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The Protection of Private Property: The Government as a Free-Rider

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Abstract

This paper develops a positive theory of government that explains the cross country differences in the relative importance of publicly and privately provided protection of property. The theory focuses on the decision of the government to free-ride or not to free-ride on privately provided security. If the government chooses to free-ride on privately provided security then it shirks from the provision of a nonexcludable public good: the deterrence of stealing. The theory implies that governments are more likely to free-ride on privately provided security the less efficient is stealing in capturing private property, the less efficient is the tax system, and the more efficient is stealing in capturing government property. The analysis also reveals that a self-interested government provides the amount of protection of private property that maximizes production, given that the tax rate is chosen to maximize the government's net income.

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"*We avoid bad neighborhoods. We lock our doors and windows. We avoid public spaces like parks, ceding them to criminals. We install burglar alarms and buy guns. We hire private security guards and move to gated communities...In short, we do what we can to spare ourselves from crime, we bemoan government's persistent failure to protect us even from known criminals, and we become increasingly numb to the everyday carnage others suffer.*"[1]

Economists have long regarded the protection of private property as an archetypal function of government. In the *Wealth of Nations*, Adam Smith argued that government has the fundamental duty to protect,"as far as possible, every member of the society from the injustice or oppression of every other member of it" (p. 669), and, quoting John Locke, that "government has no other end but the preservation of property" (p. 674).[2] However, in many countries around the world, Smith's normative statement is at odds with actual government behavior. Indeed, cross country differences in the relative importance of publicly and privately provided protection of property are a major, but little studied and often ignored, source of cross-country differences in the quality of life.

Only sixty police cars patrol Lima, less than one police car per one hundred thousand people for the eight million person metropolis, while it has been estimated that at least three thousand police cars would be necessary to adequately protect its inhabitants against crime.[3] Not surprisingly, Lima, once known as *Garden City* for its relaxed architecture of street-looking gardens and balconies, is now a city dominated by high walls and fences. *Limeños* have developed a siege architecture mentality: "For each balcony that Mayor Andrade refurbishes, neighbors build hundreds of walls and raise thousands of fences, not to mention electrified perimeters and advanced security systems. Those who used to own friendly collies...now look for rodweilers, mastiffs and qualified prey animals, as a complement of the security personnel armed with shortened-barrel rifles".[4] Even according to official statistics, a person is eight times more likely to be killed at the hands of delin-

[1]DiIulio (1996) on the private efforts to allocate resources to security in some parts of the United States.

[2]Even Marx, quoted in Spitzer (1987, p. 43), said that "Security is the supreme social concept of civil society, the concept of the *police*, the concept that the whole society exists only to guarantee to each of its members the preservation of his person, his rights, and his property." In fact, the very etymological origin of the word police is linked to the state. Police, as well as politics, comes from the ancient Hellenic "politea", Latinized as "politia", that means the condition of the state. See Becker and Becker (1986).

[3]*Caretas*, 05.07.98.

[4]*Expreso*, 05.18.98, in Spanish in the original.

quents and two and a half times more likely to be robbed in Bogota than in Copenhagen, but the number of public policemen per inhabitant is lower in Colombia than in Denmark.[5] In South Africa,"[p]olicemen seldom patrol Johannesburg on foot, and not much even in their cars", and "[h]ouses are hidden behind high perimeter walls, topped with razor spikes, their alarms electronically linked to alert private armed guards".[6] The experiences of Peru, Colombia and South Africa are by no means unique or extraordinary. In many other countries, especially in Latin America, Africa, some parts of Asia, as well as in some regions of the United States, governments do not adequately protect private property, and, as a result, citizens must undertake substantial private security measures.[7]

But the experience of Lima and other similar places is not universal. Casual observation suggests that most citizens in Western Europe, Japan and other countries in Asia, rely much more on publicly provided security for the protection of their property than in other regions of the world. Criminal victimization surveys conducted by the United Nations have found that households in Latin America and Asia are two and half times more likely to have caretakers protecting their houses than their Western European counterparts.[8] Likewise, as reported in Table 1, the ratio of private guards to public guards exhibits wide cross-country variation from at least 10:1 in "lawless places" such us Russia or South Africa to less than 0.3:1 in Finland.

[5]The homicide rate and the robbery rate of Bogota are of 71.4 and 300 per hundred thousand people respectively, compared with 8.7 and 130 in Copenhagen. The ratio of population per police officer is 421 in Colombia and 399 in Denmark. Homicide and robbery data is for 1994. Police data is for 1990. The source is the Fifth United Nations Survey on Crime Trends and Operations of Criminal Justice Systems (1997). Furthermore, the differences in crime rates are presumably underestimated due to higher rates of under-reporting of crime in Colombia.

[6]*The Economist*, 07.15.95,08.10.96.

[7]For example, the national studies contained in Findlay and Zvekic (1993) clearly illustrate the absence of adequate public protection of private property in, among other countries, Indonesia, The Philippines, Tanzania, South Africa and Yugoslavia. Salas (1993) provides a similar account of the importance of privately provided security in Venezuela. Davis (1990) highlights the effects of the lack of adequate public protection of property on the architecture of both rich and poor neighborhoods in contemporaneous Los Angeles.

[8]Alvazzi del Frate (1997).

Table 1. Ratio of private to public guards.*

Russia	>10
South Africa	>10
Hungary	4
United States	2.8
Israel	2.4
Australia	2
Canada	2
United Kingdom	2
New Zealand	1.1
Belgium	0.5
France	0.5
Spain	0.5
Netherlands	0.4
Finland	< 0.3.

** Circa 1990. Own calculations based on Cunningham, Strauchs and Meter (1990), Johnston (1992), The Economist (04.19.97), and the Sunday Telegram (08.02.98).*

A puzzling related observation is that even in countries where governments provide little protection for private property, governments might allocate substantial resources to the protection of their own property. For example, in Lima, where only sixty police cars are allocated to the protection of private property, the government allocates more than fifteen hundred police cars to the protection of the houses and residences of government officials.[9]

Existing economic theories do not answer the positive question of why in some countries and not in others the government provides little protection for private property. In the words of Isaac Ehrlich (1996, p. 49) "...the economic literature has focused mainly on the determination of optimal means of law enforcement and crime control, rather than the basic rationale for public rather than private enforcement of laws".[10] This paper develops a positive theory of government that focuses on

[9] *Caretas*, 05.07.98. If in some countries policemen mostly protect government property while in other countries they mostly protect private property, then the cross-country differences in privately and publicly provided protection of private property are underestimated by Table 1.

[10] Within the public finance literature, Shoup (1964, 1969) studies the optimal distribution of publicly provided security among subgroups of the population according to different welfare criteria, but abstracts from modeling privately provided security even though he acknowledges that privately provided security is common and usually coexists with publicly provided security. Additional work on crime prevention in the public finance literature has been mostly empirical and concentrated on finding the degree of 'publicness' of crime prevention. The general conclusion has been that the consumption of crime prevention services is rival because it exhibits high levels of congestion. For a survey of the empirical evidence see Eden and McMillian (1991). Within the crime and law enforcement literature,

the government's choice between protecting private property and free-riding on privately provided security, leaving property owners to protect their own property.[11]

In order to understand the *positive* behavior of government this theory assumes that the government is self-interested and concerned with the maximization of its net income, the difference between its tax collection and its spending on security.[12] Unquestionably, governments might also have a concern for social welfare instead of or in addition to their interest in maximizing their net income. However, by assuming that the government is not concerned with the maximization of its net income, the existing literature is not able to rationalize the cross-country differences in privately and publicly provided security. In contrast, as shown below, the assumption that the government is self-interested does not preclude an equilibrium in which the government chooses to protect private property.

