Expropriation risk and competition within the military

Madhav S. Aney[a], Giovanni Ko[b,*]

[a]*School of Economics, Singapore Management University, 90 Stamford Road, 178903, Singapore.*
[b]*Division of Economics, School of Humanities and Social Sciences, Nanyang Technological University, 14 Nanyang Drive, 637332, Singapore.*

Abstract

How can agents in the military, who control the means of coercion, commit not to expropriate from producers? In this paper we propose competition within the military as one of the mechanisms that can deter predation and consequently create commitment. In our model, even if agents within the military could expropriate all output costlessly, it is attractive to protect producers from predating military units. This is because there is a marginal defensive advantage and consequently defence is an effective way to potentially eliminate other military units, reducing competition and leading to higher future payoffs. Our model predicts that greater internal competition within the military lowers the risk of expropriation and that this effect is strongest for countries with low institutional and economic development. Testing this prediction empirically, we find a robust negative relationship between competition within the military and expropriation risk. In line with our model this effect is strongest for countries at lower stages of institutional and economic development, and it weakens as the latter improve. These results indicate that there may be a short-run component to property rights institutions that varies with the degree of competition among agents who control the means of coercion.

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1. Introduction

The enforcement of property rights and contractual agreements ultimately depends on the presence of agents, such as the police or the military, who can use coercive power to punish those who violate them. But how can these agents commit not to abuse this power for their own gain? This commitment is important since the possibility of ex-post expropriation would seriously undermine incentives for ex-ante investments leading to poor economic outcomes.

Our answer to this question of "who guards the guards themselves?" is that "the guards guard each other", that is, competition between agents in the military and in particular, their inability to commit not to turn against one another, keeps predatory behaviour at bay. In our model, even if these agents could expropriate all output costlessly, it is attractive to protect producers from predators. This is because there is a marginal defensive advantage and consequently defence is an effective way to potentially eliminate competitors since a reduction in competition leads to higher future payoffs. Producers can therefore engineer a Prisoner's dilemma that exploits the desire of agents with coercive power to get rid of competitors, to threaten potential predators with elimination.

Using this basic mechanism we find a negative relationship between short-run expropriation risk and the number of specialists in violence[1]. We interpret this as a mechanism through which we may expect

*Corresponding author
Email addresses: madhavsa@smu.edu.sg (Madhav S. Aney), gko@ntu.edu.sg (Giovanni Ko)
[1]We follow North et al. (2009) in using this term to refer to agents with control of coercive power.

competition between specialists in violence to reduce expropriation risk. Embedding this mechanism in a richer model with occupational choice, and a public goods role for the specialists in violence, we find that this negative relationship is decreasing in magnitude in the level of long-run institutional and economic development, as the relative payoff of production increases as improved institutions increase the costs of predation.

We test this model using a panel of 168 countries over 11 years. Controlling for country and year fixed effects, we find a robust negative relationship between the short-run risk of expropriation and the number of military units in a country. In line with the predictions of our model we find that this effect attenuates in the level of long-run institutional quality. In particular we find that the negative relationship predicted by our model is significant for countries below the 30th percentile of institutional development and becomes weaker for countries with higher institutional quality.

Our paper contributes to the large literature in economics and political science that attempts to explain the existence of the commitment by those who have power to expropriate. The dominant view in the literature on this issue is the one laid out in the seminal work of Olson (1993), who argued that as a specialist in violence faces fewer threats from competitors and becomes more entrenched, his incentives for full expropriation decrease, leading to reduced predation. Hence commitment by the specialist in violence arises as a result of his need to stimulate private investments in order to maximise revenue.[2] Our model departs from the Olsonian view in two ways.

First, the Olsonian insight works only in an infinitely repeated setting. If the game is only finitely repeated then the result unravels through backwards induction and we are left with full predation and consequently no investment in equilibrium, regardless of the number of specialists in violence. In the Olsonian setting, an infinitely repeated game allows the producers and specialists in violence to use trigger strategies to support equilibria characterised by high investment and low expropriation. However, in an infinitely repeated setting it is unclear why increasing the number of specialists in violence increases predation since it may be possible for producers to play trigger strategies that allow low predation to be sustained even with a large number of specialists in violence. Rather than taking it for granted that more specialists in violence leads to more conflict and lower investment, we supply explicit micro-foundations for the interaction between many specialists in violence. In doing so we also show that it is possible to sustain less than full predation in a one-shot setting.

