Rooking the State*

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Abstract

Throughout history, governments have engaged in exchange with private actors. Recent work has documented the prevalence of opportunism in a number of government bounty schemes, exploring how private entrepreneurs may rook the state and hence undermine the stated aims of these programs. We draw on transaction cost economics to provide a theory that explains the variation in the extent of opportunism in public-private exchange. The nature and extent of opportunism depends on the ability of the public authority to observe the production process of the good being claimed and the incentives to deny false claims. Where transaction costs limit observation, alternative (i.e., opportunistic) production processes will be prevalent. Where institutional features incentivize lax enforcement, opportunistic production processes will be prevalent. We illustrate our theory with two cases: navigational prizes in Great Britain and wolf bounties in North America. The cases provide evidence consistent with our theory.

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1 Introduction

Governments have engaged in exchange with citizens to solve problems for thousands of years. Greeks employed the use of a bounty to bring a traitor to justice during the Persian Wars (499–449 BC) (Beck 2013). On May 7, 1662, the Massachusetts Bay Colony instituted a bounty with the following words: "This Court doth order, as an encouragement to persons to destroy Woolves, That henceforth any person killing any Woolf, shall be allowed out of the Treasury of that County where such Woolf was slain, Twenty shillings..." (Early American Imprints, 1st series, no. 88).

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At the present day, the United States executive branch operates an "Office of Social Innovation and Participation" that uses "cash prizes and other incentives to reach beyond the 'usual suspects' and increase the number of problem-solvers addressing a critical issue," (White House 2016).[1] As described below, bounties have also been a favorite tool of governments facing a destructive pest population across a variety of species.

Despite their prevalence, such government programs have met with varying degrees of success. Some have failed not only to achieve their stated ends, but have positively engendered the very opposite of that which they were implemented to curtail. In fact, fraud is evident to varying degrees across time, place, and type of good in bounty programs. Consider the following examples. The South African government's payment to individuals infected with tuberculosis generated an illicit trade in infected sputum (Lucas and Fuller 2017). Rewards for military enlistment during the Civil War incentivized individuals to enlist, defect, and then enlist again in attempt to collect the bounty multiple times (Heidler and Jeanne 2002, p. 257). Jacob and Levitt (2003) demonstrate that linking teacher punishments to student outcomes generated cheating on the part of teachers. Van Buren (2011) suspects that attempts at trash collection in reconstruction-era Iraq were undermined by fraudulent generation of trash. In colonial Congo, failure to meet rubber quotas carried the death penalty. Overseers were required to present the severed hands of those executed for failure to meet the quota. This policy incentivized overseers to sever the hands of living innocents in an attempt to prove their thoroughness and competence (Stanley 2012).

Perhaps most notably (and sometimes humorously), government bounties have often precipitated fraudulent outcomes in the case of pest control. Lucas and Fuller (2017) document several cases where governments have set bounty prices for the removal of pests from public spaces, including rats in Hanoi, Vietnam and feral pigs in Fort Benning, Georgia. In the former case, rats had proved a major carrier of disease in Hanoi and a general pestilence. The government opted to purchase rat tails to curb the rat population. Eventually, tail-less rats began mysteriously appearing.

[1] Since its founding in 2010, the Office has posted over 450 challenges and awarded over $150 million in prizes for devices that could better detect food-borne illnesses like Salmonella or an app that improved public safety services (White House 2016).

What determines the extent of opportunism in government bounty programs? When does the state get rooked? Our paper provides an answer to this under-explored question. To shed light on it, we extend the insights of transaction cost economics to the study of government bounties.[2]

We argue that opportunism in public-private exchange becomes more frequent when transaction costs limit the state actor's ability to observe the supplier's production process and when incentives of the purchasing actor are inconsistent with the policy ends. We illustrate our theory with two cases of government-instituted bounties. Our evidence is qualitative in nature. Hence, we face well-recognized issues in establishing the explanatory and predictive power of our theory of bounties (King et al. 1994). Among the many potential candidates (Lucas and Fuller 2017), we selected our historical case studies in such a way as to minimize these issues.[3] Both case studies refer to efforts to incentivize the private provision of governance, involving the interconnections between government and private actors in the co-production of services (Grabosky 1995, Boettke et al. 2011, Alford and O'Flynn 2012). The two differ in the key features of our theory: transaction costs and incentive alignment. In one case we examine—prizes for navigational solutions—we find success. In another case—prizes for wolf eradication—we find evidence of widespread opportunism.

The first case—one where our theory predicts limited opportunism—is Great Britain's navigational awards in the 18th century. As we discuss below, the navigational prizes established by the British government exemplify a low transaction cost, incentive-aligned bounty program. The program thus approximated the ideal or "best-case" conditions for limiting opportunism. The second—a case where our theory predicts rampant opportunism—is the case of state and local wolf bounties in 19th century North America. The wolf bounties neatly capture a high transaction costs environment rife with incompatible incentives.

While the economic goods in these two cases are quite unique, the nature of the exchange

[2]For a theoretical discussion, see North (1990), Hammond (1996), and Williamson (2005). This framework has been fruitfully applied to a wide array of governance institutions, including seventeenth century Pirate societies (Leeson 2007), American prison gangs (Skarbek 2011), and Latin American ransom markets (Shortland 2017).

[3]Unfortunately, there is no guarantee that such issues can ever be entirely eliminated, especially when it comes to qualitative, non-experimental analysis.

between government and citizenry is analytically commensurable. Both represent opportunities for *ex ante* unspecified individuals to claim payment for the provision of a good from the government. Furthermore, the differences in the two goods themselves are useful for our analysis: they present an exogenous source of transaction cost variation.

A limitation in any study of illegal activity is the difficulty in assessing the true extent of that activity. The more successful fraud is, the less one might expect to know about its frequency and nature. Thus, without access to quantitative data on the extent of fraud, we present an analytical narrative relying on reports and firsthand accounts as evidence of the extent of fraud. While this is an imperfect exercise, we utilize as many sources as possible to provide a reasonable picture of opportunism. It is at least plausible that more "uncovered" fraud is correlated with more actual fraud.

