

# **“Public Good,” or “Good for the Public?” How Political Entrepreneurship Endogenized the Public Funding of Science\***

Ryan Safner<sup>†</sup>

October 30, 2019

Public goods are traditionally classified according to an exogenous, technological definition of possessing the characteristics of nonrivalry and nonexcludability. This paper takes a more endogenous approach, where goods are defined by the political purposes that specific actors have revolving these goods, and emerge through political entrepreneurship. I use government sponsorship of basic scientific research as a case study. Proponents argue that scientific research constitutes a public good requiring government assistance, but in fact, government provision of science is endogenous, and better explained by the political entrepreneurship involved in convincing the public of the superiority of political over private provision.

**JEL Classification:** H40, H41, B25, D70

**Keywords:** Public goods, public choice, political economy, political entrepreneurship, science

---

\* I thank Richard Wagner, Edward Stringham, Diana Thomas, and three anonymous reviewers for helpful comments. I gratefully acknowledge the Mercatus Center Summer Research Fellowship for financial assistance. Any remaining errors are my own.

<sup>†</sup> Email: safnerr@hood.edu, Address: Hood College, George B. Delaplaine, Jr. School of Business, Frederick, MD

## 1. Introduction

The concept of “public goods” is one of several critical economic concepts where non-economists confidently assume they know the everyday meaning of the term and then promptly proceed to commit economic fallacies with it. Ask the average undergraduate to provide examples of “public goods” and they will invariably produce a laundry list of government-provided services: roads, national defense, infrastructure, healthcare, social safety nets, and so on. Perhaps this is because the term “public goods” is so close to “public services,” a set of activities that *is* coterminous with what governments *actually* provide.

In economics, a good is technically defined as “public” if and only if it is (a) not strictly rivalrous in consumption and (b) not strictly excludable. This means that only those goods for which a person’s consumption does not diminish another’s ability to consume and for which a user cannot exclude non-payers from consumption are classified as public goods. Naturally, this has led to much confusion and conflation between the real-world activities and expenditures of governments and the abstract economic models in public finance and welfare economics. It is typical for economists and non-economists alike to claim that markets *in fact* provide private goods and governments *in fact* provide public goods, as well as argue that this *should* be the correct demarcation. In any case, the analytic concept of “public goods” is easily conflated with government activities that are commonly viewed as simply “good for the public.” This rhetorical distinction between these two phrases is minor, but in terms of understanding the distinction between public and private enterprises, it is crucially important.

The main contribution I make in this paper is to draw a sharp analytic distinction between what I term the traditional or “exogenous” theory of public goods—which is driven by the technological properties assumed about a good and the implications of market failures in the presence of these properties—and a more “endogenous” theory of public goods. In this latter framework, the “publicness” of a good is not a technological *assumption* but is classified *intentionally* by individuals who view these goods as serving specific purposes that can be made intelligible to us only by understanding these individual choices.

Ultimately, the determination of which goods will be provided privately and which goods publicly is made through collective action. Rather than an objective criterion that can be known in advance, the nature of such collective action creates opportunities ripe for political entrepreneurship to sway collective

decisions about the uses of goods in different directions. While a person's preferences about goods they may themselves consume can be interpreted through their purchasing decisions, interpreting preferences about *other people's* actions and uses of goods involves a significant degree of subjectivity (Aligica and Tarko, 2013). An action that one person perceives as a negative externality may be perceived by another person as a positive externality; one person's economic rent may be another person's public good (Wagner 2013). If economists hope to maintain the value freedom implied by positive economics, we must first admit the difficulty in trying to objectively disentangle these subjective relationships based on exogenous technological criteria. By applying the broader lens of political economy to look at the incentives of various players and the institutions that they operate within, we can better understand the process that collectively determines how goods are provided (Buchanan 1959). People with different interests may establish organizations or attempt to change social institutions to further those interests regarding particular goods, and it is only through the emergent result of all of these activities that a good ends up being provided by entrepreneurs in markets, government agencies, or by some institution of civil society (Ostrom 1990). Just as oil in the ground is not a valuable resource until certain entrepreneurs recognize and persuade others that it can be extracted and used in some productive process for future consumption, *public* goods are similar in social and political relationships. Enterprising individuals may find it in their interest under certain conditions to argue that a good should be provided by a public or quasi-public agency, rather than through market-based transactions. Historically, a critical mass of these types of market-politicizing decisions are made during national emergencies such as war and natural disasters, which generate a sympathetic public, and institutional momentum carries these new enterprises far beyond the national emergency (Higgs 1989). Consistent with this story, public enterprises often end up being led by the very people or their coalition who called for such political action in the first place.

The goal of this paper is expressly *not* to argue from a normative or optimal standpoint how to determine which goods should be produced, funded, or subsidized by governments, and which left to market processes. Instead, this paper modestly observes that the reason these industries are subject to government involvement rarely due to any inherent flaw in the goods themselves or the market process interacting with these goods, but often because of enterprising political and social entrepreneurs have convinced society that they must be.

In the remainder of this paper, I first survey the traditional view of public goods and its connection to public finance, and then construct an alternate theoretical framework of endogenous public goods which is driven by political entrepreneurship. I apply this framework and demonstrate its insight with a case study of basic scientific research, where the government allocates grants of financial capital to scientific projects. This practice is commonly justified to the public on the grounds that scientific discovery is a public good that markets have difficulty in providing, and thus, government funding is necessary to ensure optimal provision. I argue that this institutional outcome is driven less by the classic public goods story of market failure, and more by political entrepreneurs successfully engineering public opinion to consider science a “public” or government enterprise.

## 2. The Standard Exogenous Theory of Public Goods

Economists and their predecessors writing on public affairs have long noted that certain goods may not be produced naturally except by government and collective action. Adam Smith (1776[1904]) argued that the political sovereign had the duty of

erecting and maintaining certain public works and certain public institutions which it can never be for the interest of any individual, or small number of individuals, to erect and maintain; because the profit could never repay the expence to any individual or small number of individuals, though it may frequently do much more than repay it to a great society (Book VI, Ch. 9).

This idea was ultimately formalized by Samuelson (1954; 1955), which identified the lack of a preference-revelation mechanism in Smith’s invisible hand to cope with what Samuelson termed “collective consumption goods.” Certain goods allow multiple users to consume the good simultaneously without detracting from one another. This opens the possibility of free riding, where each user will purchase (or contribute) less than their *true* willingness to pay for the good (compared to a private, fully rivalrous, and excludable good) as they still benefit from using good regardless of their contribution. If a significant portion of potential users choose not to contribute, then the good will not get produced at all, and society loses out on efficient gains from exchange. Samuelson’s attempt to describe the logic of government spending was synthesized with other problems in markets by Bator (1958), which helped solidify market failure and public goods theory as part and parcel of both public finance and welfare economics.

Modern economics textbooks define public goods as any good that possesses the properties of (a) not being strictly rivalrous and (b) not being strictly excludable. The implication, sometimes explicit but in

contemporary times, more casually implicit, is that government must step in to provide the corrective remedy to improve market outcomes. The failure of the market process to elicit true preferences and contributions from users risks the underprovision of public goods. Hence, traditional public finance and welfare economics suggests that government provides these goods to correct for this market failure, as it can use its coercive powers to compel sufficient payments for the good to be produced.

From this straightforward logic, it is quite easy to shift between positive and normative accounts of government expenditures, which simultaneously become both *explained* by and *justified* by public goods theory. Thus, public finance textbooks such as Rosen et al. (2003: 53) state “just as analysis of pure competition yields important insights into the operation of actual markets, so the analysis of pure public goods helps us to understand problems confronting public decision makers.”