Second, our paper is inspired by the fact that some real world institutional arrangements seem at odds with this Olsonian view and are predicated on the commonly held belief that diffusion of power is good. For example, in order to avoid collusion leading to abuses of their power, there are often strict protocols governing the manner in which the highest ranks of the military meet.[3] Another famous historical example, which we deal with in more detail in section Appendix A.1 in the appendix, comes from the Roman Republic, where ultimate power over the army was typically vested in two consuls with a view to keep a check on their power. This idea of checks and balances lies at the heart of our model, where the presence of several military units keeps each one in check creating a balance of power conducive to investments.[4] The insight that we formalise here is that commitment should not be seen as an additional strategy that may or may not be available to these agents as a result of exogenous institutional arrangements.[5] Instead, we argue that

[2]This idea was formalised in McGuire and Olson (1996) and Grossman and Noh (1990). It is interesting to note that the problem of commitment becomes salient only in economies where output depends on ex-ante investments. In a pure exchange economy the ability to commit is irrelevant since the equilibrium is likely to be Pareto efficient even with predation since there are no incentive effects. Piccione and Rubinstein (2007) present a model that makes this point formally.

[3]Our paper is related to Besley and Robinson (2010), who model the interaction between the military and civilian government when there is the possibility of the former seizing power through a coup. In their model, a key concern is the ability of the *government* to commit to pay the military, whereas our focus is on the commitment of the *military*. Furthermore, a major difference is that in our model agents within the military can collude to expropriate fully without incurring any costs.

[4]Acemoglu et al. (2009) is another paper which incorporates some aspects of our model, in that it features elimination (through voting, rather than fighting) of competitors that can potentially be a threat in future rounds of elimination. They analyse the conditions under which a military junta would degenerate into personal rule. They find that stable coalitions emerge only if the game between the members of the junta is infinitely repeated and the members have a high enough discount factor. In contrast in our model, we will find that it is possible to maintain a unique stable coalition of specialists in violence all of whom side with the producers, even in a one shot setting.

[5]The mechanism at play in our model is reminiscent of Dal Bó (2007), where a lobbyist can affect the outcome of a vote by

commitment should be seen as a feature of an equilibrium arising from a game played between more than one specialists in violence.

The empirical findings in our paper are complementary to the research agenda that seeks to identify the long-run determinants and effects of institutions (see for example, Efendic et al. (2011) for a meta-analysis of the literature). This literature shows how variables such as factor endowments (Engerman and Sokoloff, 2000), legal origins (Djankov et al., 2003), and colonial history (Acemoglu et al., 2001) can explain long-run cross-country differences in institutions and economic performance. Our findings suggest that in addition to the time-invariant component of institutions that has been emphasised in this literature there may also be a short-run component.[6] Our results suggest that the short-run component of expropriation risk can be explained partly through an "extractive" channel, that is the degree of competition between specialists in violence who control coercive power.

In particular, the extractive mechanism we model is one where equilibrium expropriation arises from the strategic interaction among players who have exclusive control of coercive power. In line with the literature[7], our model predicts that this mechanism is prominent at lower levels of economic and institutional development. Our empirical results support this idea and indicate that a greater degree of internal competition among specialists in violence is associated with lower short-run expropriation risk but only in countries at a lower level of development. As predicted by our model, this mechanism is empirically irrelevant in developed countries.

As such, these results also contribute to the empirical literature on the relationship between the military and economic outcomes. Alptekin and Levine (2012) conduct a meta-analysis of the results in this literature and find evidence in favour of a non-linear relationship between military expenditure and economic growth. Our results support a non-linear relationship between the size of the military and expropriation risk that is mediated by long-run institutional quality.

Our paper is also related to the literature on the role of the military in non-democratic or autocratic regimes and the effects of autocratic takeover on economic outcomes, such as Nannicini and Ricciuti (2010). In contrast to Acemoglu et al. (2010) and Svolik (2013), who study the role of the military as a repressive tool of an autocratic regime, we are more concerned with the effect that the structure of the military has on investment incentives.