The paper proceeds as follows. Section 2 develops a simple model of the interaction between a public authority and its subjects when the former introduces a bounty. Section 3 applies the theory to Great Britain's navigational awards. Section 4 applies the theory to wolf bounties in the United States and Canada. Section 5 concludes.

2 Theory

In their simplest form, bounties and prizes can be characterized as a loosely specified form of exchange. We define a bounty program as an outstanding offer by the state to pay a predetermined price for a specified good to any supplier. On one side of the transaction is the public authority (federal, state, or local government). On the other side are the citizens, any of whom can complete the state's "ask." "Pest management" bounties, "whistleblower" rewards (e.g., the False Claims Act), and discovery "prizes" all have these common features: anyone can submit the correct pest, information, or invention for these prizes and expect to receive payment. Thus, all of these can be addressed with a common theory. Government contracts between a government agency and a *designated* supplier (e.g., military contracts) fall beyond the scope of our analysis.

We follow Allen (1999, 2015) in defining transaction costs as “the costs of establishing and enforcing property rights.” According to this interpretation, in a world of zero transaction costs, all contracts would be perfectly specified and costlessly enforced, which is to say that the Coase theorem would apply (Coase 1960). According to this approach, such issues as opportunistic behavior, external economies, and conflict over resources are all due to the presence of transaction costs. As stated, our definition of transaction costs is a mere tautology. In order to make it empirically relevant, one must specify the nature of the costs preventing property rights and contracts from being perfectly enforced. Perhaps the most successful attempt to apply transaction costs economics is the theory of the firm. Coase (1937) identifies the cost of using market-generated prices in organizing production as the main determinant of the existence of firms.

Coase’s ideas have been extended and modified to identify more specifically the nature of these costs, giving rise to the modern, alternative, theories of the firm. For example, Alchian and Demsetz (1972) identify metering and monitoring costs (respectively, the cost of measuring the contribution of an input to overall output and the cost of identifying shirking in the context of team-work) as fundamental determinants of the creation of hierarchical organizations. Other applications include vertical integration (Williamson 1971), the structure of ownership of assets within and across firms (Cheung 1983; Hart and Moore 1990), and a wide array of contractual relations such as piece-rate compensation schemes (Cheung 1983; Lazear 1986) and franchise contracts (Klein 1980).[4]

An important strand of the transaction costs literature relates to the possibility of fraud and opportunism (Williamson, 1985). Transactions costs can arise to do the difficulty in measuring aspects of the bundles of property rights that are being exchanged, enabling suppliers to intentionally (or unintentionally) mislead consumers (Barzel, 1982). Similarly, Allen (1999) writes, ”The inability to separate the contributions to quality by nature and man allows for cheating to take place in equilibrium” (Allen, 1999, p. 907). These insights have been applied fruitfully in a variety of

[4]The transaction costs approach has been extended to the study of a large number of economic, social, legal, and political institutions, including slavery (Barzel 1977), criminal firms (Leeson 2007), and social norms (Ellickson 2009). All these works share the fundamental proposition that the organization of human interactions depends on the ability of the parties involved to monitor each other’s behavior, reward cooperation, and punish opportunism.

contexts. Brinig and Alexeev (1995) discuss the extent of fraud in marriage contracts. Historical investigations reveal how ancient societies developed transaction cost-saving social and political institutions to mitigate fraud (Karayiannis and Hatzis, 2012). In work more closely related to ours, Auriol and Søreide (2017) analyze efforts to penalize corruption in public procurement contracts via debarment.

Our theory is a straightforward extension of the transaction costs approach fraudulent activity in the context of government bounties.[5] In the case of bounties, positive transaction costs are likely to lead to opportunism, that is, the attempt to supply a bundle of property rights (a "good") that does not match the government's desired one. We illustrate the relevance of this insight via a hypothetical scenario. Imagine that a group of citizens living in a territory infested by a species of very dangerous snakes. The presence of the snakes has detrimental effects on the productivity of society. Due to the classic free rider problem, if left to themselves, the citizenry finds it uneconomical to solve the snake problem and eliminate the public bad.

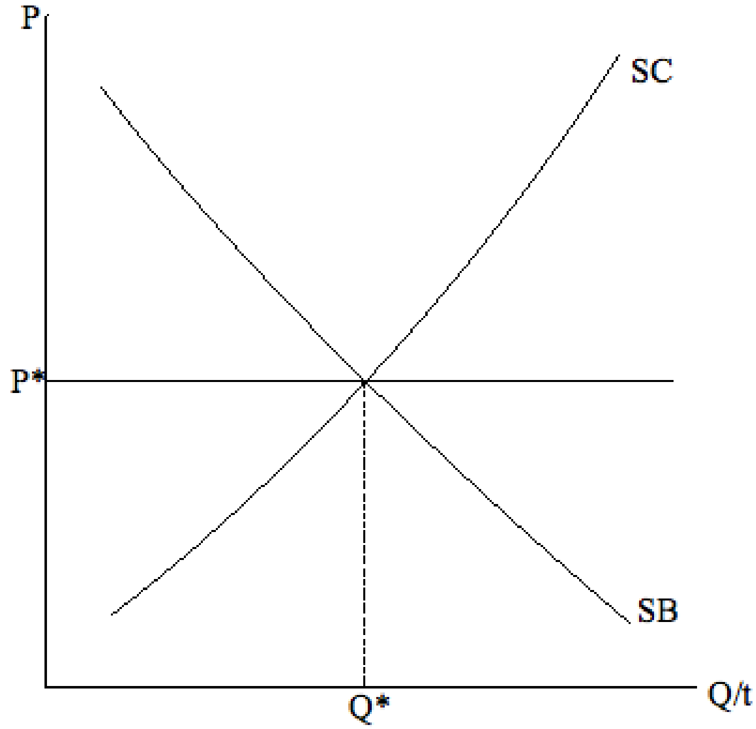
This leads the local government to step in by introducing a bounty. For simplicity, we first assume that the authority motivates the bounty with public interest considerations (e.g., the solution of a collective action problem in eliminating a public bad). For the moment, we abstract from considering the extent of the principal-agent problem of bureaucratic administrations (Tullock 2005; Prendergast 2003; Niskanen 1971) and treat the public authority as if it were an individual with full residual claimancy over the benefits of its policies.[6] This government pays a given amount p to any citizen who kills a snake in the public territory.