I term this standard account of public goods as the “exogenous theory of public goods,” as what makes any given good “public” is determined solely based on some exogenous physical characteristic that make them not amenable to efficient market provision. Leading economics textbooks simply apply the exogenous definition of public goods to various public policy problems.<sup>1</sup>

The standard literatures about public goods, public finance, and welfare economics have met many critics during their tenure. They might be described according to three main categories: lack of a clear real world connection between the blackboard analysis and actual public policy, accounts of markets or other private institutions successfully providing public goods, and the fact that most government expenditures are not actually on public goods.

First, Hammond (2015) documents the original controversies and debates launched by Samuelson’s original definition between Samuelson, Minasian (1964), and Buchanan (1967) among others.

---

<sup>1</sup> For instance, Mankiw (2004: 225), a leading principles of economics textbook defines uses the example of a tornado siren in a small town:

*Public goods* are neither excludable nor rival. That is, people cannot be prevented from using a public good, and one person's use of a public good does not reduce another person's ability to use it. For example, a tornado siren in a small town is a public good. Once the siren sounds, it is impossible to prevent any single person from hearing it. Moreover, when one person gets the benefit of the warning, he does not reduce the benefit to anyone else (emphasis in original).

Gruber (2011: 183) a leading public finance textbook uses the example of national defense:

A classic example of a pure public good is national defense. National defense is not rival because if I build my house next to yours, my action in no way diminishes your national defense protection. National defense is not excludable because once an area is protected by national defense, everyone in the area is protected: there is no way the government can effectively deny me protection since my house is in a neighborhood with many other houses.

Much like some other formalistic economic concepts in neoclassical theory (Clapham 1922), it has been difficult to find real world examples of what cleanly satisfies the definition of public goods. Much rarer have been successful demonstrations of a public goods problem *causing* governments to begin providing what markets could not. Samuelson (1969), after being pressed for many years on the theory of public goods and their relationship to actual public decisions and expenditures, ultimately found the concept to be a rather empty economic box for public policy purposes.

Second, a large volume of scholarship has uncovered through detailed case studies that actual practice often contradicts what the formal theory of public goods would predict. Markets or other voluntary social organizations have historically provided many of the “classic” public goods that today happen to be provided by governments, such as lighthouses (Coase 1974), property rights (Anderson and Hill 2004), roads (Klein 2002), police (Davies 2002), law and order (Friedman 1979; Benson 1989; Ellickson 1994), and the internalization of externalities (Cheung 1973). A number of scholars have described theoretical methods by which private entrepreneurs can use the market process to cleverly get around free rider problems. Entrepreneurs can for instance employ price discrimination (Demsetz 1970), tying of private and “public” goods (Demsetz 1964), or dominant assurance contracts (Tabarrok 1998) to provide the optimal quantity of public goods, even under Samuelson’s (1954) original conditions.

Furthermore, “institutional” entrepreneurs can create new organizations or institutions to create new governance spaces where public goods can be provided without resorting to coercive action. Groups can establish a “club” and only provide public goods to paying-members, creating exclusion rights and negating the free rider problem (Buchanan 1965; Goldin 1977). “Higher-tiered” entrepreneurs can innovate new forms of organization to better protect property where state capacity is lacking (Leeson and Boettke 2009; Li et al. 2006), or change political rules to reach more profitable political outcomes (Martin and Thomas 2013). Or they can tap into an informal community-defined set of norms and rules (Ostrom 1990, 2010; McGinnis 1999; Aligica and Tarko 2013, Safner 2016).

Finally, the goods typically provided by modern democratic governments are largely not “public goods,” under the exogenous technical definition. In the United States as of the second quarter of 2015, nominal U.S. gross domestic product was about \$17.9 trillion, with total government expenditures accounting for about \$5.9 trillion, or about 33% (FRED 2015). Of this, about 27% is healthcare spending,

25% is entitlement spending, 22% is defense spending (US Government Spending 2015). There is much debate about how many State-provided goods actually constitute public goods in the Samuelsonian sense. In general, Woolley (2006:5) describes how goods in the abstract, such as “law and order,” can certainly be considered public, but inputs into these goods, such as access to courts, are certainly rival. Even something as ‘obviously’ public as national defense turns out to be more complicated when we consider it not as a single good with a supply of one unit, but as a discrete series of marginal decisions (see e.g. Rothbard 2008[1962]: 1031; Holcombe 1997: 15-16; Woolley 2006: 4-6; Coyne 2015: 374-375). “The military” surely provides domestic citizens with the non-rival benefit of invasion deterrence, but what about the actual strategic decisions made to e.g. commission or allocate a new ballistic missile, which can only operate over a particular area? Government budget items that are closer to the Samuelsonian model of public goods, such as general governance and protection services (courts, police, maintenance of law and order) collectively account for well below 10% (US Government Spending 2015). Woolley (2006: 3) suggests that hypothesizing about how a good can be non-excludable in theory is easier to conceptualize in practice by observing what the government provides to everyone ‘for free’ (e.g. roads, education, and in many countries, healthcare). As a result, many have made the illegitimate leap of implying non-excludability from those goods that happen to be financed and distributed by the government.

Holcombe (1997) argues that the theory of public goods created by Samuelson (1954) and Bator (1958) is often conflated with positive explanations of public expenditures, as most goods provided by governments are often Samuelsonian private. Yet, the public goods argument is inexorably linked to both positive and normative accounts of public vs. private behaviors. Holcombe argues that governments use such a theory to increase their budgets for providing these goods by propagating a self-serving myth that technical economics proves markets cannot fulfill these needs.

In addition to the three main criticisms above, there is a more foundational issue with assuming an exogenous technological or physical standard for defining public goods. As Wagner (2003) astutely observes, the problem of “free riding is an artifact of a particular set of institutional assumptions.” That is, free riding is only a problem contingent on there being some greater *institutional* failure. In the abstract realm of pure economic theory purged of any real-world institutions, anonymous rational-maximizers can

indeed fail victim to the free rider problem.<sup>2</sup> Thus, it is not enough to simply identify that a good has the *potential* to exhibit the free rider problem, what matters is the *institutional environment* within which this good exists. Enterprising individuals recognizing an opportunity can thus use market, political, or cultural institutions in ways that are “productive, unproductive, or destructive” (Baumol 1990) to earn personal profits.

Following Buchanan (1959), I argue that as political economists constrained by imperfect information about individual preferences and opportunity costs, we must treat public goods more as an endogenous component of collective decision-making. With this new conception of political economy, it makes more sense to view “public goods” partially as a feature of a political argument used by some individuals to extend their political sphere of influence over commercial exchange or other voluntary social relationships. An economist, pundit, or political agent may use the concept of public goods as a normative argumentation device, perhaps contingent upon their relationship with a political authority, in order to extend their political influence over production or distribution of a particular good.<sup>3</sup>

### **3. The Endogenous Theory of Public Goods: Political Entrepreneurship**

In laying out the endogenous theory of public goods, it might be useful to start with an analogy to the theory of private goods: Oil in the ground is mere black goo. Were geologists or physicists to discover it first, they may derive technical and conceptual definitions for oil based on its chemical content, fluid dynamics, or other objectively verifiable characteristics. However, it takes a subjective act of entrepreneurship to make that black goo into something of value for society (beyond mere scientific study). An enterprising individual must recognize, and personally bear the risk to bring about, in hopes of personal profit, the potential benefits of extracting, refining, processing, and selling oil and oil by-products to

---

<sup>2</sup> Indeed, some experimental evidence further confirms that individuals free ride less when their actions are no longer anonymous (McCaleb and Wagner, 1985). Applying this critical role of institutions in preventing Hardin’s original tragedy of the commons example, Cole et al. (2014, 353) similarly point out that Hardin’s (1958) original tragedy of the commons results only with a specific set of flawed institutions.