The paper is structured as follows. Section 2 discusses the baseline model with homogeneous agents and derives the comparative statics of the equilibrium. Section 2.4 extends the baseline model to allow heterogeneity in the strength of each specialist in violence. Section Appendix A.1 is a case study of a historical institution, namely consulship during the Roman Republic, which supports the intuition of our argument. Section 3 extends the model to allow for occupation choice and public good provision by specialists in violence. This yields testable implications that we take to the data in section 4. Section 5 provides concluding remarks.

2. Model

The economy is populated by an exogenously given number of producers and specialists in violence. We can think of a specialist in violence as an individual soldier, endowed with some strength, who unilaterally decides whether to predate or defend the producers. Alternately, it is also possible to think about a specialist in violence as a military leader who commands an independent military unit. This would be appropriate if we believe that the decision to predate or defend is taken by a military leader whose soldiers simply

a committee by offering members transfers which compensate voters for voting against their own preferences only when they are pivotal. Since this makes voting according to the wishes of the lobbyist a dominant strategy, the compensatory transfers are never paid out. The analogue idea in our model is that producers need to pay the specialists in violence only their payoff when they are the sole predator fighting against all others, i.e., when they are pivotal in predation, making this "bribe" small. On the other hand, our paper does not assume the existence of any kind of contract enforcement, which is required in Dal Bó (2007).

[6] One paper that uses short-run fluctuations in institutions is Busse and Hefeker (2007) which estimates the effect of institutions on foreign direct investment using fixed effects estimation.

[7] See for example North et al. (2009).

act on his orders. For different organisational forms within the military it may be appropriate to think of the specialist in violence as the general, the colonel, or an individual soldier depending on who makes the decision to predate or defend. At this stage we can remain agnostic about which one these is true.[8] For now all specialists in violence are assumed to be of equal strength. This assumption will be relaxed in section 2.4.

Producers operate a technology that requires some ex-ante investment in order to generate output. We assume that specialisation is complete, so that producers cannot defend themselves against specialists in violence, whilst the latter cannot control the former's investment decisions.[9] The interaction between these two groups is modelled as a game that unfolds as follow.

Timing.

1. Producers make investments.
2. Output is realised and producers choose a fraction t of total output to offer to each specialist in violence.
3. Each specialist in violence independently chooses whether to predate or defend.
   (a) If all specialists in violence choose to defend then each is paid the transfer t by the producers and the game ends.
   (b) If some specialists in violence choose to predate, there is a fight between predators and defenders, with defeated specialists in violence obtaining a payoff of 0.
4. (a) If the predators win, they expropriate all output and they share it among themselves, since producers cannot fight back.
   (b) If the defenders win, they enter a subgame where they are the only specialists in violence playing the same game, and producers once again make transfers and the game restarts from stage 3.

We first model the predation stage (the last three steps in the above timing) where specialists in violence make the decision of predating or defending. This decision depends on the transfers that are on offer from the producers. We then go back one step and derive the transfer that producers offer each specialist in violence.

2.1. Fighting

Suppose that at this stage, $p > 0$ specialists in violence have decided to predate and $q > 0$ have decided to defend. The probability that the predators win is

$$\frac{p}{\delta q + p}\ , \tag{1}$$

whereas the probability that the defenders win is

$$\frac{\delta q}{\delta q + p}\ . \tag{2}$$

These probabilities are similar to those given by contest success functions commonly used in the conflict literature, but differ from the latter since they depend solely on the number of agents on each side of the

[8] We discuss the implications of cross country variation in the military organisational forms when we take the model to the data in section 4.4 since this issue will be relevant in the empirics.

[9] Our paper is also related to the large literature on the co-existence of economic activity and conflict. Examples include Skaperdas (1992), Hirshleifer (1995), and Grossman and Kim (1995). See Garfinkel and Skaperdas (2007) for a survey of this literature. This literature models choices of agents when agents can invest to produce as well as increase their predatory capacity. Typically some investment occurs even though this is lower than the first best where agents can commit not to predate. This literature assumes that all agents work as producers as well as specialists in violence or that within a unit where agents specialise, the producers and specialists in violence have solved their commitment problem. The key innovation that distinguishes our paper from this literature is that we attempt to unpack how commitment between producers and specialists in violence can arise in the first place.

fight and not on the effort exerted by them. Therefore, fighting is completely costless in this formulation. Introducing an exogenous cost to conflict in this framework is straightforward and only strengthens our result further, since the outside option to co-operation with producers becomes less attractive (see section 2.5). On the other hand, introducing endogenous fighting costs in our setting may affect our result in a non-trivial way.[10]

This formulation implies that if all specialists in violence decide to predate, they win costlessly with probability 1. The parameter δ indicates the degree to which the technology of fighting favours defenders. Throughout our analysis, we make the following assumption about the defence advantage δ.