First, we can imagine a first-best or unconstrained outcome: the result of a bounty scheme enacted by a perfectly benevolent and omniscient government. With perfect information and incentives, the state costlessly observes the true production process associated with each individual bounty claim. Thus, any attempt by citizens to engage in opportunism (e.g., deliver a rubber

[5] Our contribution is thus to apply the insights of the transaction costs tradition to a specific governance institution that to our knowledge has not yet been addressed in this way.

[6] This allows for analysis of the functioning of the exchange rather than the legislative decision to offer the bounty in the first place, which is beyond the scope of our analysis. As Martin and Thomas (2013) suggest, entrepreneurs may compete within given political rules, or they may seek to alter the political rules themselves. To the extent that there are organized groups with interests in establishing a particular bounty scheme, these efforts are conceivable.

Figure 1: Social Optimum



snake) will necessarily fail. Under these conditions, the government sets $p = p^*$, its socially optimal value. Snakes will be killed and bounties claimed until quantity q^* is reached, that is, the quantity of snakes such that social benefits equal the social cost (Figure 1).

In practice, this social optimum will never be realized. This is because the "best-case" assumptions—benevolence and omniscience—do not comport with reality. A more realistic approximation of the nature of this transaction requires that we relax these assumptions. To do this, we allow for positive transaction costs. Positive transaction costs imply that the contract between the two parties would never be complete or perfectly specified (Allen 1999). In this situation, the inability to reach a complete contract comes from the fact that the public authority cannot costlessly observe all the features of the good purchased. Hence, the government will have to infer certain features, some of which will be essential to the stated purpose of the bounty. More specifically, the purchaser must infer the process by which the good has been produced. This opens up the potential for opportunism: goods might be submitted for payment that are supplied via a production process inconsistent with the desires of the government. In our example, the public authority must choose a method to evaluate the evidence that the good is a snake killed in the public territory before paying the bounty to the citizen.[7]

Any output can be produced in an indefinite number of ways. An infinite combination of inputs enter into the decision calculus of the supplier. The choice of the production process will depend on available technology, relative prices, and market demand. In the simple, standard treatment of the supply side in the partial equilibrium model, the production process is uniquely determined by these exogenous factors. The standard model assumes that either consumers do not care about the specific production process undertaken or that the production process itself is a defining feature of the good in question. In some cases, the production process does in fact define the nature of the consumer good (e.g., “fair-trade” coffee). In such cases, the transaction costs associated with the incomplete contract matter immensely.

Transaction costs play a key role in determining the type and extent of fraud in a world without omniscient government. Zero transaction costs should imply zero fraud. With positive transaction costs come appropriable rents. Opportunistic behavior over the choice of the production process will arise to capture such rents. In our example, the local government’s fundamental demand is snakes killed in a specific time and place. But, per the discussion above, purchasing this good directly may be too costly. It is costly to directly observe each snake hunter in action; furthermore, it is costly to transport and dispose of an entire snake, dead or alive. In light of this, we can imagine a bounty that offers pecuniary rewards for snake *tails* turned in to a bureaucratic office.[8] Note that the public authority’s demand for snake tails is really an indirect demand for snake eradication within its territory.

This illustration highlights a more general problem. A government may be constrained such that it cannot purchase the good in question directly; instead, it purchases something *indicative* of the fundamental good. Stated differently, the local government must choose a way to verify the good it’s purchasing from the citizenry. The determination of this method is a function of a

[7] Of course, different ways of doing this will impose different burdens on the budget of the local government.

[8] Anecdotal evidence from the British experience in colonial India seems to suggest that this peculiar monitoring scheme was actually employed in at least one case.

number of variables, including the expectations of the production processes available to suppliers, the relative costs of the different methods, the government's budget constraint, and the available technology.

The choice to pay for snake tails is illustrative. A far cheaper alternative (in terms of disposal and verification costs) would be to just pay anyone who shows up and claims to have killed a snake within the government's territory. Like the snake tail, a testimony of successful hunting is a potential proxy for the fundamentally demanded good. But there are multiple "production processes" associated with such a testimony. Not all of these production processes actually involve the killing of a snake. The government rationally expects there to be a cheaper way to produce a testimony than the actual killing of a snake: lying. The choice to purchase snake tails can be seen as a way to restrict the subset of production processes available to potential suppliers. This increases the likelihood that any given bounty payment purchases a good with the particular production process that satisfies the government's fundamental demand.

Absent transaction costs (e.g., with omniscient and benevolent monitoring by the public authority), suppliers would always select the government's preferred production process.[9] With positive transaction costs, however, multiple production processes may be feasible to suppliers. As long as the government's favored process also maximizes the profits of the supplier, the presence of transaction costs does not change the equilibrium result. However, this condition need not hold; it is perhaps even unlikely.

In the snake tails example, suppliers (citizens) have access to alternative production processes to the preferred process (the hunting of snakes within the designated geography during the admissible time period). Instead of hunting them, a supplier might buy snakes from outside the area. She might attempt to fashion a snake tail out of rubber bands. She could start breeding snakes in order to sever their tails for payment.

To the individual supplier, the bounty price is set by the state and can thus be treated as a

[9] Our analysis treats the particular policy choice (e.g., snake tails vs. testimony) as exogenous from the perspective of the individual supplier. One could imagine situations where individual actors engage in exchange with the public authority to facilitate more "lenient" bounty programs that are more subject to opportunism.

fixed, exogenous, perfectly elastic demand curve. Given the relatively "open" and competitive nature of bounty programs, we can for simplicity present an individual supplier decision as if it were that described by standard production theory. Figure 2 details the firm's available production processes. For simplicity, we can assume that suppliers have access to two production processes for snake tails: the desired process, hunting (production process 1) and opportunism—breeding—(production process 2). MC_1 is the marginal cost curve associated with production process 1, hunting. MC_2 is the marginal cost curve associated with production process 2, breeding. In production process 1, this relationship is one-to-one: every snake tail redeemed corresponds to a snake removed from the public territory. In production process 2, more tails are produced than snakes are killed.

