathbf{c} = (\lambda_1, \dots, \lambda_k)$ A choice vector: a tuple of choices, one for each coalition in a coalition structure. (Chapter 5)

$(CS, \mathbf{c})$ An outcome for an NTU game: a coalition structure together with a vector of choices, one for each coalition in the coalition structure, where the choices in the choice vector must be feasible for the corresponding coalition. (Chapter 5)

Appendix C: Sample risk allocation chart

Risk	Contractor	Operator	Equity	Lenders	Government	Insurance	Unallocated
1. Construction overruns/delays	*						
2. Change in legal regimes					*		
3. Land acquisition					*		
4. Approvals/ licences/permits	*				*		
5. Variations	*				*		
6. Taxation	*		*	*	*		
7. Tariffs and charges		*	*		*		
8. Revenue/Traffic/ Demand			*	*	*		
9. Operation		*					
10. Maintenance		*					
11. Defects liability		*					
12. Natural disaster						*	
13. Industrial action		*	*		*		
14. Environmental			*		*		
15. Civil disobedience		*			*		
16. Insurance						*	
17. Force majeure							*
18. Confiscation					*		
19. Interest rate risk			*	*			

Source: Transport Policy and Development Section, United Nations Economic and Social Commission for Asia and the Pacific (ESCAP).
https://www.unescap.org/ttdw/ppp/ppp_primer/611_risk_matrix.html