<sup>3</sup> Holcombe (1997) comes closest to arguing this, but instead puts forth a more general argument that it is simply in the interest of “the State” (collectively conceived) to promote a mythos of public goods qua non-rivalrous non-excludable goods requiring government provision, using the examples of education and national defense. Holcombe’s analysis consists of broad strokes, where a truly endogenous approach would consider individual persons with subjective and conflicting views of what are public goods and how to direct scarce and rivalrous public finances towards providing them.

consumers and other firms as a fuel source to be used to power automobiles, factories, and the modern world. It requires integration with the current capital structure of complementary goods all calibrated to serve the demands of consumers through time. Entrepreneurship is ultimately what creates value from land.

I propose that there is a similar analogy for those types of goods that economists typically define as “public.” Instead, it requires the acts of choice by individuals, which will affect others externally, to consider a good to be worth producing politically or privately. It takes an entrepreneur, often in the political realm, to recognize and bear an opportunity for personal gain, to convince members of the public (as voters, bureaucrats, legislators, firms) that the government must provide a good to meet the needs of society. As the realm of politics is largely one of language, it requires considerable rhetorical investment in the scientific language of public goods (the exogenous definition) in order to convince a sufficient number of people that they are “good for the public” and should be produced or subsidized by the public till. Thus, just as oil in the ground is only given value by private entrepreneurship, I argue that goods only take on “publicness” attributes by public entrepreneurship. An enterprising individual can recognize that there is a greater profit opportunity to be made by utilizing the political process, rather than through the market process (Holcombe 2002: 143).

The logical models of public goods in blackboard abstractions omit the critical components of time, innovation, and economic organization that go a long way in determining real world outcomes.<sup>4</sup> As an example, consider the example of wireless networking (“Wi-Fi”). In and of itself, Wi-Fi meets the exogenous public goods test: one’s use of a Wi-Fi network in a public area does not prevent other people from simultaneously using the same Wi-Fi network,<sup>5</sup> and no person has the ability to exclude other people from using the network. However, it is simple, almost trivial, to transform Wi-Fi from a public good to a club good, where a group of users can exclude non-group members from using the network (Buchanan 1962): The owner of the network can simply place a password on the Wi-Fi network and selectively give the password out to her friends (the “club” members).

There are several major aspects of political entrepreneurship that are important for seeking public support for government provision or assistance in producing some good through the public goods

---

<sup>4</sup> I thank an anonymous reviewer for calling my attention to the importance of these omissions.

<sup>5</sup> In the upper limit, with many users simultaneously using the same network, Wi-Fi might be considered a common resource, subject to a tragedy of the commons: If enough people download large files simultaneously on the same network, the network will slow down as broadband becomes more scarce and rivalrous.

argument. First, what constitutes a public good, or a good that has benefits that spill over to others, is to a large degree subjective, and depends upon individual preferences for how *other* individuals are to behave. Second, individuals seeking to use the political process to obtain a private benefit must build a coalition to persuade enough other individuals that the authority ought to invest in a particular enterprise. Rather than economic competition or innovation, this requires the employment of rhetorical strategies and masquerading of private benefits as something “good for the public” and may use the logic of public goods as justification.

### **3.1. Subjectivity of Public Goods**

As economic value is subjective and determined by individual choosers, outside observers can only make sense of the value and purposes placed on economic objects by interpreting human exchanges. A woman purchasing an apple to consume can safely be said to value the apple more than the money given up for it in exchange. It is less clear cut, however, to analyze actions that affect other people, and furthermore, individual preferences over those other-regarding actions (Aligica and Tarko 2013). Just as “one man’s trash is another man’s treasure,” one person’s subjective belief that an action constitutes a social harm may just as legitimately be viewed as a social benefit by another person.

Suppose a fervent vegetarian argues for moralistic reasons that the slaughter of animals for consumption ought to be prohibited by law. Assuming the law can be perfectly enforced, all citizens can simultaneously enjoy the ‘benefit’ (in the vegetarian’s view) of living in a humane society where animals are not slaughtered, and none can be excluded from it. This good appears to pass the exogenous public good criteria, so long as it is viewed from the subjective perspective of the vegetarian. On the other hand, a fervent carnivore could plausibly argue for equal and opposite moral or practical reasons that the slaughter of animals must be allowed, encouraged, or perhaps even subsidized. Advocates of such a dietary choice would view the fact that meat is equally available to all as a social benefit, again, passing the exogenous public good test. Each advocate may furthermore view the opposite proposal as a public bad, conferring moral or material harms upon society.

While this example may seem docile or slightly absurd, it is effortless to extend this logic to contemporary political issues such as gay marriage, environmental preservation, gun ownership,

transgender bathroom access, immigration, social welfare programs, or certain religious practices. Each issue will depend upon how different individuals subjectively view the external benefit or harm to society from allowing persons to marry whom they choose, to carry firearms, or to engage in peculiar religious practices. Even the existence of markets and democratic institutions themselves may constitute exogenous public goods as (ideally) all individuals can enjoy the *existence* of the services these institutions provide without excluding or subtracting from others' benefits from the system. Such arguments are common in the literature on sentimental or “existence value” for preserving the environment – people who do not use, or may never even visit the preserved land supposedly all enjoy positive value from simply *knowing that it exists* (Krutilla 1967).

In any event, the relevant issue is how these different individuals subjectively perceive these externalities to be *policy relevant* (Aligica and Tarko 2013). People who have very strong preferences about other people's behavior will view the other person's behavior as an externality upon themselves and upon society. Those that are indifferent or do not have a horse in the race may not be swayed by the public good argument. Rather than whether a good can objectively be proven to exogenously exhibit non-rivalry and non-excludability, the key component is that these criteria are largely met *within* the mind of a proponent of these services.

## **2.2. Democratic Coalition-Building**

In modern democracies, government provision or assistance in providing public goods requires at least the passage of a new law or the establishment of a new regulatory agency. As Buchanan and Tullock (1962) demonstrate, individuals have heterogeneous preferences that may often be incommensurate, but political institutions in some sense reach consensus on the goods that must be provided (e.g. common defense). In a modern, democratic society, this requires entrepreneurs to assemble a political coalition that is either sufficient to pass majority voting, or can influence a regulatory agency. Again, due to the subjectiveness of public goods, entrepreneurs need not convince *everyone* of the goods' public benefits (as is unlikely in a large pluralistic society), but only the politically-influential coalition of sufficient size.

Public choice economists have long noted the dominant influence on politics of those coalitions that are able to concentrate benefits and diffuse costs. Olson (1965) describes how smaller groups that stand

to benefit from a particular policy have lower costs of organization and lobbying political authorities than those larger groups that must bear most of the cost (as each individual only bears a very small proportion of the total cost). In the case of many goods that the government provides or subsidizes, from agricultural subsidies to sports stadiums to scientific research, the individual taxpayer only pays pennies or dollars each year in taxes to finance these programs. However, the recipients of these finances, the wheat farmers, the sports team owners, and the scientists receiving grant money, each earn very large private benefits.