Assumption 1. *Defending specialists in violence have a combat advantage over predators, so that* $\delta > 1$.

2.2. Predation vs defence

Since by this stage output is already realised, we will normalise it to 1, so that all payoffs are fractions of total output. Consider the decision of a specialist in violence to predate or defend when there are p predators and q defenders.

If he joins the predators, their number increases to $p+1$ so that the probability of them winning is $\frac{p+1}{\delta q+p+1}$. Should they win, predators share output equally, each getting a share $\frac{1}{p+1}$ of output. Note that this equal sharing rule is equivalent to the predators engaging in a (costless) contest for the expropriated output, which is naturally the sole mechanism available to them after successful predation[11]. Since they are all assumed to be equal, in the equilibrium of this contest, they would each win output with equal probability. Therefore, the expected payoff from joining p predators is

$$\Pi_q^{p+1} \stackrel{\text{def}}{=} \frac{1}{\delta q + p + 1} \ . \tag{3}$$

Should he instead join the defenders, their number rises to $q+1$ so that the probability of the defenders winning is $\frac{\delta(q+1)}{\delta(q+1)+p}$. After a successful defence, the remaining specialists in violence enter a subgame where they are offered transfers by producers and then choose to predate or defend. In that subgame, a specialist in violence has the option of predating and getting at least the payoff from being the sole predator.[12] Then, the expected payoff from joining q defenders is at least

$$\begin{aligned} \Delta_{q+1}^{p} &\stackrel{\text{def}}{=} \frac{\delta(q+1)}{\delta(q+1)+p}\Pi_q^1 \\ &= \frac{\delta(q+1)}{\delta(q+1)+p}\frac{1}{\delta q+1} \ . \end{aligned} \tag{4}$$

Given these payoffs from predation and defence, the following lemma shows that the latter dominates the former.

Lemma 1. *Iff* $\delta > 1$, $\Delta_{q+1}^{p} \geq \Pi_q^{p+1}$ *for all* p *and* q, *with strict inequality if* $p > 0$.

Proof. *By inspection.*

This lemma shows that when there is a defensive advantage, a specialist in violence strictly prefers to join forces with defenders rather than the predators, if there are any of the latter. This is because the payoff from defending first and predating in the subsequent subgame, where some specialists in violence have been eliminated, is strictly greater than the payoff from predation. This means that in every subgame, there will be at most one predator.

[10] The fact that the win probabilities in equations (1) and (2) depend only on the number of specialists in violence who are predators and defenders implies there are no free-rider problems of the kind discussed by Olson (1965). Nitzan and Ueda (2014) in their "anti-Olson theorem" show that the probability of winning is increasing in group size as long as $c'(0) = 0$ and c' is convex, where $c(x)$ is the cost of exerting effort x. Therefore, we can think of our formulation as arising out of a contest between predators and defenders with endogenous effort where these conditions on marginal costs are satisfied, guaranteeing that free-rider effects are dominated by group-size effects.

[11] Similarly, note that after successful predation there is no more room for producers to offer transfers to specialists in violence.

[12] Note that for fixed $p+q$, Π_q^{p+1} is increasing in p.

2.3. Transfers

In the last stage, we saw that, from the point of view of an individual specialist in violence, it is always better to defend than to predate if some of the other specialists in violence are predating. But what about when all the other specialists in violence are also defending? In that case, the transfers that the producers offer will determine the choice of whether to predate or defend.

In our model, producers make a take-it-or-leave-it offer to the specialists in violence, who then independently decide their actions. Then, given that producers have all the bargaining power, it follows that specialists in violence are always pushed to their outside option.[13] This means that in every subgame after a successful defence, the producers' transfer is exactly equal to an individual specialist in violence's payoff from becoming the sole predator, so that Δ^p_{q+1} as defined in (4) is the actual defence payoff, not merely its lower bound. Since this makes specialists in violence indifferent between being sole predators and defenders we will make the following assumption.