Appendix D: Full Highway PPP data

Cleaned and compressed data

		2019	2018	2017	2016	2015	2014	2013	2012
Atlantic City-Brigantine Expressway	Executive	$ 1,168,900.00	$ 1,076,960.00	$ 945,373.00	$ 1,013,228.00	$ 862,693.00	$ 835,029.00	$ 928,677.00	$ 991,130.00
https://www.sjta.com/sjta/annual_re	Business Administration	$ 564,354.00	$ 525,385.00	$ 490,606.00	$ 354,662.00	$ 360,460.00	$ 383,671.00	$ 747,637.00	$ 753,785.00
	Engineering	$ 842,210.00	$ 1,005,266.00	$ 521,353.00	$ 426,994.00	$ 458,623.00	$ 2,875,579.00	$ 2,562,648.00	$ 2,604,871.00
	Finance	$ 1,466,891.00	$ 1,586,152.00	$ 1,594,976.00	$ 1,549,684.00	$ 1,494,778.00	$ 1,703,110.00	$ 1,683,372.00	$ 1,672,484.00
	Central Accounts	$ 10,960,232.00	$ 11,791,490.00	$ 10,397,124.00	$ 10,974,536.00	$ 13,722,118.00	$ 11,617,333.00	$ 12,284,465.00	$ 11,607,252.00
	Other Post-Employment Benefits	$ 2,095,856.00	$ 3,139,880.00	$ 2,849,650.00	$ 2,814,885.00	$ 2,383,544.00	$ 1,916,580.00	$ 1,980,880.00	$ 1,981,391.00
	Marketing and Communications	$ 194,176.00	$ 175,615.00	$ 225,580.00	$ 214,974.00	$ 386,904.00	$ 543,323.00	$ 170,541.00	$ 273,302.00
	Toll Services and Bus Management	$ 3,569,796.00	$ 3,606,322.00	$ 3,724,871.00	$ 3,761,817.00	$ 3,778,241.00	$ 3,903,138.00	$ 4,092,698.00	$ 4,005,660.00
	Maintenance	$ 11,680,489.00	$ 11,404,558.00	$ 10,534,870.00	$ 9,783,785.00	$ 10,137,704.00	$ 8,139,506.00	$ 7,473,624.00	$ 7,089,919.00
	Police	$ 8,127,665.00	$ 7,111,364.00	$ 7,744,485.00	$ 6,811,481.00	$ 6,737,745.00	$ 7,068,974.00	$ 6,686,707.00	$ 6,846,762.00
	Emergency Service Patrol	$ 5,033,663.00	$ 5,605,175.00	$ 844,650.00	$ 852,586.00	$ 844,690.00	$ 841,607.00	$ 834,382.00	$ 818,192.00
	Electronic Toll Collection Expense	$ 5,033,663.00	$ 5,605,175.00	$ 6,481,751.00	$ 4,875,265.00	$ 4,401,340.00	$ 3,976,904.00	$ 4,043,758.00	$ 4,245,372.00
	Parking (Non Airport)	$ 518,835.00	$ 577,970.00	$ 597,774.00	$ 588,229.00	$ 582,417.00	$ 659,799.00	$ 727,398.00	$ 1,007,675.00
	Information Services	$ 1,845,869.00	$ 1,845,409.00	$ 1,844,497.00	$ 1,859,212.00	$ 1,716,521.00	$ 1,776,994.00	$ 1,728,722.00	$ 1,739,128.00
	SJTPO Programs	$ 2,511,312.00	$ 2,805,337.00	$ 1,909,850.00	$ 2,302,163.00	$ 1,922,222.00	$ 2,118,080.00	$ 1,964,082.00	$ 2,156,432.00
	Transportation Services	$ 15,665,764.00	$ 15,144,318.00	$ 3,627,828.00	$ 3,223,721.00	$ 3,387,794.00	$ 2,928,223.00	$ 3,032,465.00	$ 2,575,302.00
	Revenue								
SR-91 Express lanes	: Tolls, fees, and fines (revenue)	$ 57,416,236.00	$ 57,614,831.00	$ 56,002.00	$ 52,240.00				
https://www.octa.net/News-and-Res	Total operating revenues			$ 56,002.00	$ 52,240.00	$ 46,132,245.00	$ 42,610,409.00	$ 39,288,300.00	37 742 322 3
	Management and operational services	$ 6,556,033.00	$ 6,484,482.00	$ 8,268.00	$ 8,293.00	$ 8,083,194.00	$ 7,878,501.00	$ 7,504,955.00	$ 7,222,166.00
	Administrative overhead	$ 2,834,881.00	$ 2,481,050.00	$ 2,752.00	$ 2,323.00	$ 2,606,382.00	$ 2,290,301.00	$ 2,167,631.00	$ 1,848,323.00
	Other operating expenses	$ 289,837.00	$ 27,615.00	$ 42.00	$ 27.00	$ 11,640.00	$ 11,645.00	$ 6,558.00	$ 152,553.00
	Insurance claims and premiums	$ 359,423.00	$ 331,567.00	$ 324.00	$ 334.00	$ 350,751.00	$ 333,566.00	$ 311,841.00	$ 307,803.00
	Professional services	$ 4,251,405.00	$ 6,281,463.00	$ 19,514.00	$ 6,992.00	$ 4,620,515.00	$ 3,885,434.00	$ 2,579,731.00	$ 2,651,229.00
	General and administrative	$ 683,702.00	$ 548,149.00	$ 586.00	$ 407.00	$ 414,658.00	$ 347,956.00	$ 508,628.00	$ 438,989.00