The exogenous theory is often invoked as a positive, explanatory account of why government provides the particular goods that it does, often alleging markets had failed to adequately provide the goods prior to government involvement. However, many very careful works of economic history have uncovered that many episodes of the U.S. federal government expanding its regulatory or administrative powers have been as a response to market players lobbying the government to intervene to weaken rivals in a very competitive market. Kolko (1963) provides a revisionist history of Progressive Era, where large private interests captured the government and passed landmark antitrust and pro-labor legislation in order to dominate rivals in competitive markets, unlike the standard story of progressives regulating industry and setting up administrative agencies as a benevolent response to monopoly power and market failure. McGee (1958), Posner (1978), DiLorenzo (1985, 1992, 1996), DiLorenzo and High (1988), and Boudreaux and DiLorenzo (1993) document, in similar fashion, how many of the key expansions of government regulation over competition (namely, antitrust laws) originated not as a *reaction* to overt monopolization, but rather, in most cases, as rent-seeking by industry players masquerading as protecting consumers from monopoly. Many of the economic tools which economists use today to both positively explain and normatively justify regulations or antitrust policies came during the mid-20<sup>th</sup> century, once welfare theorists such as Pigou (1920), Samuelson (1954), and Bator (1958) formalized the idea of externalities, public goods, and market failures, respectively. These tools emerged *after* the key regulatory powers were assumed by progressive governments, and hence provide great *ex post facto* rationalizations, but inaccurate economic history.

Thus, there are often clear beneficiaries when the government subsidizes production of a particular good, who will organize public opinion by way of public goods-type arguments. Public goods arguments can serve as a good catalyst for convincing individuals to support a program that would provide something that is argued to be “good for the public.” Indeed, many have pointed out that are reasons that political

provision may crowd out private provision (Podemska-Mikluch and Wagner 2013; Martin 2010; Wagner 2007). Ideas, ideological rhetoric, and cognitive biases towards political control may bias public support towards political provision relative to market provision, where entrepreneurs must make practical appeals to price and material satisfaction.

In politics, since there is no residual claimancy (Acemoglu 2003), agreement over the most efficient stewardship over public resources cannot be settled by reference to market prices or other objective criteria. As a result, heterogeneous preferences in politics creates conflict that is inefficiently and ephemerally resolved. Indeed, it is often conflict in preferences and dissent from the status quo that sets the political process in motion, as will be discussed below. The cost of holding and acting upon irrational beliefs is very low due to the low marginal benefit that comes from voting, if voting is merely instrumental in influencing policy (Caplan 2007).

Entrepreneurs hoping to use the political process rather than the market process must employ language that masks the fact that they have potential to gain from particular policies, or else others would see through the rhetoric and reject the proposal (Wagner 2007). Instead, they make appeals to the “public interest” or other vague notions that tend to corrupt the language of politics and create deviations between announced and actual intentions (Ostrom 1997). In Yandle’s (1983) parable of “Baptists and Bootleggers,” they must use the moralistic language of the “Baptists,” to convince the polity of the beneficence of their proposal, even if they or their allies stand to materially benefit as “Bootleggers.” Naturally, one of the most appealing and convincing rhetorical devices is to propose a political enterprise that appears to have some objective backing from the mantle of science. Public goods arguments, using the exogenous definition above, may provide a perfect combination of such qualities.

#### **4. Case Study of Political Entrepreneurship in Creating Public Goods: Scientific Research**

Scientific research is one of the quintessential examples of a public good. Indeed, it is difficult to find a purer public good than ideas and inventions that can benefit all of mankind. Once an idea or an invention is discovered, all can potentially acquire the knowledge and benefit from it. Scholars can use scientific theories posited from across the globe, economic competitors can copy and produce another’s profitable invention, and consumers the world over benefit from the creature comforts spawned by

improvements in technological understanding. Partially as a result of this logic, it is common knowledge that modern democratic governments sponsor basic research by allocating grants to fund scientists out of the fear that private markets do not face adequate incentives to fund basic research. However, although basic scientific research might appear logically to constitute a public good, this logic neither explains the historical lack of government sponsorship of science, the multitude of private sponsorship of science, nor the political advocacy of prominent scientists, as scholars such as Terence Kealey (1996; 2009) have documented.

#### **4.1. Scientific Research as Exogenous Public Good**

“Science” and “knowledge” constitute an enormous swath of human endeavors, thus I must first clarify the limits of this brief analysis. I intend to focus primarily (but not exclusively) on *basic* scientific research. The International Council for Science defines basic research as

fundamental theoretical or experimental investigative research to advance knowledge without a specifically envisaged or immediately practical application. It is the quest for new knowledge and the exploration of the unknown. As such, basic science is sometimes naively perceived as an unnecessary luxury that can simply be replaced by applied research to more directly address immediate needs (ICSU, 2004).

At this stage, there is the highest degree of uncertainty that one’s exploratory efforts will yield anything of value, either in terms of advancing scholarly understanding, or producing a technology that can be transformed into a profitable good or service by private enterprise or government procurement. Projects such as the European Organization for Nuclear Research (CERN)’s use of particle accelerators in the search for fundamental physical particles, constitute this category. It is this particular type of research that is often argued to be far too abstract to be profitable for private enterprise to fund, and where Smith’s dictum above, about government taking on the responsibility of unprofitable public works, applies strongest. Hence, the average educated person can point to the Manhattan Project’s construction of the first U.S. nuclear weapon, NASA’s operations that landed a man on the moon, and the Department of Defense’s ARPANET launching the network that would evolve into the modern internet. All were significant projects undertaken by the U.S. Federal Government, and required gargantuan expenditures. Some economists even argue that we do not take these instances seriously enough, that we undervalue the extent to which the federal government involves itself with what is ostensibly private research (Mazzucato 2013).

The view of science as a public good in the West can be traced back at least as far as Sir Francis Bacon, one of the earliest and most revered scientists, and also the man who invented the very idea of “progress” (Dalrymple 2003: 37). Bacon (2000 [1620], p.99) notes that “the benefits of discovery may extend to the whole human race [and] for virtually all time.” Kealey (1996: Chapter 1; 2006: Chapter 1) describes how Bacon’s motivation for famously claiming that “knowledge is power” was the Englishman’s search to discover how the Spanish succeeded in becoming the world’s greatest empire in his day. Bacon concluded that it was a result of the Spanish government’s command of technology, derived from Prince Henry the Navigator’s public backing of scientific discovery. Bacon (2000 [1620], p.99) concludes, “there is not any part of good government more worthy than the further endowment of the world with sound and fruitful knowledge.”

The idea that knowledge is—in modern economic parlance—non-rivalrous has been floated by the scientific and political elite for ages. Thomas Jefferson’s famous letter to Isaac McPherson describes how “He who receives an idea from me, receives instruction himself without lessening mine; as he who lights his taper at mine, receives light without lessening mine” (Lipscomb and Bergh 1905). Economists since Smith have taken the idea of granting specific patents and copyrights for inventors and authors as an important function of the sovereign. Solow (1957) famously described the paramount importance of technological development for economic growth, linking innovation and technology policy with development policy. It was primarily Arrow (1962) who provided the first major examination of the problems of “inappropriability” of information through the lens of public good theory, where an original discoverer could not appropriate a sufficient amount of the social surplus generated by the discovery to justify innovation in the first place (as expected returns would be negative). Furthermore, as ideas can be shared at a marginal cost of at or near zero, the efficient “price” of information would also be zero, a clearly unprofitable venture. Later endogenous growth theory researchers such as Romer (1990) famously describe the positive spillover effects of knowledge and scientific discovery, where productivity gains are captured by entire industries, rather than just the discovering firm or inventor, which cannot be captured in market prices. Dalrymple (2003) extends the logic further and calls science a “global public good” for these reasons.