As shown in Figure 2, MC_2 may lie below MC_1. In other words, there is some relevant range under which fraudulent production may be profitable. In the figure shown, the supplier can gain both inframarginal and marginal profits. Inframarginal profits will be earned on all those units that would have been supplied under the governments' preferred process and are now cheaper to produce. These inframarginal profits are represented in the light-grey area between the MC_1 and MC_2. Marginal profits emerge as the supplier produces beyond the quantity that would have been supplied if he or she would have employed the government's preferred production process. Marginal profits are represented in the same figure by the dark-grey area.

The two production processes diverge in the amount of snakes killed (removed from the locality so as to reduce the externality) per unit of snake-tail produced. Under production process 1, the supply curves for tails and snakes, S_t and S_s, coincide (see Figure 3, Panel 1). Under production process 2, on the other hand, the two supply curves do not coincide. Panel 2 of the same figure details such a case, where the supply curve for tails redeemed is to the right of that for snakes killed.

From this discussion we can identify the determinants of the extent of the fraud that would take place in such a market. We define fraud as the difference between the quantity supplied of the item for which a bounty is introduced (the snake-tail) and the the quantity supplied of the good or

Figure 2: Production Processes/Cost Curves of the Individual Supplier

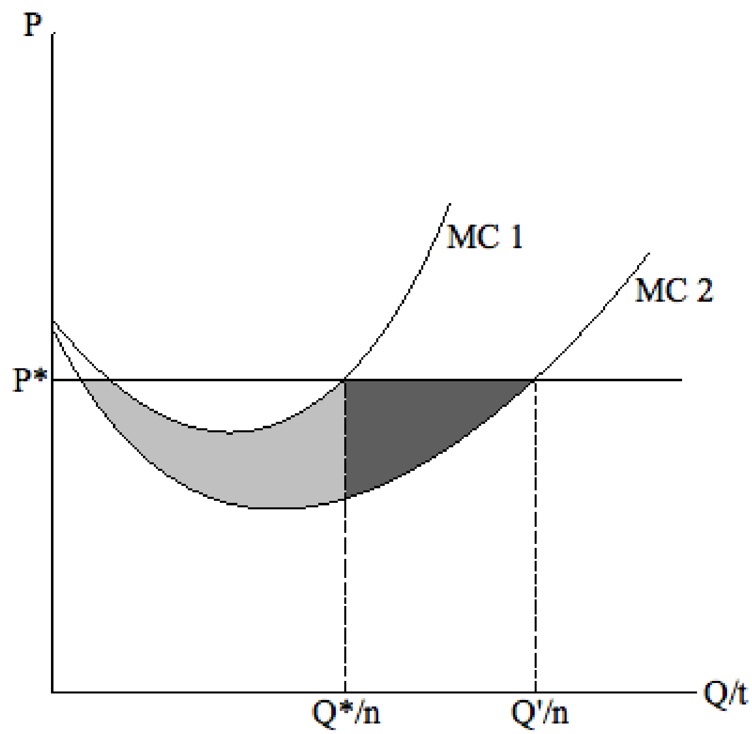
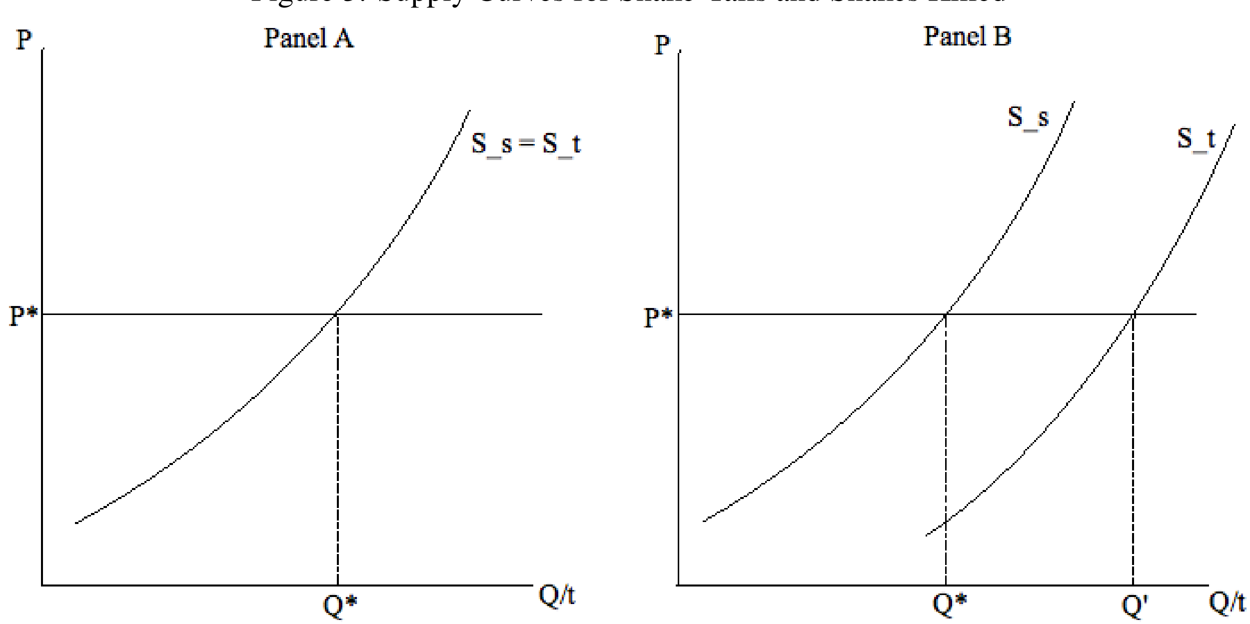


Figure 3: Supply Curves for Snake-Tails and Snakes Killed



service that constitutes the local government's actual item of interest (the killing of a snake).

Potential profits increase with the price offered, *ceteris paribus.* As higher prices are offered, more production in general will be incentivized. A higher prices also allows for a greater set of potential production processes—some of which will be fraudulent. In other words, as the benefits of submitting *something* for a bounty increase, more opportunistic behavior will ensue.