	Depreciation and amortization	$ 3,434,329.00	$ 3,472,629.00	$ 3,211.00	$ 3,133.00	$ 3,622,123.00	$ 3,793,954.00	$ 3,887,442.00	$ 5,994,396.00
	Total operating expenses	$ 18,409,610.00	$ 19,626,955.00	$ 34,697.00	$ 21,509.00	$ 19,709,263.00	$ 18,541,357.00	$ 16,966,786.00	18 615 459
	Operating income	$ 39,006,626.00	$ 37,987,876.00	$ 21,305.00	$ 30,731.00				19 126 863
Florida Turnpike									
https://floridasturnpike.com/about/f	Total Revenues	$ 1,138,633.00	$ 1,089,600.00	$ 1,048,121.00	$ 1,021,081.00	$ 907,658.00	$ 843,931.00	$ 783,234.00	$ 656,566.00
	Expenses								
	Operations and maintenance	$ 235,939.00	$ 228,905.00	$ 211,333.00	$ 188,249.00	$ 175,769.00	$ 164,191.00	$ 162,422.00	$ 177,329.00
	Business development and marketir	$ 2,405.00	$ 4,115.00	$ 4,387.00	$ 4,209.00	$ 1,391.00	$ 1,647.00	$ 1,203.00	$ 2,676.00
	Renewals and replacements	$ 121,221.00	$ 77,251.00	$ 76,839.00	$ 64,578.00	$ 59,249.00	$ 62,684.00	$ 81,912.00	$ 44,064.00
	Depreciation and amortization	$ 54,820.00	$ 47,362.00	$ 44,356.00	$ 49,365.00	$ 34,951.00	$ 35,419.00	$ 35,165.00	$ 31,038.00
	Planning and development	$ 29,460.00	$ 33,538.00	$ 29,104.00					
	Total expenses	$ 546,252.00	$ 499,822.00	$ 437,923.00	$ 407,904.00	$ 365,467.00	$ 372,584.00	$ 397,673.00	$ 384,344.00
Maine Turnpike	Revenues	$ 151,488.00	$ 148,066.00	$ 144,052.00	$ 140,379.00	$ 134,077.00	$ 128,967.00	$ 126,990.00	$ 109,603.00
https://www.maineturnpike.com/Bu	Expenses:								
	Operations	$ 26,970.00	$ 25,608.00	$ 24,716.00	$ 23,786.00	$ 22,424.00	$ 22,646.00	$ 21,605.00	$ 23,031.00
	Maintenance	$ 13,796.00	$ 13,382.00	$ 13,519.00	$ 11,809.00	$ 11,595.00	$ 11,837.00	$ 10,556.00	$ 10,565.00
	Adminstrative	$ 2,386.00	$ 2,414.00	$ 2,441.00	$ 2,491.00	$ 2,376.00	$ 2,184.00	$ 2,205.00	$ 2,399.00
	Total Expenses	$ 43,152.00	$ 41,404.00	$ 40,676.00	$ 38,087.00	$ 36,395.00	$ 36,667.00	$ 34,366.00	$ 35,995.00
New York State Thruway	Revenue	$ 814.10	$ 799.40	$ 792.20	$ 752.00	$ 728.60	$ 698.80		
https://www.thruway.ny.gov/about/	EXPENSES								
	Salaries	$ 14,360,000.00	$ 14,600,000.00	$ 14,000,000.80	$ 17,100,000.00	$ 17,300,000.00	$ 19,000,000.00	$ 17,800,000.00	$ 17,500,000.00
	Post employment obligations	$ 6,000,000.00	$ 8,330,000.00	$ 6,930,000.00					
	Employee benefits	$ 7,090,000.00	$ 6,460,000.00	$ 6,740,000.00					
	State Police - Troop T services	$ 6,260,000.00	$ 5,810,000.00	$ 6,060,000.00	$ 4,760,000.00				
	Professional and other services	$ 6,180,000.00	$ 5,110,000.00	$ 4,550,000.00	$ 5,800,000.00	$ 6,000,000.00	$ 7,700,000.00	$ 6,400,000.00	$ 6,300,000.00
	Supplies, materials and rentals	$ 2,790,000.00	$ 2,620,000.00	$ 2,160,000.00	$ 4,280,000.00	$ 4,230,000.00	$ 4,380,000.00	$ 4,620,000.00	$ 7,970,000.00
	Maintenance and repairs	$ 2,030,000.00	$ 1,660,000.00	$ 1,870,000.00	$ 1,080,000.00	$ 11,240,000.00	$ 11,470,000.00	$ 11,250,000.00	$ 10,920,000.00
	Utilities	$ 600,000.00	$ 630,000.00	$ 560,000.00					
	Insurance and claims	$ 760,000.00	$ 430,000.00	$ 500,000.00	$ 790,000.00	$ 790,000.00	$ 780,000.00	$ 810,000.00	$ 850,000.00
	Equipment	$ 100,000.00	$ 60,000.00	$ 120,000.00					
	Other	$ 10,000.00	$ 10,000.00	$ 710,000.00	$ 18,630,000.00	$ 1,590,000.00	$ 16,570,000.00	$ 6,810,000.00	$ 6,580,000.00
	Depreciation and amortization	$ 3,280,000.00	$ 3,537,000.00	$ 4,390,000.00	$ 5,447,000.00	$ 3,946,000.00	$ 3,527,000.00	$ 3,318,000.00	$ 3,100,000.00
	Total	$ 78,980,000.00	$ 81,090,000.00	$ 88,180,000.00	$ 102,400,000.00	$ 80,250,000.00	$ 77,730,000.00	$ 75,100,000.00	$ 78,350,000.00