#### 4.2. Is Science a Public Good?

There are issues with viewing and modeling knowledge and scientific research as a public good as described above. First, although it is likely less of an important effect for knowledge and science in general, but as valuation of the externality is subjective, there is the possibility that others may value the social benefit of new knowledge differently. For example, various naturalists, primitivists, and religious fundamentalists probably do not view science or technological discoveries as public goods. They are either indifferent or, quite possibly harmed by such things and view them as public *bads*. Such people have just as much technical cause to argue for the non-rivalry of science, in their perspective, actively harming the entire human race in the eyes of God, invoking the fatal hubris of man in trying to control the heavens, or perhaps risking the Earth's environment with greater technology requiring greater energy sources and resources (Storr, 2014). Indeed, most historians and students of science can recall the Catholic Church's trial of Galileo in 1633, who was found to be "vehemently suspected of heresy," and was required to "abjure, curse, and detest" the belief—contrary to Holy Scripture—that the Earth was not the center of the universe (Santillana, 1995, pp. 306-310).

Furthermore, the exogenous approach to public goods seems to imply that any new discovery is instantly broadcasted without discrimination as is a radio broadcast to any and all anonymous users capable of hearing it, and who all have sufficient interest and ability to rapidly reproduce it and capture all the value of the discovery before the discoverer can appropriate any of it. The real economic cost of broadcasting that knowledge, however, is rarely zero. Ask any teacher – both they and their students must expend substantial resources to both convey and understand, respectively, information that is often '*freely*' available on the internet! Even if the cost of disseminating information or inventions were zero, however, once a discovery is reverse-engineered and replicable, the copier still must replicate the embodied knowledge and produce the product, which requires high investments in a complementary structure of capital with specific uses directed at producing that good. Mansfield et al. (1981) estimated across 48 different products that were reverse engineered and copied by market competitors that the cost to those competitors of copying constituted about 65% of the cost of the original innovation and 70% of the time it took the first-mover to come to market. This should not surprise economists familiar with Hayek (1945), who reminds us that most relevant knowledge for economic action is tacit, and can only come from experience and "rapid adaptation

to changes in the local circumstances of time and place.” Simply giving a new pharmaceutical pill or a nuclear propulsion system to a random person to reverse engineer and copy would be akin to pulling a random person off the street and have them perform open heart surgery. Thus, only those experts that have themselves generated enough tacit knowledge through their own studies and scientific pursuits (and publications) are able to utilize the knowledge and discoveries of others. Kealey and Ricketts (2014) show that in effect, science and discovery is less of a public good, and more of a “contribution good” or a club good, as it benefits only those who are already scientists in the relevant fields themselves.

Thus, when academics send out manuscripts in the hopes of publication, they are reviewed by other academic experts who themselves have often published in the same field, rather than to random academics from other fields, or, worse yet, non-academics from the real world. Only those other academics have the tacit knowledge to criticize and/or disprove the article in question, something journal editors would prefer, rather than having an obviously wrong or misleading article slip through and reduce the reputation of the journal.

As a consequence, many scholars have productively examined science and discovery as a common resource, governed by the informal norms of the scientific community. Polanyi (1962) famously describes the “republic of science” as a spontaneous order of individual scientists cooperating and interacting according to the rules and norms of the scientific method, peer review, and prestige. Tarko (2015) documents the successes and challenges of the scientific community in the context of an institution that manages public goods on a global scale.

To be clear, the scholarly debate over whether or not science is a public good does not in and of itself disqualify other legitimate reasons for governments to fund, allocate, or nudge research. Indeed, even those who agree that basic scientific research does not constitute a technical public good put forth arguments on other grounds that scientific research deserves government sponsorship to some degree (see e.g. Guston 2013; Harden 2013). There may be many other legitimate reasons for government intervention or direction in scientific research. The controversy over science being a public good only implies that scientific research may not be as prone to failure or under-supply outside of the present regime of government allocation of scientific grants, especially as the present institutional arrangement in the United States is barely half a century old (as described below).

### 4.3 Political Entrepreneurship and the Origins of Government-Funded Science

Historically, science was rarely, if at all, funded by governments. Rather, science was either the pursuit of independently wealthy men like Bacon, Descartes, or Montaigne, or by the wealthy elite acting as philanthropic patrons for clients like Galileo, Da Vinci, and Copernicus (David 2001; 2008). Many researchers recognize that technological advancement and economic growth largely does not come from basic scientific research (Ridley 2008, p. 255-258ff). Indeed, it is a common refrain among economic historians to note that civilizations like Song China and the Islamic caliphates of the Medieval era had spectacular bursts of invention and discovery—printing, gunpowder, algebra—and yet it was only relatively “backward” Medieval Europe that would one day escape poverty at an unrivaled scale (Rosenberg and Birdzell, 1986, p.9, Ch. 9; Diamond, 1999).

Indeed, the Organisation for Economic Co-operation and Development itself surprisingly demonstrates that technological and economic growth are *negatively* impacted by government research & development, and positively impacted by *private* research & development. Their results “suggest that publicly performed R&D crowds out resources that could be alternatively used by the private sector, including private R&D (OECD 2003: 84). Park (1998) finds similar results in a theoretical model, noting a negative correlation between government research and economic growth in developed countries, but cautions that it is not clear how causal these results are. In any event, government sponsorship of research is a relatively new phenomenon.

Kealey (1996: Ch. 12; 2013) documents how, in the United States, the government did not begin any sort of subsidization of scientific research until 1940.

As late as 1940...the U.S. total annual budget for research and development (R&D) was \$346 million, of which no less than \$265 million was privately funded (including \$31 million for university or foundation science). Of the federal and states governments’ R&D budgets, moreover, over \$29 million was for agriculture...and \$26 million was for defence...America, therefore, produced its industrial leadership, as well as its Edisons, Wrights, Bells, and Teslas, under research *laissez faire* (Kealey 2013, emphasis in original).

The U.S. Constitution does authorize Congress to act “to promote the Progress of Science and useful Arts” in Article I, Section 8, Clause 8, but primarily to establish patents (“by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries”). It was under this and other constitutionally-enumerated authority that early Congresses quickly passed acts establishing,

patents (1790), copyrights (1790), the Library of Congress (1800), and a Coast Survey (1807). None of these however were viewed or designed to have the federal government administer, manage, or fund scientific research.

The fear of the politicization of science was never far from the minds of the public and of scientists. Ultimately, it was only during wartime and national emergencies that scientists were able to have their lobbying efforts pay off and yield any substantial transfer of scientific resources from private to public hands. As Higgs (1989) demonstrates, it is through crisis periods that governments obtain new authority, and once the crisis ends, institutional momentum makes it difficult for the new authority to recede. Below are three major episodes of how three different political entrepreneurs utilized these crisis points to found national institutions that progressively brought government influence over scientific research.