Conversely, where opportunistic production processes are more costly, less opportunism will occur. The principle cost we focus on is the expected punishment for fraudulent production. The expected punishment is itself a function of the local government's ability to identify fraudulent behavior in the production of snake-tails. This ability is in turn constrained by the extent of the cost of monitoring the production process used by suppliers. *Ceteris paribus*, the harder it is to observe the production process based solely on its output, the larger the amount of fraud experienced by the public authorities.[10]

While the difficulty of observing the true production process is fairly objective, the extent to which monitoring costs are then imposed on the suppliers depends on the incentives facing the public authority. In other words, an observable production process is a necessary but not sufficient condition for the costs of fraud to be large. While monitoring may be feasible for an official, the official need not impose those costs on suppliers. Specifically, the possibility of "kickbacks" or other forms of reciprocity may disincentivize careful inspection; whether or not this is explicit corruption or bureaucratic ineptitude is irrelevant for our analysis.

Table 1 summarizes the predictions generated by our theoretical discussion. The central idea is that fraud depends on the extent of monitoring, which in turn is a function of the cost of inferring the production process from output and the principal-agent problem associated with prohibiting fraudulent activity. Keeping the degree of principal-agent problem faced by the local bureaucracy constant, the extent of fraudulent behavior increases as the cost of inferring the production process from the supplied output also increases. Similarly, keeping these monitoring costs constant, a

[10]One source of difficulty in observing the true production process stems from the the degree of asset specificity in the purchase. As Williamson (1983) discusses, high asset specificity may create risks of opportunism in private exchange. However, in the case of fraudulent production, low asset specificity enables more opportunism by reducing the ability of the purchaser to identify fraudulent or "imitation" goods.

higher degree of principal-agent problem will lead to a less strict enforcement of the bounty standards by the local bureaucracy, which in turn will lead to more fraud. In the ideal scenario in which transaction costs are small both within the bureaucracy and in the monitoring of supply, little fraud should be observed. The most fraud should be observed when both principal-agent and monitoring costs are significant.

Table 1: Transactions Costs and Fraud Prevalence

		Cost of inferring production process from output: Low	Cost of inferring production process from output: High
Principal-agent problem	Low	Little fraud	More fraud
	High	More fraud	Even more fraud

3 Navigational Bounties in Great Britain

Our theory predicts that when there is relatively severe punishment for fraud, when the production process is easy to observe, and when government agents have an incentive to monitor, the extent of fraudulent activity will be dramatically reduced. The first prediction is directly in line with Becker's (1968) theory of crime and punishment. The second prediction suggests that when the asset in question is highly specific, it may be far easier to observe the production process. The final prediction is that when government actors offering the bounty possess a greater degree of residual claimancy, there is a greater incentive to monitor.

Navigational prizes—offered most notably by Great Britain during the Age of Exploration—provide evidence in support of our theory. In 1714, the British Parliament passed the Longitude Act,[11] establishing a 10,000 pound reward (over $1.3 million in 2015 dollars) for a person of any nationality who could devise a reliable method of determining longitude at sea. As one historian puts it, "...it is difficult to identify another scientific or technological problem so clearly formulated,

[11] The full title of the Act: "An Act for Providing a Publick Reward for such Person or Persons as shall Discover the Longitude at Sea."

so eagerly desired by society as a whole, and potentially within the hopes of solution by Everyman, whether in the Renaissance, the Enlightenment, or today," (Gingerich 1996). Yet, unsurprisingly, "the offer of a substantial prize...of course flushed opportunists from the bushes," (Gingerich 1996).

To be eligible to claim the reward, the calculation method was required to consistently ascertain longitude with a margin of error not greater than one degree of longitude (about 60 nautical or 70 "traditional" miles) (Longitude Act of 1714). The Act also established the Board of Longitude—a committee of experts that administered the prize—that existed until it was dissolved in 1828 (Howse 1998).

The prize was scaled, offering higher awards to those who could make marginal improvements to these baseline requirements. For example, if the margin of error was within 40 nautical miles, the prize increased to 15,000 pounds, while those devising a method with only half a degree margin of error would be awarded a prize of 20,000 pounds (Longitude Act of 1714). Other prizes were offered for those who had developed methods of calculating longitude that worked within 80 miles of the coastline, as that was the most treacherous part of most voyages (Howse 1998). As Howse (1998) documents, though established in 1714, the Longitude Board did not award its first prize until 1737, but between that year and 1828, it paid well over 100 money prizes to individuals for solving navigational puzzles.

The navigational prizes were a success both in the sense that attempts to collect the prize "fraudulently" were thwarted and also in the sense that they achieved the goal of discovering superior navigational techniques. The technical nature of the problem made it such that administering positive punishments for inaccurate solutions was infeasible. After all, it would be very difficult to distinguish between a faulty, but genuinely honest attempt, and a submission for the prize that was aimed at rooking via a solution that was known to be inaccurate. Nonetheless, there was still a large cost in attempting to fraudulently claim the prize. This is because any person attempting to submit a fake solution would have sunk time and resources into convincing the Longitude Board of the accuracy of the solution. One might think of the opportunity cost of this (wasted) time as being the "punishment" for submitting a faulty solution for evaluation to the Board of Longitude.

Furthermore, as Becker (1968) describes, expected punishment consists not only of the magnitude of the punishment, but of the magnitude times the probability of detection.

In the case of navigational bounties, the probability of detecting fraud was very high, probably near 100%. None of the "crank" solutions noted by Gingerich (1996) were administered a pecuniary award. Our theory predicts this to be true in cases where monitoring of the production process is relatively low-cost (i.e. when it is low-cost to differentiate the "genuine" product from the "fake.")