The general equilibrium model developed emphasizes that publicly provided security has a fundamental strategic advantage over privately provided security. When the government decides on the amount of publicly provided security it internalizes the effect of its choice in reducing the overall rate of stealing. In contrast, when individual citizens or small groups of citizens decide on the amount of privately provided security they take the overall rate of stealing as given.[13] In other

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the classical article of Becker (1968) poses the *normative* question of "how many resources and how much punishment *should* be used to enforce different kinds of legislation?". However, Becker's analysis, and subsequent work that closely followed it (see, for example, Landes and Posner 1975 and Clotfelter 1978, or Ehrlich 1996 for a review), was developed in a partial equilibrium framework that abstracts from the *positive* behavior of government.

[11]In recent contributions, Grossman (1999b) and Konrad and Skaperdas (1998b) have constructed general equilibrium models of the government's decision to allocate resources to public security, but their theories focus on the demand for security as a rationale for having a state and do not address the cross-country variation in private and public security. Implicitly, they abstract from the possibility that the government would free-ride on privately provided security.

[12]The government's net income can be understood as its political rent and we can imagine that the government spends it on the consumption of a ruling class that controls it. The government's maximization of its net income is the analog of a firm's maximization of its profits. As Herschel Grossman (1999a) points out, such government behavior does not warrant the use of pejorative terms such as "predatory" or "big robber", since these pejorative terms are not "usually applied to profit-maximizing private enterprises".

[13]The strategic advantage of making a centralized choice to security was clearly recognized by Sir Robert Peel, Prime Minister of England between 1822-27 and 1828-30, and creator of the first London Metropolitan Police in 1829. "Like others who had examined the problem, Peel was convinced that it was above all the multiplicity of bodies concerned with the policing of the metropolis that was the great weakness. John Wade, a lawyer and journalist, referred to the 'want of agreement and consistency in the general principles of watching and patrolling'...Peel's solution was to create a single Metropolitan Police District...Within this area all the parish watches and the forces provided by the various bodies of commissioners and so forth were swept away, the whole are paying rates to the Metropolitan Police and being protected by them." (Tobias, 1979). The strategic advantage of making a centralized choice is also relevant for the allocation of resources to other government services, where the centralized decision internalizes externalities

words, although it is individually rational for citizens to protect their property against theft, it is not individually rational to take into account the deterrent effect of privately provided security on the overall rate of stealing. Deterrence is a nonexcludable public good. If the government free-rides on the private provision of security, then it shirks from providing this public good.

Because of the strategic advantage of publicly provided security, the government's gross income can be higher if the government does not free-ride than if it free-rides. But, the decision not to free-ride has a cost. The government chooses not to free-ride only if the increase in its gross income with publicly provided security is larger than the cost of financing publicly provided security.

My analysis shows that ultimately the government's decision to free-ride depends on three factors: the efficiency of stealing in capturing private property, the efficiency of the tax system, and the efficiency of stealing in capturing government property. The less efficient is stealing in capturing private property, the smaller is the gain to the government from exploiting the strategic advantage of publicly provided security, because the fraction of output that productive citizens lose to stealing in the absence of publicly provided security is small. Thus, a necessary condition for the government to choose not to free-ride is that the efficiency of stealing in capturing private property is sufficiently high.

Assuming that the efficiency of stealing in capturing private property is high, sufficient conditions for the government to choose not to free-ride are that the efficiency of the tax system is high and that the efficiency of stealing in capturing government property is low. Low efficiency of the tax system and high efficiency of stealing in capturing government property reduce the marginal benefit to the government of allocating resources to publicly provided security, thereby making free-riding more attractive.

Section 1 presents the general assumptions of the model. Section 2 solves the representative household's optimization problem. Section 3 studies the government's net income maximization. Section 4 discusses the conditions under which the government chooses to free-ride on privately provided security and comments on the empirical relevance of the theoretical results. Section 5 extends the analysis to allow for stealing of government property. Section 6 summarizes the main findings of the paper and discusses possible extensions.

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that are not taken into account by the individual decisions.

1 The Setup

Consider an economy composed of a government and a large number of identical households with mass normalized to one. Each household is endowed with one perfectly divisible unit of time. The representative household allocates non-negative units of time to:

Units of time	Activity
l	market production,
r	stealing other households' production,
f	guarding its own production,
h	working as publicly paid guard of market production,
$1-l-r-f-h$	home production.

Income for the representative household is given by

$$U = p(1-\tau)y + q(1-\tau)Y + wh + \gamma(1-l-r-f-h). \tag{1}$$

Market output, denoted by y, is a strictly concave function of labor and equals $y = Al^{\alpha}$ where $0 < \alpha < 1$. The parameter A represents the general productivity of labor. Market output is subject to taxation at rate τ. Market output is also subject to stealing. The representative household loses a fraction $1-p$ of its market output net of taxes to stealing. Thus, the representative household's income from market production net of taxes and losses to theft is $p(1-\tau)y$. Income from all the other household activities is not taxed and cannot be stolen.

The average household's market output is denoted by Y. The representative household steals a fraction q of the average household's market output net of taxes. Thus, the representative household's income from stealing from other households is $q(1-\tau)Y$.

The wage per unit of time that publicly paid guards receive is w. Therefore, the representative household's income from working as a publicly paid guard of market output is wh.

Income from home production is linear in effort. The marginal (and average) return to home production is γ.

The process of taxation involves real costs of collecting taxes. Costs of collecting taxes are a function of the amount to be collected and of the efficiency of the tax system. For simplicity, I assume that collection costs take the linear form $c\tau Y$, where $0 \leq c < 1$. The parameter c captures the efficiency of the tax system. Larger values of c imply higher costs of tax collection and less efficiency of the tax system. Thus, the government's tax revenue net of collection costs is $(1-c)\tau Y$.

The government can spend on security by hiring households to work as publicly paid guards who protect market output. Government expenditure on security equals wH, where H is the fraction of time that the average household works as a publicly paid guard protecting market output.[14] Assume for now that the government's revenue from collecting taxes cannot be stolen. [Below, in section 5, I extend the analysis to allow for stealing of the government's tax revenue.] Therefore, the government's net income is

$$Z = (1-c)\tau Y - wH. \tag{2}$$

The degree of security enjoyed by the representative household is increasing on f, the time it allocates to guard its own output, and on H, the time of the average household that the government hires to protect market output. For simplicity, I assume that f and H are perfect substitutes and that the level of security of the representative household equals $f + H$. The degree of security of the average household equals $F + H$, where F is time allocated by the average household to guard its own output.[15]

Let R denote the time allocated to stealing market output by the average household. Assuming that stealing is a random matching process, the ratio $R/(1-\tau)y$ measures how frequently the market output of the representative household, net of taxes, is subject to stealing. The ratio $r/(1-\tau)Y$

[14] Becker and Stigler (1974), followed most notably by Friedman (1984), proposed the privatization of law enforcement because the public provision of law enforcement "has perverse incentives". My analysis differs fundamentally from these authors because the present paper emphasizes the strategic advantage of allocating resources to publicly provided security. Of course, it is entirely possible that the decision to allocate resources to security is made by the government, but that the actual provision is private. That possibility is not inconsistent with my theory, even though I do not model it explicitly.

[15] My formulation assumes that, in line with the empirical evidence summarized in Eden and McMillian (1991), the household's consumption of security is rival. Of course, this does not imply, as shown below, that publicly provided security does not have an strategic advantage over privately provided security. My formulation also assumes that privately provided and publicly provided security are equally efficient in the protection of private property. More generally, we could write the level of security of the representative household as $(1-\eta)f + \eta H$, where η is a parameter that lies between zero and one and captures the efficiency of publicly provided security relative to privately provided security. The implications of having less efficient public security, in the present model, would be the same as having a less efficient tax system.

measures how frequently the representative household, acting as a thief, has an opportunity to capture the market output net of taxes of the average household. The ratio $(f+H)/(1-\tau)y$ tells us how much security the representative household has relative to its net market output. The ratio $(F+H)/(1-\tau)Y$ tells us how much security relative to net market output is provided on average.