The first push for any major government involvement in science occurred, along with many other expansions of federal power, during the Civil War. A tidal scientist (and prestigious great-grandson of Benjamin Franklin) named Alexander Bache had been campaigning for an American academy of science along with all of the prestige and rewards that national academies had brought to the British and French elite (Kealey 1996: 234). Bache helped create his own private group of elite scientists, whom he called the Scientific Lazzaroni (Italian for beggars) to push for the standardization and nationalization of American science, modelled on the prestigious government-backed national academies in Europe (NAS 2016a). As early as 1851, Bache and the Lazzaroni sought to convince Congress and the public that “an institution of science [was needed] to guide public action in reference to science matters,” (*ibid*). Such cries fell on deaf ears for over a decade. Only the outbreak of war in the 1860s would provide the key opportunity for Bache to emphasize the public benefits of science for the war effort. Another leading scientist and Lazzaroni member, Joseph Henry, working for the U.S. Navy, called for the establishment of a commission to test new weapons (*ibid*). Together with the political support of Massachusetts senator Henry Wilson, Congress finally established the National Academy of Sciences (NAS) in 1863 to advise various government departments “whenever called upon,” and consistent with the history of separation of science and State, “[t]he Academy receives no compensation from the government for its services” (NAS 2016a; 2016b). Bache, naturally, was appointed as the Academy’s first president. The Academy historically assisted the

government in understanding how to upgrade its wooden naval fleet to ironclads, and update the weapons of its infantry amidst the Civil War.

The founding of the Academy was surprisingly controversial among scientists and the general public beyond the Lazarroni. The popular scientific periodical, *Scientific American* wrote op-eds about how this new institution would enable government control of science and the provide benefit to government scientists at the expense of objective truth (Kealey 1996: 235). However, over time, the NAS persisted as no group could sufficiently organize to remove the institution.

During World War I, the next major expansion of government involvement in science occurred amid the opportunism of wartime. An astronomer, and influential member of the newly established Academy, George Ellery Hale, called upon the NAS to form the National Research Council to assist the President the day after the United States declared war on Germany in 1917 (Kealy 1996: 240). Hale himself chaired the Council, which oversaw the development of poison gas, submarine detection, and IQ tests. Hale wrote to President Wilson to indicate that, although the Council had been created for purposes of wartime expediency and aid to the military effort, his he saw a role for the Council during peacetime to “stimulate pure and applied research for the national welfare.” (ibid, 241). This mission creep ensured that the Council Hale had built would persist despite the national emergency ending. Despite persistent lobbying efforts, Congress could not be persuaded to pass an Act to continue funding the NRC after the war (the Democrats in control remained skeptical of government management of science, which they viewed as a commercial activity). Ultimately, it would be through Hale’s connection with President Wilson, which prompted Wilson to issue an executive order mandating the Council’s continuity.

The final major act of political entrepreneurship which ushered in our current institutional regime of government allocating scientific grants also had its origins during wartime. During World War II, Vannevar Bush, the president of the private Carnegie Institution (then the U.S.’ largest funder of science) publicly lamented in his renowned *Science: The Endless Frontier* that “we have no national policy for science,” calling for a national foundation to coordinate and invest in science for the whole country (Kealy 1996: 245). Following the hints of war with Japan and Germany in the early 1940s, Bush was able to lobby President Roosevelt into creating the National Defense Research Committee (NDRC), with Bush as its chairman. Congress ultimately adopted the NDRC by law as the Office of Scientific Research and

Development (OSRD), again with Bush as the chairman, with access to \$1.6 billion in federal funds, primarily to research defense and the feasibility of nuclear weaponry (ibid, 245). Following the war's conclusion, Bush and his allies lobbied further for a National Science Foundation, envisaged as a federal institution that would allocate research grants to scientists, as selected by other scientists on the basis of merit. This met with significant political opposition, led by Senator Harley Kilgore, and ultimately even President Truman, who vetoed Bush's proposal, instead suggesting that the institution should be run by politicians and bureaucrats who allocated the grants according to "national need," indicating that Bush's proposal of scientists funding other scientists would,

"vest the determination of vital national policies, the expenditure of large public funds, and the administration of important governmental functions in a group of individuals who would be essentially private citizens. The proposed National Science Foundation...implies a distinct lack of faith in democratic processes" (quoted in Kealey 1996: 247).

As such, even the President noted that such a policy would effectively provide concentrated benefits to those scientists. However, the opposition faded as yet another wartime opportunity, this time the Korean war and the start of the Cold War, took hold. Congress passed the National Science Foundation Act of 1950, and gave the agency the mission "to promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense" (NSF 2015). Following the Soviet Union's launch of Sputnik in 1957, public support for government funding of scientific research, both through NSF, and through the newly established NASA, soared. In 1940, the federal government had spent \$22 million (in 1950 USD) on financing research, but by 1960, it was almost \$3 billion (Kealey 1996: 248). Today, the NSF has a budget of about \$7.3 billion (NSF 2015). As evidence by the common popular quips about how the United States can put a man on the moon or build atomic weapons, public support for federal funding of science remains strong.

#### **4. Implications**

The connection between formal public goods theory and welfare economics and public finance has been engrained in the technical economic literature for over 50 years. As scholarship taking institutional and political economy analysis seriously is on the rebound, we should welcome extensions of this form of analysis into sacred areas of formal economics. As such, this paper has provided a sketch of how we might

consider a more robust form of public goods as defined by their emergence within an entangled system of political economy.

The goal of this type of analysis is to continue extending positive analyses of public finance and public goods that describe them as they actually exist and emerge, rather than as normative policy prescriptions. The normative aspect of public goods theory is safely and hermetically sealed within the preferences of different individuals over the behavior of others within a society. As such, this implies that public goods theory cannot by itself provide a normative policy prescription through technical economic analysis. It requires further preferences and ideological support on the part of the economist or advocate, which requires a shift of intellectual resources away from technical public goods arguments and into other territory. As for public goods economists typically describe, it seems more appropriate to consider them an endogenous component of collective decision-making—governments provide particular goods not from a normative imperative or technological determinism, but simply because people want them to.

Perhaps a better approach would be to follow Woolley’s (2006) apparent advice to deemphasize public goods as a separate research program and pedagogical tool in favor of a concept that is far more robust and with a more fruitful literature: externalities. What is a public good if not simply a special case of a very large positive externality? In fact, Woolley (2006: 10) demonstrates that Samuelson’s (1954) optimality condition for efficient public goods provision,

$$\sum_{i=1}^n MRS_i = MRT$$

can trivially be rewritten as:

$$MRS_i + \sum_{i \neq j}^{n-1} MRS_j = MRT$$

where provision of public good  $x$  for person  $i$  produces a private benefit to person  $i$  plus a positive externality to all other individuals  $j \neq i$ . Hence, an efficient solution requires internalizing these positive externalities to produce enough of good  $x$  to reflect private valuations of the benefits of  $x$ . There is still the preference revelation mechanism dilemma that Samuelson (1954) is correctly concerned with. Furthermore, by reframing the dilemma as coping with a positive externality, we are able to tap into the vast literature of how different institutional arrangements cope with externalities.

There is some evidence for using this approach. Hammond (2015) describes how Samuelson (1969: 102), attempting to set the record straight for his critics, redefines public goods as “A public good...is simply one with the property of involving a ‘consumption externality,’ in the sense of entering into two or more persons’ preference functions simultaneously.” By operationalizing public goods as any good entering multiple utility functions (and not necessarily *everyone’s* utility function), this virtually makes every good a public good, and therefore reduces the analytical insight of public goods as a unique economic concept.

Where does this leave economists in using public goods as justification for government expenditures? Perhaps rather than attempting to use the mantle of science and justify government intervention through the public goods argument, we should instead simply call a spade a spade: and recognize that arguments for government provision are normative and based upon differing preferences, not technical disagreements. A positive theory of government expenditures and public goods recognizes this as a component of political economy. A better distinction between “public” and “private” goods might be those goods that are provided by government *de facto* are “public” and those that are provided by markets *de facto* are “private.” Both entities are capable of providing both types of goods, and this explanatory definition says nothing normative about whether one entity should provide one or the other.