Appendix E: Compressed and cleaned highway data

Atlantic City-Brigantine Expressway	2019	2018	2017	2016	2015	2014	2013	2012	Mean	S.D.	Variance
Operations	$ 45,438,809.00	$ 46,621,831.00	$ 30,372,289.00	$ 27,731,327.00	$ 26,600,041.00	$ 28,609,201.00	$ 27,824,281.00	$ 28,254,087.00	$ 32,681,483.25	$ 8,312,475.60	6.90973E+13
Maintenance	$ 11,680,489.00	$ 11,404,558.00	$ 10,534,870.00	$ 9,783,785.00	$ 10,137,704.00	$ 8,139,506.00	$ 7,473,624.00	$ 7,089,919.00	$ 9,530,556.88	$ 1,760,608.42	3.09974E+12
Adminstrative	$ 14,160,377.00	$ 14,979,987.00	$ 13,428,079.00	$ 13,892,110.00	$ 16,440,049.00	$ 14,539,143.00	$ 15,644,151.00	$ 15,024,651.00	$ 14,763,568.38	$ 975,279.62	9.5117E+11
Total Costs	$ 71,279,675.00	$ 73,006,376.00	$ 54,335,238.00	$ 51,407,222.00	$ 53,177,794.00	$ 51,287,850.00	$ 50,942,056.00	$ 50,368,657.00	$ 56,975,608.50	$ 9,459,687.89	8.94857E+13
SR-91 Express lanes											
Operations	$ 6,556,033.00	$ 6,484,482.00	$ 8,268.00	$ 8,293.00	$ 8,083,194.00	$ 7,878,501.00	$ 7,504,955.00	$ 7,222,166.00	$ 5,468,236.50	$ 3,416,559.75	1.16729E+13
Maintenance	-	-	-	-	-	-	-	-			
Adminstrative	$ 11,853,577.00	$ 13,142,473.00	$ 26,429.00	$ 13,216.00	$ 11,626,069.00	$ 10,662,856.00	$ 9,461,831.00	$ 11,393,293.00	$ 8,522,468.00	$ 5,350,145.80	2.86241E+13
Total Costs	$ 18,409,610.00	$ 19,626,955.00	$ 34,697.00	$ 21,509.00	$ 19,709,263.00	$ 18,541,357.00	$ 16,966,786.00	$ 18,615,459.00	$ 13,990,704.50	$ 8,659,085.89	7.49798E+13
Florida Turnpike											
Operations	$ 357,160.00	$ 306,156.00	$ 288,172.00	$ 252,827.00	$ 235,018.00	$ 226,875.00	$ 244,334.00	$ 221,393.00	$ 266,491.88	$ 47,110.34	2219384268
Maintenance	-	-	-	-	-	-	-	-			
Adminstrative	$ 86,685.00	$ 85,015.00	$ 77,847.00	$ 53,574.00	$ 36,342.00	$ 37,066.00	$ 36,368.00	$ 33,714.00	$ 55,826.38	$ 23,583.86	556198530
Total Costs	$ 443,845.00	$ 391,171.00	$ 366,019.00	$ 306,401.00	$ 271,360.00	$ 263,941.00	$ 280,702.00	$ 255,107.00	$ 322,318.25	$ 69,617.81	4846639643
Maine Turnpike											
Operations	$ 26,970.00	$ 25,608.00	$ 24,716.00	$ 23,786.00	$ 22,424.00	$ 22,646.00	$ 21,605.00	$ 23,031.00	$ 23,848.25	$ 1,803.68	3253267.071
Maintenance	$ 13,796.00	$ 13,382.00	$ 13,519.00	$ 11,809.00	$ 11,595.00	$ 11,837.00	$ 10,556.00	$ 10,565.00	$ 12,132.38	$ 1,291.41	1667735.982
Adminstrative	$ 2,386.00	$ 2,414.00	$ 2,441.00	$ 2,491.00	$ 2,376.00	$ 2,184.00	$ 2,205.00	$ 2,399.00	$ 2,362.00	$ 109.58	12008.57143
Total Expenses	$ 43,152.00	$ 41,404.00	$ 40,676.00	$ 38,087.00	$ 36,395.00	$ 36,667.00	$ 34,366.00	$ 35,995.00	$ 38,342.75	$ 3,069.15	9419705.643
New York State Thruway											
Operations	$ 22,840,000.00	$ 23,910,000.00	$ 22,570,000.00	$ 9,040,000.00	$ 4,230,000.00	$ 4,380,000.00	$ 4,620,000.00	$ 7,970,000.00	$ 12,445,000.00	$ 9,003,162.94	8.10569E+13
Maintenance	$ 2,030,000.00	$ 1,660,000.00	$ 1,870,000.00	$ 1,080,000.00	$ 11,240,000.00	$ 11,470,000.00	$ 11,250,000.00	$ 10,920,000.00	$ 6,440,000.00	$ 5,119,408.45	2.62083E+13
Adminstrative	$ 10,230,000.00	$ 9,087,000.00	$ 10,150,000.00	$ 30,667,000.00	$ 12,326,000.00	$ 28,577,000.00	$ 17,338,000.00	$ 16,830,000.00	$ 16,900,625.00	$ 8,435,428.72	7.11565E+13
Total Expenses	$ 35,100,000.00	$ 34,657,000.00	$ 34,590,000.00	$ 40,787,000.00	$ 27,796,000.00	$ 44,427,000.00	$ 33,208,000.00	$ 35,720,000.00	$ 35,785,625.00	$ 4,976,273.33	2.47633E+13