I assume that p, the fraction of its market output net of taxes that the representative household retains after stealing, decreases with $R/(1-\tau)y$ relative to $(f+H)/(1-\tau)y$ and is given by

$$p = \frac{1}{1+\theta R/(f+H)}. \tag{3}$$

The parameter θ measures the efficiency of stealing in capturing private property.

I assume that q, the fraction of the average household's market output net of taxes that the representative household steals, is decreasing on $(F+H)/(1-\tau)Y$ relative to $r/(1-\tau)Y$ and equals

$$q = \frac{1}{1+(F+H)/\theta r}. \tag{4}$$

Equations (3) and (4) imply that, in equilibrium, $p+q=1$.[16]

2 Household's Allocation of Time

The representative household solves

$$\max_{l,r,f,h} U = p(1-\tau)y + q(1-\tau)Y + wh + \gamma(1-l-r-f-h).$$

subject to $y = Al^{\alpha}$ and equations (3) and (4), taking τ, w, Y, R, F, and H as given.

[16]Equations (3) and (4) abstract from externalities in privately provided security or in stealing. In general, it is possible that a particular household might be more likely to be robbed the more security other households have. Similarly, a particular household, acting as a thief, might be less effective in stealing the more other households are engaged in stealing. Equations (3) and (4) can be easily generalized such that p and q also depend on the levels of private security and stealing of the representative household relative to the average levels of private security and stealing of other households. For example we can write $p = \frac{1}{1+\theta R/(f+H)E_1(F/f)}$, $q = \frac{1}{1+(F+H)/\theta r E_2(R/r)}$, where E_1' and E_2' are positive. In this expanded formulation the functions E_1 and E_2 capture externalities in private security and in stealing respectively.

The Kuhn-Tucker first order conditions are

$$\frac{\partial U}{\partial l} = \alpha(1-\tau)p\frac{y}{l} - \gamma \leq 0, \qquad l \geq 0, \qquad \frac{\partial U}{\partial l}l = 0; \tag{5}$$

$$\frac{\partial U}{\partial r} = (1-\tau)Y\frac{\partial q}{\partial r} - \gamma \leq 0, \qquad r \geq 0, \qquad \frac{\partial U}{\partial r}r = 0; \tag{6}$$

$$\frac{\partial U}{\partial f} = (1-\tau)y\frac{\partial p}{\partial f} - \gamma \leq 0, \qquad f \geq 0, \qquad \frac{\partial U}{\partial f}f = 0; \tag{7}$$

and,

$$\frac{\partial U}{\partial h} = w - \gamma \leq 0, \qquad h \geq 0, \qquad \frac{\partial U}{\partial h}h = 0; \tag{8}$$

where, from equations (3) and (4),

$$\frac{\partial q}{\partial r} = \frac{\theta(F+H)}{(F+H+\theta r)^2}, \quad \text{and} \quad \frac{\partial p}{\partial f} = \frac{\theta R}{(f+H+\theta R)^2}.$$

In a symmetric equilibrium in pure strategies in which every household behaves identically: $l = L$, $y = Y$, $r = R$, $f = F$, $h = H$ and $p = 1 - q = P$.

I assume throughout that γ is high enough such that the non-negativity constraint on home production does not bind. Then, condition (8) implies that the household supply of publicly paid guards for the protection of market output is perfectly elastic at $w = \gamma$.

Solving $\partial U/\partial l = 0$ from condition (5), the equilibrium allocation of time to market production is such that the equilibrium level of market output is given by

$$Y = L^{\alpha} = \left[\frac{A\alpha(1-\tau)P}{\gamma}\right]^{\frac{\alpha}{1-\alpha}}. \tag{9}$$

Equation (9) tells us that market output will be larger the larger is P, the fraction of output net of taxes not lost to theft, and the smaller is τ, the tax rate.

Condition (6) implies that r is chosen such that

$$\begin{cases} R > 0 & \text{if } F+H < (F+H)^*, \\ R = 0 & \text{if } F+H \geq (F+H)^*; \end{cases} \qquad \text{where} \qquad (F+H)^* = \frac{\theta(1-\tau)}{\gamma}Y.$$

The number $(F+H)^*$ is the level of security, private plus public, that deters stealing of market output, and is defined such that $F+H \geq (F+H)^*$ implies $\partial U/\partial r < 0$ and therefore $R = 0$ from condition (6). Using condition (6), the equilibrium value of P as a function of private security, F, public security, H, and market output, Y, is given by

$$P = \begin{cases} \sqrt{\dfrac{\gamma(F+H)}{\theta(1-\tau)Y}} & \text{if } F+H < (F+H)^*, \\ 1 & \text{if } F+H \geq (F+H)^*. \end{cases} \tag{10}$$

Condition (7) tells us that the representative household chooses privately provided security taking the behavior of the average household as given. That is, when the representative household chooses f it does not internalize the effect of F on R given by condition (6).

3 The Government's Problem

The government makes irreversible choices of τ, H and w to maximize its net income as given by equation (2) taking into account the behavior of households described by conditions (5) to (8) and equations (9) and (10).[17] Substituting $w = \gamma$, from condition (8), into equation (2), the government's problem becomes

$$\max_{\tau,H} Z = (1-c)\tau Y - \gamma H. \tag{11}$$

subject to (5) to (10).

[17] I abstract from dynamic inconsistency issues by assuming that the government's choices are irreversible. Grossman and Noh (1994) model how the dynamic consistency constraint affects the government's allocation of resources to a productive government service. By assuming that the survival probability of the government is not affected by its policies, the analysis also abstracts from modeling the political constraints faced by the government.

3.1 The government free-rides on private security

Suppose that the government free-rides on privately provided security. In this case, the government chooses $H = 0$ and all security is privately provided. Thus, $F + H = F$.

Let P^o denote the fraction of market output net of taxes that is not stolen if the government free-rides. In this case, conditions (6) and (7) together, as equalities, imply that in equilibrium

$$P^o = \frac{1}{1+\theta}. \tag{12}$$

Equation (12) tells us that P^o is a decreasing function of θ, the efficiency of stealing in capturing private property. Assuming that $H = 0$, conditions (6) and (7) together imply that the ratio R/F is not a function of θ. That is, even though θ affects R and F, it has no net effect on the ratio R/F. However, since equation (3) implies that P is decreasing on the ratio $\theta R/F$, a higher θ reduces the equilibrium value of P^o.

The first order condition of problem (11), assuming that $H = 0$, is

$$\frac{\partial Z}{\partial \tau} = (1-c)\left(\tau\frac{\partial Y}{\partial \tau} + Y\right) = 0, \tag{13}$$

where, from equation (9),

$$\frac{\partial Y}{\partial \tau} = -\frac{\alpha}{1-\alpha}\,\frac{Y}{1-\tau}.$$

Solving equation (13), the tax rate that maximizes Z if the government free-rides is

$$\tau^o = 1-\alpha. \tag{14}$$

Substituting equations (12) and (14) into equation (9), the level of market output if the government free-rides is given by

$$Y^o = \left[\frac{A\alpha\,(1-\tau^o)\,P^o}{\gamma}\right]^{\frac{\alpha}{1-\alpha}} = \left[\frac{A\alpha^2}{\gamma}\frac{1}{1+\theta}\right]^{\frac{\alpha}{1-\alpha}}. \tag{15}$$

Equation (15) tells us that Y^o is a decreasing function of θ, because, as explained above, P^o is decreasing on θ.