In "Cranks and Opportunists: 'Nutty' Solutions to the Longitude Problem," the author documents the "crackpot" methods of calculating longitude that were often submitted in hopes of redeeming the prizes (Gingerich 1996). It took little time for the Longitude Act to incentivize the submission of a longitude "solution." Gingerich describes Francis Haldanby's opportunistic attempt as "wonderful by its sheer naivete." As Gingerich describes, the method would work flawlessly—in the absence of ocean currents. Gingerich describes a "solution" submitted the following year by John French as "a remarkable mixture of perception, impracticality, and phoniness!" For Dr. William Whiston, the prize was just the opportunity he needed. Having been fired from Cambridge for religious heterodoxy, the mathematics professor saw the prize as a way to bolster his income, but his proposed solution quickly slid "down the slippery slope into a genuinely crank proposal," (Gingerich 1996).

Notably, when the Board was finally dissolved in 1828, the fact that it had to waste so much time on sifting through crank submissions was cited as a justification for its dissolution. In arguing for the abolishment of the board, First Secretary of the Admiralty, John Croker, argued that the Board was, "occupied in reading the wild ravings of mad men, who fancied they had discovered perpetual motion and such like chimeras, stimulated with expectation of obtaining parliamentary rewards, held out for the encouragement of inventions, which every man of science knew to be perfectly ridiculous," (quoted in Howse 1998).

As best as can be determined, the historical record indicates that the opportunists were universally discovered and no prizes were awarded for "crank" navigational methods—precisely what our theory predicts when the production process is low-cost to observe.[12] In the case of a prize for navigational solutions, it is easy to observe the production process in a low-cost fashion. After all, the solution could be judged using the impartial techniques of mathematics, about which there was widespread agreement by experts. In some (particularly outlandish) cases, evaluating the efficacy of the solution probably did not even require that it be "tested" in any formal sense.

Contrast such an outcome to (say) a bounty on pig tails, implemented in the hopes of reducing a feral pig population. It is difficult and costly to distinguish a feral pig tail from a domestic pig tail, and probably impossible to tell when the tail has simply been severed (rather than the entire pig having been destroyed) with the hope that the pig will continue to reproduce, thereby supplying a future generation of pig tails. Of course, the same logic holds for other pests such as snakes or the wolves described below.

In the present case, monitoring was made possible by the nature of the good itself (essentially a mathematical solution). What incentive, however, did government actors have to actually engage in monitoring, to incur the (low) monitoring costs that would ensure a separating equilibrium between genuine and crank solutions? We contend that the authorities in Great Britain, who offered these prizes, possessed residual claimancy over the navigational solutions their citizens proposed. This follows from the fact that navigational prizes were offered with the intent of discovering new territories or, at least, discovering more efficient routes to existing territories. Such discoveries would permit governments to enrich their coffers by claiming new lands or gaining increased prestige on the international stage.

It was not simply the lure of gain that acted as an incentive to monitor, but also the threat of potential loss. Seagoing was a dangerous business. Indeed, prior to developing reliable methods of calculating one's location at sea, seafaring was an extraordinarily risky endeavor (Landes 1998). Being able to accurately calculate one's coordinates at sea would enable ships to avoid great loss—such as the famed Scilly Naval Disaster of 1707 in which four British warships and roughly 2,000 soldiers sank due to just such an inability (Nicholls 2008: 25-30).

[12] Note that the Board did provide "intermediate" prizes to inventors who were showing promise but lacked the necessary funds to perfect their ideas.

Possessing residual claimancy over the results of the contest incentivized governments to carefully monitor the output. After all, many government ships would be the beneficiary of the reduced risk that a reliable navigational aid would confer. As evidence of the great care that the Board of Longitude took to avoid being rooked, consider the fact that "Commissioners" were appointed to vote on whether an applicant for a prize had met the requirements for the prize to be awarded. This panel of judges included the Speaker of the House of Commons, the First Lord of the Admiralty, the President of the Royal Society, and several mathematics and astronomy professors from the Universities of Cambridge and Oxford, among others. The panel was comprised of 23 judges, and for a major award, a majority vote was required before any payment was made to an individual submitting a solution (Howse 1998).

Importantly for our purposes, not only were inaccurate solutions *not* rewarded, but the potential for a prize *did* incentivize innovation of navigational methods that accurately yielded one's position at sea. On June 30, 1737, the Board of Longitude awarded John Harrison the first pecuniary award (500 pounds) for his development of a clock that had been tested in voyages between London and Lisbon (Howse 1998). Harrison was only awarded the full amount of the prize owed in the early 1770's, after a protracted battle with the Board of Longitude (Burton and Nicholas 2017).

Significantly, for the purposes of our paper, there was not a complete absence of successful opportunism in the case of the Longitude awards. However, the opportunism, to the extent it existed, was successfully perpetrated not by inventors vis-a-vis the state, but by the Board of Longitude "holding up" the conferral of a monetary award, which was eventually rectified (Burton and Nicholas 2017). In contrast to the the case of animal bounties in the next section, the governing body here was *under-eager* (rather than seemingly over-eager) to make good on the promise to award a bounty. This suggests that, in cases where the production process is highly observable, there is little risk of opportunism by the claimant to the prize, but there may still be a significant risk of opportunism by the one conferring the prize.

Harrison would become the most prolific of any individuals claiming longitude-related prizes from the Board, and his marine chronometer (used to calculate longitude) is described by Mokyr

(2010) as "one of the epochal innovations of the 18th century." In addition to Harrison, over 100 individuals would be financially rewarded for accurate navigational solutions before the Board was disbanded in 1828. The highest prizes (3,000 pounds each) were awarded to Thomas Mudge, Thomas Earnshaw, and John Roger Arnold (Howse 1998).

Consistent with our theory, navigational prizes offered by the government of Great Britain were successful, as they incentivized successful discovery of better navigational routes. Best of all, for those implementing the prize, this successful outcome was achieved without rewarding fraud in the process.

4 Wolf Bounties in North America

Our theory provides three predictions regarding the extent of opportunism in government purchases. Greater punishments raise the cost of opportunism, dis-incentivizing fraudulent production processes. Higher costs of indentifying the true production process lower the probability of detection, thereby increasing the extent of fraud. Larger incentives to monitor purchases increase the probability of detection, reducing the profitability of opportunism.

Wolf bounties in North America provide an instructive case study in rooking. These bounties were often subject to opportunism; however, there was noticeable variation in the extent of fraud. This variation comports with the predictions of our theory.