Appendix F: Full test results for monte carlo tests

Atlantic-Brig

1% Increase

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.009056343
R Square	8.20174E-05
Adjusted R Square	-1.79944E-05
Standard Error	9385804.369
Observations	10000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	7.22433E+13	7.22E+13	0.82007674	0.365179552
Residual	9998	8.80757E+17	8.81E+13		
Total	9999	8.80829E+17			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	57484209.29	562869.6405	102.127	0	56380871.5	58587547.08	56380871.5	58587547.08
X Variable 1	-0.00878901	0.009705384	-0.90558	0.365179552	-0.027813516	0.010235496	-0.027813516	0.010235496

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.000587
R Square	3.44E-07
Adjusted R Square	-1E-04
Standard Error	9386188
Observations	10000

ANOVA

	df	SS	MS	F	Significance F
Regression	1	3.03E+11	3.03E+11	0.003444	0.953205
Residual	9998	8.81E+17	8.81E+13		
Total	9999	8.81E+17			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	57014714	571659.5	99.73545	0	55894146	58135281	55894146	58135281
X Variable 1	-0.00058	0.00986	-0.05868	0.953205	-0.01991	0.018748	-0.01991	0.018748

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.015537
R Square	0.000241

Adjusted R Square	0.000141
Standard Error	9385056
Observations	10000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2.13E+14	2.13E+14	2.414044	0.120283
Residual	9998	8.81E+17	8.81E+13		
Total	9999	8.81E+17			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	57857295	571358.4	101.2627	0	56737317	58977272	56737317	58977272
X Variable 1	-0.01522	0.009795	-1.55372	0.120283	-0.03442	0.003982	-0.03442	0.003982

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.010958
R Square	0.00012
Adjusted R Square	2.01E-05
Standard Error	9385626
Observations	10000

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*

Regression	1	1.06E+14	1.06E+14	1.200575	0.273233
Residual	9998	8.81E+17	8.81E+13		
Total	9999	8.81E+17			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	57595491	568056.4	101.3905	0	56481986	58708996	56481986	58708996
X Variable 1	-0.01069	0.009754	-1.09571	0.273233	-0.02981	0.008432	-0.02981	0.008432