Substituting $H = 0$ and equations (12), (14) and (15) into equation (11) the value of the government's net income if the government free-rides is given by

$$(16) \qquad Z^o = (1-\alpha)\ (1-c)\ Y^o.$$

3.2 The government does not free-ride on private security

Suppose instead that the government does not free-ride on privately provided security. Assume now, without loss of generality, that the efficiency of stealing in capturing private property is high relative to the efficiency of the tax system, such that $\theta > 1-c$.

In contrast with atomistic households, the government takes into account the effect of its choice of H in the behavior of the average household. That is, the government has a strategic advantage of allocating resources to publicly provided security. Assuming that if $H > 0$ then $F = 0$, equations (9) and (10) together imply that[18]

$$(17) \qquad Y = \left[\frac{(A\alpha)^2}{\gamma\theta}(1-\tau)H\right]^{\frac{\alpha}{2-\alpha}},$$

as long as $H < (F+H)^*$, which will be satisfied in equilibrium given $\theta > 1-c$.

Let $\tau^\bullet$ and $H^\bullet$ denote the values of the tax rate and the resources allocated to publicly provided security that maximize Z if the government does not free-ride. Assuming that $\theta > 1-c$, the first order conditions of problem (11) are

$$(18.1) \qquad \frac{\partial Z}{\partial H} = (1-c)\tau\frac{\partial Y}{\partial H} - \gamma = 0, \qquad \text{and} \qquad H < (F+H)^*,$$

and

$$(18.2) \qquad \frac{\partial Z}{\partial \tau} = (1-c)\left(\tau\frac{\partial Y}{\partial \tau} + Y\right) = 0,$$

[18] Footnote 19 checks that, in equilibrium, if $H > 0$ then $F = 0$ obtains.

where, from equation (17),

$$\frac{\partial Y}{\partial H} = \frac{\alpha}{2-\alpha}\ \frac{Y}{H}, \qquad \text{and} \qquad \frac{\partial Y}{\partial \tau} = -\frac{\alpha}{2-\alpha}\ \frac{Y}{1-\tau}.$$

Solving conditions (18.1) and (18.2), using equation (17), we find that

(19) $$H^{\bullet} = (1-c)\ \frac{\alpha}{2\gamma}\ Y^{\bullet},$$

and,

(20) $$\tau^{\bullet} = 1 - \frac{\alpha}{2}.$$

Equations (10), (19) and (20) together imply that the fraction of market output net of taxes that is not stolen if the government does not free-ride is

(21) $$P^{\bullet} = \sqrt{\frac{1-c}{\theta}}.$$

Thus, with $\theta > 1-c$, assuming that the government does not free-ride, the choices of τ and H are such that stealing of market output is not deterred, $P < 1$, and therefore that households lose some of their market output to stealing.[19] Equation (21) tells us that $P^{\bullet}$ is decreasing on θ, the efficiency of stealing in capturing private property, and increasing on $1-c$, the efficiency of the tax system.

To understand the effect of θ on $P^{\bullet}$ given by equation (21), observe that, according to equation (3), P is a decreasing function of the ratio $\theta R/H$. Conditions (6) and equation (19) imply that the ratio R/H is decreasing on θ. However, equations (3) and (19) and condition (6) together imply that the direct effect of an increase in θ on P dominates the partial offset of the decrease in the ratio R/H, and that $P^{\bullet}$ is decreasing on θ.

[19] Conditions (6) and (7) and equations (19), (20) and (21) imply that, if $H = H^{\bullet}$, then $F = 0$ because $\partial U/\partial f < 0$ at $f = F = 0$ obtains. In other words, if the government does not free-ride, publicly provided security will be sufficiently large such that households will not supplement it with privately provided security. To confirm this result observe that solving condition (6) as an equality the resources allocated to stealing of market output are $R = P^{\bullet}(1-P^{\bullet})(\alpha/2\gamma)Y^{\bullet}$. Then, conditions (6) and (7) together imply that $\partial U/\partial f < 0$ at $f = 0$ and $H = H^{\bullet}$ if and only if $H^{\bullet} > R$ which is trivially satisfied given that $P^{\bullet} = \sqrt{(1-c)/\theta}$ and $H^{\bullet} = (1-c)\alpha Y/(2\gamma)$ from equation (19).

To understand the effect of c on $P^\bullet$ given by equation (21), observe that condition (18.1) implies that, for a given tax rate and for a given marginal effect of H on Y, higher costs of collecting taxes reduce the marginal effect of H on Z. That is, higher costs of tax collection reduce the marginal benefit to the government of allocating resources to publicly provided security, resulting in a lower choice of H. In turn, the lower choice of H results in a lower equilibrium level of $P^\bullet$.

From equations (9), (20) and (21) we calculate that, $Y^\bullet$, the equilibrium level of market output if the government does not free-ride, is given by

$$Y^\bullet = \left[\frac{A\alpha\ (1-\tau^\bullet)\ P^\bullet}{\gamma}\right]^{\frac{\alpha}{1-\alpha}} = \left[\frac{A\alpha^2}{2\gamma}\sqrt{\frac{1-c}{\theta}}\right]^{\frac{\alpha}{1-\alpha}}. \tag{22}$$

Equation (22) tells us that if the government does not free-ride both larger costs of collecting taxes and higher efficiency of stealing in capturing private property reduce the level of market output. The result obtains because $Y^\bullet$ is increasing on $P^\bullet$, and $P^\bullet$ is decreasing on c and θ.

Given $\theta > 1-c$, substituting equations (19) to (22) into equation (11), the value of the government's net income if the government does not free-ride is given by

$$Z^\bullet = (1-\alpha)\ (1-c)\ Y^\bullet. \tag{23}$$

Equations (14) and (20) imply that the choice of the tax rate depends on whether $H > 0$ or $H = 0$. Conditions (6) and (7) together imply that if the government free-rides, then its choice of τ has no net effect on P, because it has no net effect on the ratio R/F. To understand this result note that condition (6) implies that R depends negatively on τ because a higher τ reduces the marginal return to stealing, whereas condition (7) implies that F depends negatively on τ, because a higher τ reduces the marginal return to private guarding.

In contrast, if the government does not free-ride then it does not take P as given when choosing the tax rate. Equation (9) tells us that Y is increasing on P as well as decreasing on τ. Assuming that $H > 0$ and $F = 0$, condition (6) and equation (10) imply that, because higher Y raises the marginal return to stealing, P is decreasing on Y, for given values of H. Thus, increasing τ decreases Y directly, but this decrease in Y also increases P, which, in turn, dampens the decrease in Y. Therefore, for given values of H, the marginal negative effect of τ on Y is smaller if the government does not free-ride than if the government free-rides. Consequently, if the government does not free-ride it chooses to impose a higher tax rate than if it free-rides.

4 The decision to free-ride

The government compares $Z^\bullet$ with Z^o in order to decide whether or not to free-ride on privately provided security. Recall that, according to equation (9), Y depends positively on P. Because publicly provided security has a strategic advantage over privately provided security, P can be higher with publicly provided security than with privately provided security. A larger value of P would imply that, for a given tax rate, Y can be higher if the government does not free-ride than if it free-rides. Also, we have seen that $\tau^\bullet$ is larger than τ^o. Thus, the gross income of the government can be higher if the government does not free-ride than if it free-rides.

But, the decision not to free-ride has a cost to the government given by $\gamma H^\bullet$. The government does not free-ride only if the increase in its gross income with publicly provided security is larger than $\gamma H^\bullet$. That is, the government does not free-ride if

$$(1-c)\ \tau^\bullet\ Y^\bullet - \ (1-c)\ \tau^o\ Y^o \ > \ \gamma\ H^\bullet. \tag{24}$$

Condition (24) is equivalent to $Z^\bullet \geq Z^o$. Observe now, from equations (14), (19), and (20), that the choices of $\tau^\bullet$, $H^\bullet$, and τ^o are such that

$$\gamma\ H^\bullet = (\tau^\bullet - \tau^o)\ (1-c)\ Y^\bullet.$$

Thus, as we can see from equations (18) and (23), condition (24) implies that $Z^o \geq Z^\bullet$ as $Y^o \geq Y^\bullet$.