Assumption 2. *Specialists in violence who are indifferent between predating and defending choose defence.*

We make defence the preferred option in case of indifference in order to rule out equilibria where only one specialist in violence predates and everyone (including the producers) gets exactly the same expected payoff as in the case where all specialists in violence accept the producers' offer.[14] However, such equilibria are purely an artefact of the producers pushing the specialists in violence to their outside option, and disappear as soon as the latter have some bargaining power. Given this assumption, the preceding arguments lead to the following proposition.

Proposition 1. *The unique subgame-perfect Nash equilibrium of the game with s specialists in violence consists of producers offering each specialist in violence a fraction*

$$\bar{t}(s) = \frac{1}{1+\delta(s-1)} \tag{5}$$

of total output, with all specialists in violence choosing not to predate.

Proof. The proof is established by induction on the number of specialists in violence. Firstly, note that when there is only one specialist in violence, his expected payoff from predation is one, since that is the probability with which he can expropriate all output. Then, producers can ensure that he does not predate by $t = 1$: this would make the specialist in violence indifferent between predation and non-predation, and by Assumption 1 the specialist in violence would not predate.

Next, suppose that we have already managed to prove that the proposition holds whenever the number of specialists in violence is less than or equal to some number $s-1$, and let us examine whether the proposition still holds if there are s specialists in violence.

To analyse the predation and defence payoffs of an individual specialist in violence, suppose that $p \geq 1$ of the other specialists in violence have decided to predate and $q \leq s-2$ have decided to defend. Then his payoff from joining the p other predators is

$$\frac{p+1}{p+1+\delta q}\frac{1}{(p+1)} = \Pi^{p+1}_q \ . \tag{6}$$

On the other hand, the payoff from joining the q defenders is the expected value of the product of the probability that $q+1$ defenders win against p predators and of the payoff in the subgame where the

[13] The results are robust to changing the bargaining power of the producers and specialists in violence as long as the latter do not have all the bargaining power. With full bargaining power, specialists in violence make a take it or leave it offer leaving producers with nothing, and consequently the incentive for ex-ante investment is destroyed.

[14] The only difference with these equilibria is that unlike the unique equilibrium in Proposition 1 with no predation, these contain a positive probability of predation. However, the expected level of expropriation is equal to the total transfers in the no predation equilibrium and moreover the central message of the paper about decrease in expropriation through increased competition remains a feature of these equilibria.

defenders have won and there are only $q+1$ remaining specialists in violence. Since we are considering subgame-perfect equilibria we know that the payoff in that subgame will be the Nash equilibrium of that subgame. Furthermore, we assumed that the proposition holds in any game where the number of specialists in violence is at most s so that the Nash equilibrium payoff in a subgame where there are only $q+1$ specialist in violence is $\frac{1}{1+\delta q}$. The payoff from defence is then

$$\frac{\delta(q+1)}{p+\delta(q+1)}\frac{1}{1+\delta q}=\Delta^p_{q+1} \tag{7}$$

By Lemma 1, $\Delta^p_{q+1}>\Pi^{p+1}_q$ for all values of p, with strict inequality since $p\geq 1$. Therefore a specialist in violence always strictly prefers defence to predation if there is at least one other potential predator.

Suppose instead that, from the point of view of an individual specialist in violence all of the other specialists in violence are defenders. Then his payoff from predation is $\frac{1}{\delta(s-1)+1}$, whereas that from defence is simply the transfer t. By Assumption 2, producers can ensure that this specialist in violence does not predate by offering a transfer exactly equal to his predation payoff. Therefore, when there are s specialists in violence, the only equilibrium is one where producers offer $\bar{t}(s)=\frac{1}{\delta(s-1)+1}$ and all specialists in violence do not predate.