As indicated in the introduction, wolf bounties have been offered by governments in the American colonies as early as the 17th century. Indeed, it is suggested that these bounties led to the eradication of wolves in the eastern United States by 1800 (Barclay 2002). Our period of analysis focuses on the western United States and Canada. Wolf bounties were instituted in the western and midwestern United States and provinces of Canada throughout the 19th century. By the beginning of the 20th century, such bounties had become commonplace. Table 2 details the prices paid for bounties by US state and Canadian provincial governments as of 1909. Adult wolves fetched between \$3.00 and \$25.00. Coyotes were generally less of a threat to livestock (National Live Stock

Historical Association 1905, pp. 722–723); consequently, they generally fetched between $1.00 and $3.00 (with an exceptional $10.00 bounty in Michigan).

Many state bounties paid out considerable sums.[13] By January, 1898, North Dakota had received over 10,000 claims, generating payment of $30,000 (New York Times 1898). In 1880, Wisconsin paid out $7,071 on 1902 scalps (New York Times 1881). Minnesota paid $13,831 on 2,973 claims in 1894 (Executive Documents of the State of Minnesota 1895, p. 461). In Montana's first bounty year (1884), 5,450 wolf scalps were submitted; over the next 35 years, over 80,000 rewards would be issued in that state (Riley et al. 2004).

That the bounty incentivized hunters to kill wolves is evident elsewhere as well. In 1854, longtime hunter Philip Tome wrote, "When there was no bounty on wolves, we did not kill them..." (1854, p. 190). But once the bounties were in place, hunters responded. Even soldiers on posts in the frontier set traps for wolves: "It was profitable to set out traps and to poison wolves, and this was one of the occupations at every frontier post" (Ware 1911, p. 361).

Despite a dramatic increase in the extent of wolf hunting, wolf populations persisted in many localities into the early 20th century. Harding (1909) writes, "While these animals are trapped, shot, poisoned, hunted with dogs, etc., their numbers, in some states, seem to be on the increase rather than the decrease in face of the fact that heavy bounties are offered" (1909, p. 1). While the complexity of wildlife management undoubtedly contributed to this trend, opportunism in wolf bounty programs also proved pernicious.

Typically, state legislation allowed for the exchange of money for the wolf's scalp. Minnesota's 1849 bounty law reads: "That the several Boards of County Commissioners or Supervisors ... of the several counties in this Territory, may at any regular or special meeting of said board, make such provision, and allow such bounties for the destruction of wolves in their respective counties as they may deem necessary, not exceeding three dollars for each wolf or wolfs whelp ... Every

[13]The bounty had to be profitable to inspire production, genuine or fraudulent. Transaction costs increase with regulatory complexity. Both fraudulent and genuine wolf hunting were limited when regulatory burdens were strict: "One thing that is detrimental to the success of the bounty system, is the invariable 'red tape' connected with such laws. In some states the bounty regulations are so complicated and so exacting, that trappers do not care to follow 'wolfing' because of the trouble in securing the bounty money" (Harding 1909, p. 23).

Table 2: Wolf Bounties as of 1909

Territories	Wolves: Adult	Wolves: Young	Coyote	Bounty Year*
US States				
Arizona	$10.00		$2.00	1893
Arkansas	$8.00			1838
Colorado	$5.00		$1.00	1893
Idaho	$10.00		$1.00	
Kansas	$5.00		$1.00	1877
Michigan	$25.00		$10.00	1838
Minnesota	$7.50		$1.00	1872
Montana	$10.00		$3.00	1884
Nebraska	$4.00		$1.25	
New Mexico	$20.00		$2.00	1893
North Dakota	$4.50	$2.50		
Oregon	$10.00		$7.00	1843
South Dakota	$5.00	$1.50		1898
Utah	$10.00		$2.50	
Washington	$15.00		$1.00	1871
Wisconsin	$20.00	$8.00		1865
Wyoming	$5.00		$1.25	
Canadian Provinces				
Alberta	$10.00	$1.00	$1.00	1899
British Columbia	$15.00	$2.00		1900
Ontario	$15.00			1793
Quebec	$15.00			1793
Saskatchewan	$3.00		$1.00	1899

*Earliest known bounty legislation.

Sources: Harding (1909), Busch (2007), state legislation, newspaper archives.

person intending to apply for such bounty shall take every wolf or wolfs whelp, killed by him, or the scalp thereof, with the ears entire thereon, to one of the justices of the peace of the county in which such wolf or whelp shall have been taken" (Minnesota Session Law Ch. 62, 1849, pp. 131–132).

In the case of wolf bounties, identifying the true production process was extremely costly. This difficulty manifested on multiple margins. The first obstacle involved identifying whether or not the scalp in question actually belonged to a wolf. In many states, both wolf and coyote bounties were often employed, but different prices were offered. These scalps were difficult to distinguish from one another, making credible distinction between the two difficult. Wolf scalps were also difficult to distinguish from dogs, foxes, and other furry creatures. The difficulty of adjudicating between real and imitation scalps typically made the production process altogether unclear.

As a result, fraud in terms of these imitation goods was common. Available evidence suggests that many animals were successfully submitted in exchange for "wolf scalp" payment. A 1909 Bureau of Biological Survey Circular indicates the prevalence of rooking for these bounties: "The bounty system has everywhere proved an incentive to fraud, and thousands of dollars are wasted annually in paying bounties on coyote scalps offered in place of wolves, and on the scalps of dogs, foxes, coons, badgers, and even cats, which are palmed off for wolves and coyotes" (Bailey 1909).

The difficulty of credible identification is evident in the curious efforts by public actors to provide information that would clarify the distinguishing features of wolves and other wildlife. The Wisconsin Conservation Department issued a news release with information to help bureaucrats identify fraud: "It is not always easy to distinguish between dog and wolf pups, according to conservation department authorities, but definitely its not true that the former lap water like cats, and the wolf pup drinks water in the same manner as horses. Instead, young of both species lap water, except that wolves tend to lap more slowly, and tend to take more water at each lap" (quoted in Thiel 1993, p. 75).