Given $\theta > 1-c$, equations (15) and (22) imply that $Y^o \geq Y^\bullet$ obtains and the government chooses to free-ride on privately provided security if and only if

$$\frac{1}{1+\theta} > \frac{1}{2}\sqrt{\frac{1-c}{\theta}}. \tag{25}$$

Condition (25) tells us that the government is more likely to free-ride the smaller is θ, the efficiency of stealing in capturing private property, and the smaller is $1-c$, the efficiency of the tax system.[20]

Equations (12) and (21) imply that even though an increase in θ, the efficiency of stealing in capturing private property, reduces both $P^{\bullet}$ and P^{o}, the ratio of $P^{\bullet}$ to P^{o} rises monotonically with θ, again due to the strategic advantage of publicly provided security. Thus, the incentive to free-ride is unambiguously reduced as θ increases, because an increase in θ augments the gain to the government from the strategic advantage of publicly provided security at any given tax rate.

Why do higher collection costs make free-riding more attractive? Notice first, from equation (15), that higher collection costs do not affect Y^{o}. However, as explained above, higher costs of tax collection imply a smaller $H^{\bullet}$, because they reduce the marginal benefit to the government of allocating resources to publicly provided security. In turn, a smaller $H^{\bullet}$ implies a smaller $P^{\bullet}$ and thus a smaller value of $Y^{\bullet}$.

Now relax the assumption that $\theta > 1-c$. Appendix 1 shows that if the efficiency of stealing in capturing private property is low, $\theta \leq 1-c$, then total deterrence would be achieved with publicly provided security, $P = 1$. This would imply that, for a given tax rate, the tax base would be higher with publicly provided security than with privately provided security. However, the chosen tax rate if the government does not free-ride is again higher than the chosen tax rate if the government free-rides. Thus, the tax base is lower with publicly provided security, for a given value of P. Appendix 1 shows that with $\theta \leq 1-c$ the negative effect of the chosen tax rate on the tax base if the government does not free-ride outweighs the positive effect of total deterrence and, thus, that the government chooses to free-ride. Therefore, this model predicts that, consistent even with casual observation, total deterrence of stealing of market output, $P = 1$, is never an equilibrium.

Figure 1 summarizes, in θ and $1-c$ space, the possible equilibria that the economy can have. The locus labeled $Z^{\bullet} = Z^{o}$ indicates combinations of $1-c$ and θ such that the government is indifferent between protecting market output or free-riding on privately provided security. In

[20] To derive this result observe that by first solving condition (25) as an equality, and then picking the root of θ that conforms to the assumption that $\theta > 1-c$, condition (25) can be rewritten as,

$$\theta \leq \frac{1+c+2\sqrt{c}}{1-c}. \tag{25}$$

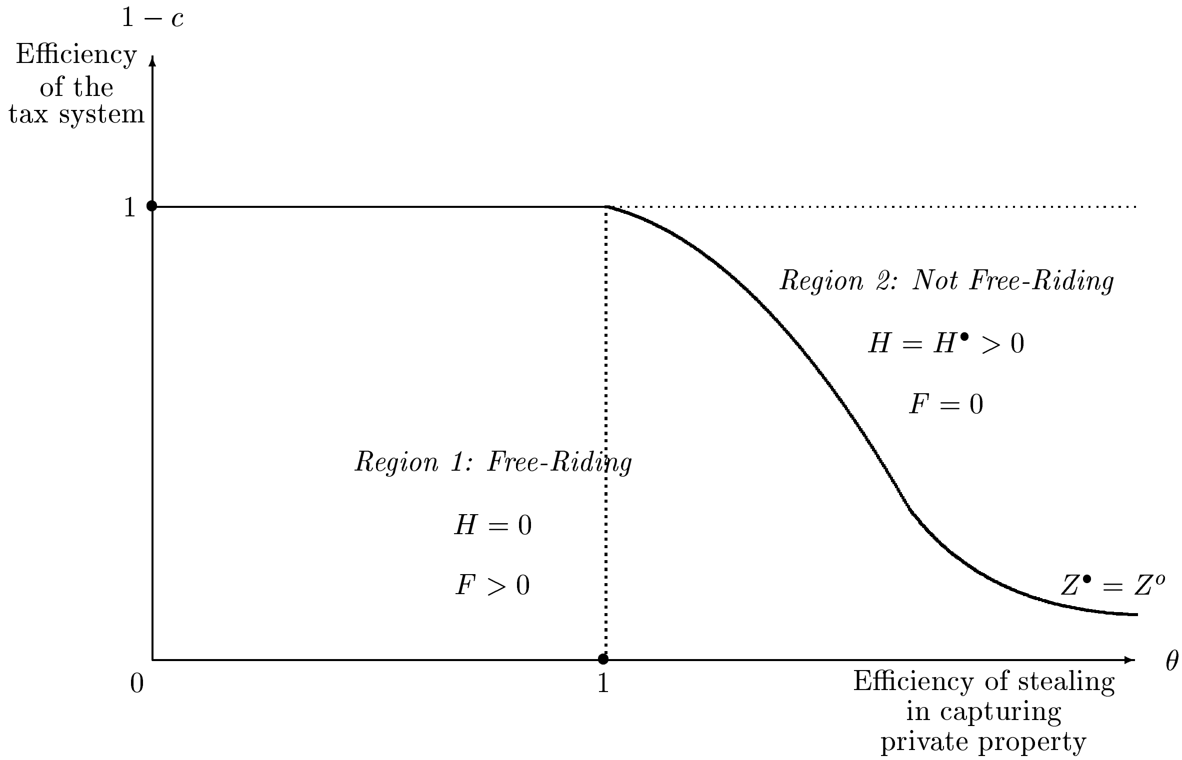

Figure 1: Free-Riding or not Free-Riding

region 1, to the left of $Z^{\bullet} = Z^{o}$, the government chooses to free-ride on privately provided security. In region 2, to the right of $Z^{\bullet} = Z^{o}$, the government does not free-ride and provides $H = H^{\bullet} > 0$ for the protection of market output.

Given these theoretical results, how can we explain the observed cross-country differences in the amount of privately provided security relative to publicly provided security? Unfortunately, there are not enough country observations of the ratio of private to public guards, reported in Table 1, to conduct systematic testing of this theory. Nevertheless, as suggested by the historical accounts of Barker(1966), Bayley (1985) and Tobias (1979), the evolution of publicly provided security relative to privately provided security appears to have been closely linked to the development of efficient public taxation in Western Europe in the nineteenth century. More recently, Webb(1991) emphasizes how the collapse of the Peruvian tax system since the 1950's has resulted in "[s]ecurity, whether in the countryside, urban low-income settlements, or private companies and rich neighborhoods, [being] a matter of bodyguards and small private armies".[21] Thus, cross-country variation in the efficiency of the tax system appears to be a good candidate for explaining the observed cross-country differences in the amount of privately provided security relative to publicly provided security.

What about θ, the efficiency of stealing in capturing private property? The efficiency of stealing in capturing private property might vary across countries because of different community norms towards criminals. Akerlof and Yellen (1994) and Konrad and Skaperdas (1998a) stress the importance of "social norms and ethical beliefs" in the efficiency of criminal activities. Johnston (1992), quoting L. Lee, provides a telling example of the importance of social norms in controlling crime in rural England during the 1920's: "...[T]here was no tale-bearing then, or ringing up 999; transgressors were dealt with by local opinion...Sometimes our sinners were given hell, taunted and pilloried, but their crimes were absorbed in the local scene and their punishment confined to the parish." The evidence reviewed by Johnston on several English communities suggests that in communities where criminals were less socially tolerated, which we can associate to low values of θ, security was more likely to be provided privately rather than publicly.