## References

- Acemoglu, Daron. 2003. “Why not a Political Coase Theorem? Social Conflict, Commitment, and Politics.” *Journal of Comparative Economics*, 31: 620-652.
- Aligica, Paul Dragos, & Vlad Tarko. 2013. “Co-production, Polycentricity, and Value Heterogeneity: The Ostroms’ Public Choice Institutionalism Revisited.” *American Political Science Review*, 107(4): 726-741.
- Anderson, Terry and Peter J. Hill. 2004. *The not so wild, wild west: Property rights on the frontier*. USA: Stanford Economics and Finance.
- Bacon, Francis. 2000 [1620]. *The New Organon*. L. Jardine and M. Silverthorne, eds. Cambridge, UK: Cambridge University Press
- Bator, Francis. 1958. “The Anatomy of Market Failure.” *Quarterly Journal of Economics*, 72: 351-379.
- Benson, Bruce L. 1989. “The Spontaneous Evolution of Commercial Law.” *Southern Economic Journal*, 5: 644-661.
- Boudreaux, Donald J. and Thomas J. DiLorenzo. 1993. “The Protectionist Roots of Antitrust.” *Review of Austrian Economics* 6(2): 81-96.
- Buchanan, James M. 1959. “Positive Economics, Welfare Economics, and Political Economy.” *Journal of Law and Economics*, 2: 124-138.

- \_\_\_\_\_. 1964. "What Should Economists Do?" *Southern Economic Journal*, 30(3): 213-222.
- \_\_\_\_\_. 1965. "An Economic Theory of Clubs." *Economica*, 32(125): 1-14.
- \_\_\_\_\_. 1967. "Public Goods in Theory and Practice: A Note on the Minasian-Samuelson Discussion." *Journal of Law and Economics* 10: 193-197.
- Buchanan, James M. and Gordon Tullock. 1962. *The Calculus of Consent: Logical Foundations of Constitutional Democracy*. Ann Arbor, MI: University of Michigan Press.
- Caplan, Bryan. 2007. *The Myth of the Rational Voter: Why Democracies Choose Bad Policies*. Princeton, NJ: Princeton University Press.
- Cheung, Steven N.S. 1973. "The Fable of the Bees: An Economic Investigation." *Journal of Law and Economics*, 16: 11-33.
- Clapham, J. H. 1922. "Of Empty Economic Boxes." *The Economic Journal*, 32(127): 305-314.
- Coase, Ronald H. 1974. "The Lighthouse in Economics." *Journal of Law and Economics*, 17(2): 357-376.
- Cole, D. H., Epstein, G., and McGinnis, M. D. (2014). Digging deeper into Hardin's pasture: the complex institutional structure of 'the tragedy of the commons'. *Journal of Institutional Economics*, 10(3):353–369.
- Cowen, Tyler. 2005. Self-deception as the root of political failure. *Public Choice*, 124(3): 437-451.
- Coyne, Christopher J. 2015. "Lobotomizing the Defense Brain." *The Review of Austrian Economics*, 28(4): 371-396
- Dalrymple, Dana. 2003. "Scientific Knowledge as a Global Public Good: Contributions to Innovation and the Economy" Chapter 5 in National Research Council, *The Role of Scientific and Technical Data and Information in the Public Domain: Proceedings of a Symposium*. Washington, DC: The National Academies Press.
- David, Paul A. 2001. "From Keeping 'Nature's Secrets' to the Institutionalization of 'Open Science'." *University of Oxford Discussion Papers in Economic and Social History* 23.
- \_\_\_\_\_. 2008. "The Historical Origins of 'Open Science': An Essay on Patronage, Reputation and Common Agency Contracting in the Scientific Revolution." *Capitalism and Society*, 3(2): 1-103.
- Davies, Stephen. 2002. "The Private Provision of Police During the Eighteenth and Nineteenth Centuries." In *The Voluntary City: Choice, Community, and Civil Society*, ed. David T. Beito, Peter Gordon, and Alex Tabarrok, 151-181. USA: University of Michigan Press.
- Diamond, Jared M. 1999. *Guns, Germs, and Steel: The Fates of Human Societies*. New York: W.W. Norton & Company.
- DiLorenzo, Thomas J. 1985. "The Origins of Antitrust: An Interest-Group Perspective." *International Review of Law and Economics* 5:73-90.
- \_\_\_\_\_. 1992. "The Myth of Predatory Pricing." *Cato Policy Analysis*, No. 169.
- \_\_\_\_\_. 1996. "The Myth of Natural Monopoly." *Review of Austrian Economics* 9(2): 43-58.
- DiLorenzo, Thomas J. and Jack High. 1988. "Antitrust and Competition, Historically Considered." *Economic Inquiry* 26(3): 423-435.
- Demsetz, Harold. 1964. "The Exchange and Enforcement of Property Rights." *Journal of Law and Economics*, 7: 11-26.
- \_\_\_\_\_. 1970. "The Private Production of Public Goods." *Journal of Law and Economics*, 13: 293-306.

- Ellickson, Robert. 1994. *Order Without Law: How Neighbors Settle Disputes*. Cambridge, MA: Harvard University Press.
- FRED. 2015. "Government Total Expenditures" and "Gross Domestic Product." Federal Reserve Bank of St. Louis.
- Friedman, David D. 1979. "Private Creation and Enforcement of Law: A Historical Case." *Journal of Legal Studies*, 8: 399-415.
- Goldin, Kenneth D. 1977. "Equal Access vs. Selective Access: A Critique of Public Goods Theory." *Public Choice*, 27: 53-71.
- Gruber, Jonathan. 2011. *Public Finance and Public Policy*, 3<sup>rd</sup> ed. New York: Worth Publishers.
- Guston, David. 2013. "The State Will Always Need Science," *Cato Unbound*. August 13, 2013. <<http://www.cato-unbound.org/2013/08/14/david-guston/state-will-always-need-science>>
- Harden, Victoria. 2013. "History Supports Government Funding for Public Health." *Cato Unbound*. August 7, 2013. <<http://www.cato-unbound.org/2013/08/07/victoria-harden/history-supports-government-funding-public-health>>
- Hayek, F. A. 1973. *Law, Legislation, and Liberty Volume 1: Rules and Order*. Chicago: University of Chicago Press
- \_\_\_\_\_. 1989. *The Fatal Conceit: The Errors of Socialism*. London: Routledge
- Higgs, Robert. 1989. *Crisis and Leviathan: Critical Episodes in the Growth of American Government*. Oxford: Oxford University Press.
- Holcombe, Randall G. 1997. "A Theory of the Theory of Public Goods." *Review of Austrian Economics*, 10(1): 1-22.
- \_\_\_\_\_. 2002. "Political Entrepreneurship and the Democratic Allocation of Economic Resources." *Review of Austrian Economics*, 15(3): 143-159.
- ICSU. 2004. "The value of basic scientific research." *International Council of Science*. <<http://www.icsu.org/publications/icsu-position-statements/value-scientific-research/the-value-of-basic-scientific-research-dec-2004>>
- Kealey, Terence. 1996. *The Economic Laws of Scientific Research*. New York: St. Martin's Press.
- \_\_\_\_\_. 2009. *Sex, Science, & Profits: How People Evolved to Make Money*. London: Vintage Books.
- \_\_\_\_\_. 2013. "The Case Against Public Science." *Cato Unbound*, August 5, 2013. <<http://www.cato-unbound.org/2013/08/05/terence-kealey/case-against-public-science>>.
- Kealey, Terence and Martin Ricketts. 2014. "Modelling Science as a Contribution Good." *Research Policy*, 43: 1014-1024.
- Kolko, Gabriel. 1963. *The Triumph of Conservatism: A Reinterpretation of American History 1900-1916*. New York: The Free Press.
- Klein, Daniel. 2002. The Voluntary Provision of Public Goods? The Turnpike Companies of Early America. In *The Voluntary City: Choice, Community, and Civil Society*, ed. David T. Beito, Peter Gordon, and Alex Tabarrok, 76-101. USA: University of Michigan Press.
- Krutilla, John V. 1967. "Conservation Reconsidered." *American Economic Review*, 57(4): 777-786.
- Leeson, Peter T. and Peter J. Boettke. (2009). "Two-Tiered Entrepreneurship and Economic Development." *International Review of Law and Economics* 29(3): 252-259.
- Li, D. D., J. Feng, and H. Jiang. (2006). "Institutional Entrepreneurs." *American Economic Review*, 96(2): 358-362.