Another opportunistic production process involved obtaining genuine wolf scalps, but from outside of the geography designated for a particular bounty. As with the other processes discussed, observing this form of fraud would require monitoring of the hunter throughout the course of the hunt, which was prohibitively costly. This led to a common practice of submitting wolves in the highest-paying localities regardless of the true kill location. Trappers would also engage in interstate exchange in order to secure bounties in high-paying regions. One man discovered to be submitting scalps in Iowa killed elsewhere confessed to purchasing them through a South Dakota operation that purchased scalps "by the car lot" from non-bounty states and sold them to Iowa farmers, who in turn claimed a $5.00 bounty from the state (New York Times 1896).

Marginal profits were also obtained through a third production process: wolf breeding. Thiel (1993) reports multiple newspaper accounts of wolf farming between 1878 and 1879, writing, "Farming wolves for money provided a healthy income" (1993, p. 71). Multiple wolf farms were uncovered in the northern counties of Minnesota in 1891; an estimated $25,000 in fraudulent claims were identified (Chicago Tribune 1891). A 1902 investigation by the Nebraska State Auditor revealed multiple cases of wolf-farming: "it was found that one farmer had raised more than 100 wolves last Summer from several animals he had trapped and penned up for that purpose. Other cases were unearthed where from fifty to sixty of these animals had been reared" (New York Times 1902). As the National Live Stock Historical Association describes it: "The range States and Territories took a hand in the crusade by offering bounties for wolf scalps...the bounties ranging from $2.00 to $10.00 per scalp. This led to a class of professional wolf-hunters, or 'wolfers,' as they were commonly called, some of whom are still in the business; and to the expenditure of large sums of money. This also led to the development of a new kind of range stock industry: rearing wolves for the bounties. An enterprising man, by capturing and corralling young wolves in some out-of-the-way place, could be doing fairly well within a few years from the increase of his pack" (National Live Stock Historical Association 1905, p. 722).

Of course, the ability to economically identify fraudulent production processes is a necessary but insufficient mechanism by which opportunism is limited. As purchaser, the state actor must herself have an incentive to incur the costs of process identification in order to raise the probability of punishment. The available evidence indicates that wolf bounties provided weak incentives to limit fraud. As is true with most bounty programs, the "state" as a whole lacked residual claimancy to tax-funded bounty expenditures. However, wolf bounties faced an even greater incentive problem. Rather than an incentive to limit fraud, local politicians themselves were occasionally involved in the fraudulent supply. A Montana newspaper account from 1895 indicates one such case:

> The late lamented Legislature passed a bounty law fixing the price to be paid for the scalps of wolves and coyotes at $3 each. Since the enactment of the law a number of cowboys have resigned from the range and gone into the bounty business for there is more in it. But these gentlemen are discounted by Commissioner Barton of Choteau County, who, according to the River Press, has purchased from a Cree Indian a she-wolf and litter of nineteen pups that were captured alive. According to the River Press, "it is the intention of Mr. Barton to kill the animals and secure a bounty on the scalps." The deal will be a profitable one no doubt and could be made still more profitable if the thrifty commissioner would kill only the pups, secure a mate for the she- wolf and go into the breeding business. If she is as prolific at all times as with the litter in question there is money in it (River Press 1985, quoted in Wise 2016, pp. 38–39).

Officials estimated that over $4,000 in fraudulent bounties were obtained in Washington state in 1906 (Busch 2007, p. 117). An estimated $6,000 in fraudulent claims were estimated in Jackson County, Wisconsin alone (Thiel 1993, pp. 74–75).[14]

Our theory also predicts that a higher bounty price incentivizes more fraudulent production. We find evidence that opportunists were indeed responsive to price. Michigan, which boasted the largest bounties throughout the 19th and early 20th centuries, experienced perhaps the most rampant fraud in the wolf bounty scheme. Many cases of "imported" scalps brought in from lower-bounty states were reported (Michigan Department of Conservation 1922, p. 307). In Wisconsin, which had a large bounty of $20 in the early 20th century, it was asserted that wolf farming was a "regular industry" in certain counties (New York Times 1881). While we lack comparable data on the relative extent of fraud, evidence of bounty-shopping is consistent with the notion that opportunism increases with price. Similarly, most of the fraudulent practices uncovered were in "high-bounty" states and territories.

[14]One particularly liberal estimate by Wisconsin's Deputy Conservation Warden in 1915 pinned the total fraudulent payment by that state at $500,000 (New York Times 1915).

5 Conclusion

Our paper has two primary implications. First, the success or failure of government bounty programs can be explained by variation in transaction costs. As an economic outcome, success or failure depends on both the ability and the incentive to observe the production process that precipitates claiming of the bounty. The ability and the incentive to monitor, in turn, shape the payoffs to prospective suppliers of the good in question. Lack of monitoring, for whatever reason, incentivizes fraudulent supply relative to genuine production. Furthermore, decisions to engage in fraudulent bounty supply need not stem from "bad apples" or intrinsically amoral opportunists. Whether the means (e.g., a bounty) selected are compatible with the ends (e.g., pest eradication) depends on the costs and benefits of alternative production processes available to suppliers. When it is difficult to observe the true production process, the state is increasingly likely to get rooked. This knowledge should inform future attempts to solve a problem via bounty policy, whether on the part of private or public actors.

Second, institutions which confer residual claimancy on the party enacting the bounty are less likely to generate fraud. Individuals acting within a framework of property, contract, and consent (i.e., private actors) are less likely to be rooked than are their public counterparts. This is largely because such an institutional framework forces decision-makers to bear the full costs and benefits of their actions. To the extent that public institutions do the same, they are also less likely to suffer from frequent and severe instances of fraud. In other words, when government implementation of bounties more closely approximates the conditions we would expect to hold at all times for private actors, there is a lesser incidence of fraud. However, governments are territorial monopolists, implying they don't face direct competition. A private party instituting a bounty program faces the threat of competition from other private parties, which may ensure better safeguards against the possibility of being defrauded. This logic begs the question of whether private institutions are sufficiently robust to address problems that have often been handled by public actors—with rooking an all-too-often occurrence.

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