However, casual observation tells us that countries in which the government free-rides on privately provided security have higher rates of stealing than countries in which the government does not free-ride. Is this consistent with the theory developed? An empirical approximation of the rate of stealing might be given by $1-P$. Figure 2 graphs the equilibrium value of $1-P$ as a function of θ for given values of c. To the left of $\hat{\theta}$, in Figure 2, the government free-rides on privately provided security. To the right of $\hat{\theta}$, the government chooses to protect private property.[22] The rate of stealing is discontinuous on the efficiency of stealing in capturing private property because the private provision of security neglects the deterrent effect of security on the overall rate of stealing.

As illustrated by Figure 2, my analysis predicts that the relationship between the rate of stealing

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[21] Webb tells us that "[until] the mid-twentieth century...[t]axes were politically and simple to collect at customs (or the Central Bank) and from a small number of large taxpayers". He then signals "the increasing importance of hard-to-tax small-scale and informal modes of production" as a direct cause of higher collection costs. De Soto (1989), among others, underlines that the emergence of informal modes of production in urban Peru since the 1950's is closely related to the increasing fractionalization of the cities. De Soto also indicates that the increasing fractionalization of the cities is explained by the large scale migration from the countryside.

[22] From condition (25) and Appendix 1 $\hat{\theta} = (1 + c + 2\sqrt{c})/(1 - c)$. To the left of $\hat{\theta}$, $1 - P = \theta/(1 + \theta)$. To the right of $\hat{\theta}$, $1 - P = 1 - \sqrt{(1 - c)/\theta}$.

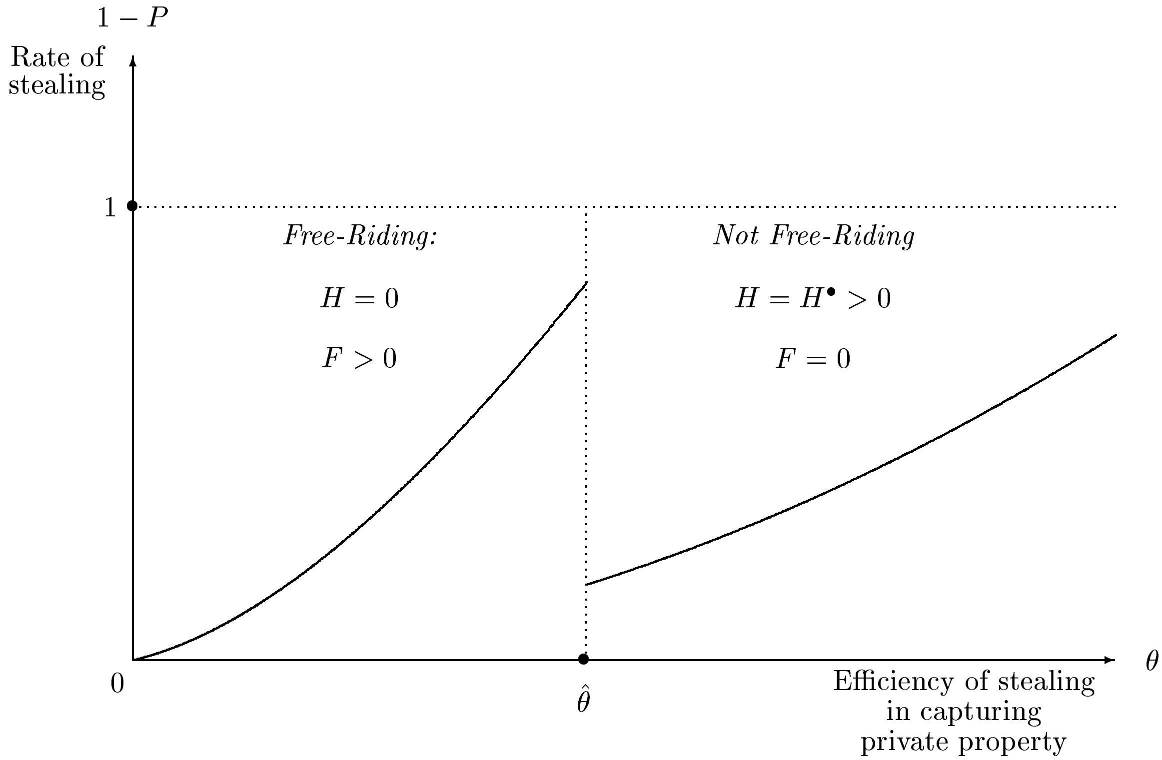

Figure 2: Rate of Stealing

and the efficiency of stealing in capturing private property is not monotonic. Thus, this theory is consistent with the observation that countries in which security is publicly provided can have lower rates of stealing than countries in which security is privately provided.

My analysis has shown that, given that the tax rate is chosen to maximize the government's net income, the government chooses guarding to maximize market output. Observe, however, that equations (17), (22) and condition (25) imply that there is not necessarily a monotonic correspondence between the ratio of resources allocated to publicly provided security to the resources allocated to privately provided security and the level of market output across countries. Notice that the parameter A, that reflects the general productivity of labor and presumably varies across countries, does not affect the decision to free-ride.[23] In line with this prediction, the evidence re-

[23] Furthermore, even abstracting from cross-country differences in A, depending on the relative magnitude of the parameters θ and c, one country can have a higher level of market output than another country and yet only allocate resources to security privately. Consider, for example, two hypothetical countries, 1 and 2, such that $A_1 = A_2$, $c_1 = c_2 = 1/4$, $\theta_1 = 3/4$, and $\theta_2 = 5/4$. According to condition (25) the government of country 1 free-rides while

ported in Table 1 tells us that, for example, the ratio of private to public guards is much higher in the United States than in Belgium, Finland or Spain, even though income per capita in the United States is higher than income per capita in Belgium, Finland or Spain.

5 Stealing of Government Revenue

This section extends the analysis to allow for the possibility of stealing of the government's tax revenue. The purpose of this extension is to account for the puzzling observation that even in countries where governments provide little protection for private property, governments might allocate substantial resources to the protection of their own property. For example in Lima, as mentioned above, only sixty police cars protect private property but more than fifteen hundred police cars protect the houses and residences of government officials.

To analyze stealing of the government's property, assume that in addition to its other possible activities, the representative household can now allocate non-negative units of time to s, stealing the government's tax revenue and to g, working as publicly paid guard of the government's tax revenue. Recall that the government's tax revenue net of collection costs is given by $(1-c)\tau Y$. Assume that the representative household steals a fraction $\hat{q}$ of the government's tax revenue net of collection costs. Then, the representative household income from stealing from the government is $\hat{q}(1-c)\tau Y$. The representative household's income from working as a publicly paid guard of the government's tax revenue is wg, where w is the wage per unit of time paid to public guards. Accordingly, the income of the representative household is now given by

$$(1^*) \qquad U = p(1-\tau)y + q(1-\tau)Y + \hat{q}(1-c)\tau Y + w(h+g) + \gamma(1-l-r-s-f-h-g).$$

The government loses the fraction $1-\hat{P}$ of its tax revenue, net of collection costs, to theft. Therefore, tax revenue net of collection costs and losses to theft is $\hat{P}(1-c)\tau Y$. In addition to possibly hiring households to work as publicly paid guards who protect market output, the government hires households to work as publicly paid guards who protect its own tax revenue. Government expenditure on security then equals $w(H+G)$, where H is the fraction of time that

the government of country 2 does not, but yet, according to equations (17) and (22), $Y_1 > Y_2$. Notice that this result would be even stronger if we were to allow γ, the marginal return from home production, to vary across countries.

the average household works as a publicly paid guard protecting market output, and G is the fraction of time that the average household works as a publicly paid guard protecting tax revenue. Thus, the government's net income is now

$$Z = \hat{P}(1-c)\tau Y - w(H+G). \quad (2^*)$$

I assume that $\hat{P}$, the fraction of tax revenue net of collection costs that the government retains after stealing, is decreasing on $S/(1-c)\tau Y$ relative to $G/(1-c)\tau Y$, where S is the time allocated to stealing tax revenue by the average household, and equals

$$\hat{P} = \frac{1}{1+\phi S/G}. \quad (26)$$

The parameter ϕ measures the efficiency of stealing in capturing government property.