- Lipscomb, Andrew A. and Albert Ellery Bergh, eds. 1905. *The Writings of Thomas Jefferson*, 20 vols. Washington, D.C.: Thomas Jefferson Memorial Association.
- Mankiw, N. Gregory, ed. 2004. *Principles of Microeconomics*. USA: Thomson South-Western.
- Mansfield, Edwin, Mark Schwartz and Samuel Wagner. 1981. "Imitation Costs and Patents: An Empirical Study." *The Economic Journal* 91(364): 907-918.
- Martin, Adam. 2010. "Emergent Politics and the Power of Ideas." *Studies in Emergent Order*, 3: 212-245.
- Mazzucato, Mariana. 2013. *The Entrepreneurial State: Debunking Public vs. Private Sector Myths*. New York: Anthem.
- McGinnis, Michael D., ed. 1999. *Polycentric Governance and Development: Readings From the Workshop in Political Theory and Policy Analysis*. Ann Arbor, MI: University of Michigan Press.
- McGee, John S. 1958. "Predatory Price Cutting: The Standard Oil (N. J.) Case." *Journal of Law and Economics* 1:137-169.
- Minasian, Jora R. 1964. "Television Pricing and the Theory of Public Goods." *Journal of Law and Economics* 7: 71-80.
- National Academy of Sciences. 2016a. "History." <<http://www.nasonline.org/about-nas/history/archives/founding-and-early-work.html>>
- National Academy of Sciences. 2016b. "Mission." <<http://www.nasonline.org/about-nas/mission/>>
- National Science Foundation. 2015. "About the National Science Foundation." <<http://www.nsf.gov/about/>>
- Odagiri, Hiroyuki and Naoki Murakami, 1992. "Private and Quasi-social Rates of Return on Pharmaceutical R&D in Japan." *Research Policy* 21(4): 335-345
- OECD. 2003. *The Sources of Economic Growth in OECD Countries*. Paris: OECD Publishing.
- Olson, Mancur. 1965. *The Logic of Collective Action: Public Goods and the Theory of Groups*. Cambridge, MA: Harvard University Press.
- Ostrom, Elinor. 2010. "Beyond Markets and States: Polycentric Governance of Complex Economic Systems." *American Economic Review*, 100(3): 641-672.
- Ostrom, Vincent. 1997. *The Meaning of Democracy and the Vulnerability of Democracies*. Ann Arbor: University of Michigan Press.
- Park, Walter G. 1998. "A Theoretical Model of Government Research and Growth." *Journal of Economic Behavior & Organization* 34: 69-85.
- Podemska-Mikluch, Marta and Richard E. Wagner. 2013. "Airports and Economic Coordination Within a Mixed Ecology of Enterprises." Working Paper.
- Polanyi, Michael. 1962. "The Republic of Science: Its Political and Economic Theory." *Minerva* 1:54-74.
- Posner, Richard A. 1978. *Antitrust Law: An Economic Perspective*. New York: The Free Press.
- Ridley, Matt. 2010. *The Rational Optimist: How Prosperity Evolves*. New York: Harper Collins
- Romer, Paul. 1990. "Endogenous Technological Change." *Journal of Political Economy* 98:71-102.
- Rosen, Harvey S., Bev Dahlby, Roger Smith and Paul Boothe. 2003. *Public Finance in Canada*, Second Edition. Toronto: McGraw-Hill Ryerson.

- Rosenberg, Nathan and L. E. Birdzell, Jr. 1986. *How the West Grew Rich: The Economic Transformation of the Industrial World*. United States: Basic Books.
- Rothbard, Murray N. 2008 (1962). *Man, Economy, and State with Power and Market*. Auburn, AL: Ludwig von Mises Institute.
- Samuelson, Paul A. 1954. "The Pure Theory of Public Expenditures." *Review of Economics and Statistics*, 36(4): 387-389.
- \_\_\_\_\_. 1955. "Diagrammatic Exposition of a Theory of Public Expenditure." *Review of Economics and Statistics*, 37(4): 350-356.
- \_\_\_\_\_. 1969. "Pure Theory of Public Expenditure and Taxation." in *Public Economics: An Analysis of Public Production and Consumption and Their Relations to the Private Sectors*, J. Margolis and H. Guitton, eds. London: Macmillan, pp. 98-123.
- Santillana, Giorgio de. 1955. *The Crime of Galileo*. Chicago: University of Chicago Press.
- Safner, Ryan. 2016. "Institutional Entrepreneurship, Wikipedia, and the Opportunity of the Commons." *Journal of Institutional Economics*, forthcoming.
- Schotter, Andrew. 1981. *The Economic Theory of Social Institutions*. Cambridge: Cambridge University Press.
- Solow, Robert. 1957. "Technological Change and the Aggregate Production Function." *The Review of Economics and Statistics* 39(3): 312-320.
- Smith, Adam. 1776[1904]. *An Inquiry into the Nature and Causes of the Wealth of Nations*, ed. Edwin Cannan. London: Methuen & Co., Ltd.
- Storr, Will. 2014. *The Unpersuadables: Adventures with the Enemies of Science*. New York: Overlook Press.
- Tarko, Vlad. 2015. "Polycentric structure and informal norms: competition and coordination within the scientific community." *Innovation: The European Journal of Social Science Research*, 28(1): 63–80.
- Tabarrok, Alexander. 1998. "The Private Provision of Public Goods via Dominant Assurance Contracts." *Public Choice*, 96: 346-362.
- US Government Spending. 2015. "US Federal Budget Analyst"  
[http://www.usgovernmentspending.com/budget\\_pie\\_gs.php](http://www.usgovernmentspending.com/budget_pie_gs.php)
- Wagner, Richard E. 2003. "Public finance without taxation: Free-riding as institutional artifact." *Journal of Public Finance and Public Choice* 30, 191–202.
- Wagner, Richard E. 2007. *Fiscal Sociology and the Theory of Public Finance*. Cheltenham, UK: Edward Elgar.
- \_\_\_\_\_. 2013. "Entangled Political Economy: A Keynote Address." *Advances in Austrian Economics*, Forthcoming.
- Yandle, Bruce. 1983. "Bootleggers and Baptists: The Education of a Regulatory Economist." *Regulation*, 7(3): 12-16.