I assume that $\hat{q}$, the fraction of tax revenue net of collection costs that the representative household captures, decreases with $G/(1-c)\tau Y$ relative to $s/(1-c)\tau Y$, and is given by

$$\hat{q} = \frac{1}{1+G/\phi s}. \quad (27)$$

Equations (26) and (27) imply that, in equilibrium, $\hat{P} + \hat{q} = 1$.

Appendix 2 solves the model allowing for stealing of government revenue. Appendix 2 shows that the effects of c and ϕ on the government's decision to free-ride or not to free-ride are isomorphic. That is, appendix 2 tells us that the ratio of resources allocated by the government to protect its own tax revenue to its tax revenue, $\gamma G/(1-c)\tau Y$, is only a function of ϕ, the efficiency of stealing in capturing government property, and independent of the tax rate and whether the government chooses to free-ride or not to free-ride on privately provided security.

Thus, extending the analysis to allow for stealing of government revenue does not affect the essential results that a sufficient condition for free-riding by the government on privately provided security is that the efficiency of stealing in capturing private property is low, and that, assuming that the efficiency of stealing in capturing private property is high, less efficiency of the tax system increases the likelihood of free-riding. Likewise, this extension does not alter the result that, given that the tax rate is chosen to maximize the government's net income, the government pursues a policy that maximizes market output.

The main new implication of extending the analysis to allow for stealing of government revenue is that, assuming that the efficiency of stealing in capturing private property is high, higher efficiency of stealing in capturing government property increases the likelihood of free-riding. This extension also allows us to rationalize why even in countries where governments provide little protection for private property, governments might allocate substantial resources to the protection of their own property.

6 Summary and Concluding Remarks

Cross country differences in the relative importance of publicly and privately provided protection of property are a major, but little studied and often ignored, source of cross-country differences in the quality of life. The existing literature does not address the *positive* question of why in some countries and not in others citizens allocate substantial resources to private security measures. In contrast with traditional *normative* approaches of government behavior, this paper rationalizes these cross-country differences by developing a *positive* theory of government, in the context of a general equilibrium model that endogenizes the allocation of resources to productive and criminal activities, as well as to privately provided and publicly provided security.

The theory developed implies that the observed cross-country variation is explained by whether or not the government chooses to free-ride on privately provided security. The model emphasizes that publicly provided security has a fundamental strategic advantage over privately provided security, because the allocation of resources to publicly provided security does not take the overall rate of stealing as given.

Abstracting from the cost of financing publicly provided security, the government's gross income can be higher if the government does not free-ride than if it free-rides due to the strategic advantage of publicly provided security. But, the decision not to free-ride has a cost. The government chooses not to free-ride only if the increase in its gross income with publicly provided security is larger than the cost of financing publicly provided security.

If the efficiency of stealing in capturing private property is low, the government chooses to free-ride because the gain to the government from exploiting the strategic advantage of publicly provided security is small. Assuming that the efficiency of stealing in capturing private property is high, the government is less likely to choose to free-ride on privately provided security the more efficient is the tax system and the less efficient is stealing in capturing government property. Low efficiency of the tax system and high efficiency of stealing in capturing government property make free-riding more attractive because they reduce the marginal benefit to the government of allocating resources to publicly provided security.

In line with the historical evolution of publicly provided security, the cross-country variation in the efficiency of the tax system is a good candidate to account for the observed cross-country differences in the importance of publicly provided relative to privately provided security. In addition, as some authors have suggested, the efficiency of stealing in capturing private property and the efficiency of stealing in capturing government property might vary across countries because they might reflect cross-country variations in social norms and attitudes towards crime.

The theory reveals that a self-interested government provides the amount of protection of private property that maximizes production, given that the tax rate is chosen to maximize the government's net income. But, the analysis also implies that privately provided security could be predominant relative to publicly provided security both in low income as well as in high income countries.

The analysis has abstracted from technological differences between publicly provided and privately provided security by assuming that publicly provided and privately provided security are perfect substitutes in consumption. Clearly, some forms of security, such us locking one's door from the inside, can only be enforced privately. Other forms of security might be truly public goods, nonexcludable and nonrival in their consumption. But, technological differences between private and public security presumably do not vary systematically across countries and, thus, are not likely to explain cross-country differences in private and public security. However, without changing the spirit of the model, the analysis can be easily extended assuming that private and public security are less than perfect substitutes. This extension will provide us with predictions on government free-riding when the equilibrium ratio of private to public security is bounded away from zero.

This study has shown that interpersonal differences, such as differences in the distribution of income, are not essential for rationalizing the cross-country variation in the relative importance of privately provided and publicly provided security. Nevertheless, in light of its potential empirical relevance, an interesting extension of the paper would be to learn how differences in the income distribution might affect the government's decision to free-ride.[24] Previous empirical work has found that a less efficient tax system is likely to result, among other things, from a high degree of fractionalization of the population, possibly because it is more costly for the government to collect taxes from a more heterogenous population.[25] To the extent that higher income inequality is related to a higher degree of fractionalization of the population, and thus, to a less efficient tax system, extending the analysis to allow for differences in the distribution of income is likely to predict that higher income inequality would increase the likelihood of free-riding on privately provided security by the government.[26]

This theory has abstracted from modeling the political constraints faced by the government. In particular, I have assumed that the survival probability of the government is unaffected by its policies. A natural extension of the paper is to study the effect of more or less tight political constraints on the government's decision to free-ride.

Because publicly provided security has a strategic advantage over privately provided security, if the government free-rides on privately provided security then it shirks from the provision of a nonexcludable public good: the deterrence of stealing. Finally, an interesting extension of the paper would be to learn to what extent free-riding by the government is relevant for a *positive* analysis of the government provision of other goods and services.

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[24]Recent studies of inequality and predation include Grossman and Kim (1999), that focus on the welfare implications of inequality in a economy populated by potential predators, and Grossman (1998) that studies how inequality affects the ability to make collective choices to security. However, these studies implicitly abstract from the possibility of free-riding by the government.

[25]Alesina, Baqir and Easterly (1997) have found that less goods are publicly provided in US cities that are more ethnically fragmented, because "voters choose lower public goods when a significant fraction of tax revenues collected on one ethnic group are used to provide public goods shared with other ethnic groups". Easterly and Levine (1997) report similar findings in a sample of Sub-Saharan African countries.

[26]Alternatively, one might think that income inequality matters because in more unequal societies the median voter might want less publicly provided security than the average voter. This argument would predict that only the rich would supplement publicly provided security. However, anecdotal evidence suggests that in countries where publicly provided security is inadequate *both rich and poor* citizens resort to substantial private security measures as illustrated by the experiences of Peru, summarized by Webb (1991) (mentioned above in section 4), Starret City, a relatively poor neighborhood of New York City, and of South Africa. As reported by *The Economist* (04.19.97), "Starret City is not richer than its surroundings nor exceptional in any way but one:...it employs its own police force of 60 people. In a survey of the residents, 90% said Starret City would not be safe without private security. Private guards, it seems, are not just for the rich." Builta (1995) describes the private security efforts against crime among the poor black South Africans. Moreover, in countries in which income inequality is high the rich appear to be usually in control of the government. Therefore, the median voter model does not appear to describe the decision making process for publicly provided security.

Appendix 1. Total deterrence is not an equilibrium.

Assuming that $\theta \leq 1-c$, if the government does not free-ride then, from equations (9) and (10) together, Z is maximized with

$$\frac{\partial Z}{\partial H} > 0, \qquad \text{and} \qquad H = (F+H)^* = \frac{\theta(1-\tau)Y}{\gamma}, \tag{28.1}$$

and,

$$\frac{\partial Z}{\partial \tau} = (1-c)\left(\tau \frac{\partial Y}{\partial \tau} + Y\right) - \gamma \frac{\partial H}{\partial \tau} = 0, \tag{28.2}$$

where, from equation (9) and $H = (F+H)^* = \theta(1-\tau)Y/\gamma$,

$$\frac{\partial Y}{\partial \tau} = \frac{\alpha}{1-\alpha}\,\frac{Y}{1-\tau}, \qquad \text{and} \qquad \frac{\partial H}{\partial \tau} = -\theta Y/\gamma.$$

Conditions (28.1) and (28.2) imply that, if $\theta < 1-c$,

$$H^{\bullet\bullet} = \theta\,\frac{\alpha}{2\gamma}\,Y^{\bullet\bullet}. \tag{29}$$

and,

$$\tau^{\bullet\bullet} = \frac{(1-\alpha)(1-c)+\theta}{1-c+\theta}, \tag{30}$$

where, given $\theta \leq 1-c$, the level of market output if the government does not free-ride is

$$Y^{\bullet\bullet} = \left[\frac{A\alpha(1-\tau^{\bullet\bullet})P^{\bullet\bullet}}{\gamma}\right]^{\frac{\alpha}{1-\alpha}} = \left[\frac{A\alpha^2}{\gamma}\,\frac{1}{1+\theta/(1-c)}\right]^{\frac{\alpha}{1-\alpha}}. \tag{31}$$

Equations (10), (29) and (30) imply that, given $\theta < 1-c$, if the government does not free-ride, then it would choose H large enough to deter the stealing of market output. Hence, $P^{\bullet\bullet} = 1$.

Substituting equations (29), (30) and (31) and $P^{\bullet\bullet} = 1$ into equation (11), the government's net income if $\theta \leq 1-c$ and the government does not free-ride is given by

$$Z^{\bullet\bullet} = (1-\alpha)\ (1-c)\ Y^{\bullet\bullet}. \tag{32}$$

Given $\theta \leq 1-c$, equations (16) and (32) imply that $Z^o \geq Z^{\bullet\bullet}$ as $Y^o \geq Y^{\bullet\bullet}$. In turn, equations (15) and (31) imply that $Y^o \geq Y^{\bullet\bullet}$ obtains and the government chooses to free-ride if

$$(1-\tau^o)P^o \geq (1-\tau^{\bullet\bullet})P^{\bullet\bullet},$$

which implies from equations (12), (14), (30) and $P^{\bullet\bullet} = 1$ that the government chooses to free-ride if

$$\frac{1}{1+\theta} \geq \frac{1}{1+\theta/(1-c)}, \tag{33}$$

which is always satisfied for $\theta \leq 1 - c$.

Condition (33) will be satisfied as an inequality for any positive level of collection costs, $c > 0$. In the absence of collection costs, $c = 0$, condition (33) will be satisfied as an equality and the government's net income would be the same whether it free-rides or not. Since free-riding is a passive activity I assume that if condition (33) holds as an equality then the government would free-ride.

Appendix 2. Stealing of government revenue.

The representative household maximizes its net income, as given by equation (1*), by choosing its time allocation to its seven possible activities, subject to $y = Al^{\alpha}$ equations (3), (4), (26) and (27), taking τ, w, Y, R, S, F, H, and G as given. In addition to conditions (5) to (8), the first-order Kuhn-Tucker conditions of this problem are

$$(34) \qquad \frac{\partial U}{\partial s} = (1-c)\tau y \frac{\partial \hat{q}}{\partial s} - \gamma \leq 0, \qquad s \geq 0, \qquad \frac{\partial U}{\partial s} s = 0;$$

and,

$$(35) \qquad \frac{\partial U}{\partial g} = w - \gamma \leq 0, \qquad g \geq 0, \qquad \frac{\partial U}{\partial g} g = 0,$$

where, from equation (27),

$$\frac{\partial \hat{q}}{\partial s} = \frac{\phi G}{(G + \phi s)^2}.$$

In a symmetric equilibrium in pure strategies in which every household behaves identically: $l = L$, $y = Y$, $r = R$, $s = S$, $f = F$, $h = H$, $g = G$, $p = 1 - q = P$ and $\hat{P} = 1 - \hat{q}$.

Assuming, as before, that γ is high enough such that non-negativity constraint on home production does not bind, condition (35) implies that the household supply of publicly paid guards for the protection of the government's tax revenue is perfectly elastic at $w = \gamma$. The household's choice of l and r are still represented by equations (9) and (10). In addition, the household's choices of s from condition (34) implies that the equilibrium value of $\hat{P}$, the fraction of tax revenue not lost to stealing, as a function of G, the resources allocated to protect tax revenue, is given by

$$(36) \qquad \hat{P} = \begin{cases} \sqrt{\dfrac{\gamma G}{\phi(1-c)\tau Y}} & \text{if } G < G^*, \\ 1 & \text{if } G \geq G^*. \end{cases} \qquad \text{where} \qquad G^* = \frac{\phi(1-c)\tau}{\gamma} Y.$$

The number G^* is the level of security of tax revenue that deters stealing of tax revenue and is defined such that $G \geq G^*$ results in $S = 0$ because $\partial U / \partial s < 0$ from condition (34).

The government maximizes its net income, as given by equation (2*), by making irreversible choices of τ, H and G subject to equations (5) to (10) and (34) to (36).

Solving the government's problem using equation (36) we find that the government chooses

$$(37) \qquad G = min\{\ \phi,\ \frac{1}{4\phi}\ \}\ \frac{1-c}{\gamma}\ \tau Y,$$

and, substituting equation (37) into equation (36), that the equilibrium fraction of tax revenue net of collection costs retained by the government after losses to theft is

$$\hat{P} = min\{\ 1,\ 1/2\phi\ \}. \tag{38}$$

Equations (37) and (38) together imply that if the efficiency of stealing in capturing government property is low, in particular if $\phi \leq 1/2$, then the government chooses $G = G^*$ such that stealing of government revenue is deterred, $\hat{P} = 1$. But, if the efficiency of stealing in capturing government property is high, $\phi > 1/2$, then $G < G^*$ and the government loses the fraction $1/2\phi$ of its tax revenue to stealing, $\hat{P} = 1/2\phi$.

Equation (37) also tells us that the ratio of resources allocated by the government to protect its own tax revenue to its tax revenue, $\gamma G/(1-c)\tau Y$, is only a function of ϕ, the efficiency of stealing in capturing government property, and independent of the tax rate and whether the government chooses to free-ride or not to free-ride on privately provided security.

Substituting equations (37) and (38) into equation (2*), the government's problem after taking into account the choice of G, is given by

$$\max_{\tau,H} Z = (1-c)B(\phi)\tau Y - \gamma H. \tag{11*}$$

subject to (5) to (10), where

$$B(\phi) \equiv 1-\phi \quad \text{if} \quad \phi \leq 1/2, \quad \text{and} \quad B(\phi) \equiv 1/4\phi \quad \text{if} \quad \phi > 1/2.$$

Given that the ratio $\gamma G/(1-c)\tau Y$ does not depend on whether the government chooses to free-ride or not, equations (12) to (25) still describe the equilibrium except that $(1-c)B(\phi)$ appears now in place of $1-c$. Since $B'(\phi) < 0$, the effects of c and ϕ on the government's decision to free-ride or not to free-ride are isomorphic.

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