To reiterate, the intuition of this result is as follows. Although a larger number of predating specialists in violence increases the probability of a successful predation, the payoff conditional on success is weighed down by the decreased share each specialist in violence receives.[15] As a result it is more attractive for a specialist in violence to stave off predation with the expectation of the larger share he receives if the defenders win. Even a marginal defensive advantage ensures that it is a dominant strategy for all specialists in violence to defend.[16] If all other $s-1$ specialists in violence are defending the payoff of a lone specialist in violence who considers predation is $\Pi^1_{s-1}=\frac{1}{1+\delta(s-1)}$. Hence when producers offer him this amount they make him indifferent between predation and defence and given Assumption 2, he defends.

It is now possible to see why $\delta>1$ is foundational to our results. It ensures that potential predators always prefer to defend in order to eliminate competitors and guarantee themselves a higher payoff in the subsequent sub-game. There are several ways in which such a defensive advantage could arise. For instance it could arise out of the possibility of producers helping defending specialists in violence in the fight against the predating ones. Although in our model producers possess no combat ability, they could still provide help to defending specialists in violence through non-armed resistance in the form of intelligence gathering, sabotage or strikes, etc. Such activities would be of limited use to producers in protecting themselves from expropriation but could be a boost to a military force that can take advantage of them. However, the induction structure of the proof implies that this way of thinking about the defensive advantage may be problematic. To see this note that producers should side with the defenders even in the case where there is only one defender. However, in this case the producers should anticipate full predation following a successful defence and should consequently be indifferent to helping the defender.

Another way of motivating the presence of a defensive advantage is through the idea of social norms. In a society where the idea of protecting producers is firmly entrenched, and a specialist in violence is a military leader who commands a military unit, we would expect that troops would be at least marginally less likely to obey a command to predate. If this is the case, we may think of $\frac{1}{\delta}$ as the proportion of a predator's troops that stay loyal to him. This delivers the structure we need on the probability of victory for the two sides. It is interesting to note that it would be natural for such a social norm to arise in a society since all agents including specialists in violence are better off with it. In the absence of such a norm, producers

[15] It is interesting to note that the reason why the increase in the numerator of the probability of successful predation is exactly offset by the reduction in the share of each specialist in violence is because p enters linearly in the numerator of the probability of successful predation defined in equation (1). Allowing for a more general functional form $\frac{f(p)}{\delta f(q)+f(p)}$ changes the results. Typically the uniqueness of equilibrium may no longer be available with a general $f(p)$ as multiple stable coalitions between specialists in violence may arise.

[16] Hence, the equilibrium is the same if we allow deviations by coalitions.

would correctly anticipate full expropriation at the end of the period and will consequently invest nothing at the start. This in turn would reduce the payoff of the specialists in violence to zero. Hence the existence of such a norm turns out to be Pareto efficient since it underpins the ability of specialists in violence not to fully expropriate.

Proposition 1 shows that the transfer that each specialist in violence receives is decreasing in the number s of specialists in violence but it turns out that total transfers to all specialists in violence are also decreasing in their number, as our next result shows.

Proposition 2. *Total transfers to specialists in violence are decreasing in their number.*

PROOF. *Total transfers are*

$$s\bar{t}(s) = \frac{s}{1+\delta(s-1)} = \frac{1}{\delta-(\delta-1)1/s}. \tag{8}$$

Since $\delta > 1$, we can see that they are therefore decreasing in s.

This shows that not only is the transfer paid to an individual specialist in violence decreasing in s, but that the sum of transfers is also decreasing in the number of specialists in violence. This is because, as the number of specialists in violence increases, the deviation payoff from predation becomes worse, which in turn decreases the equilibrium transfers they are paid. We can summarise this result as follows.

Remark 1. *Expropriation is decreasing in the number of specialists in violence.*

This result captures the mechanism that this paper highlights. Total expropriation tends to decrease when power is diffuse. In particular, total expropriation decreases in the number of specialists in violence as the balance of power between them is such that unilateral predation becomes more and more unattractive. This result is interesting when contrasted with the Olsonian idea that decreasing the number of specialists in violence decreases their incentives to expropriate fully.

As we would expect, total expropriation is decreasing in the defensive advantage. The intuition for this is straightforward. As defence becomes easier, the expected payoff from predation decreases. Consequently specialists in violence are satisfied with a lower transfer and the degree of expropriation the producers face goes down.

The central message of the model is that competition among specialists in violence creates a balance of power that makes predation unattractive, leading to a commitment not to predate. The intuition behind this result is simple: the defensive advantage not only skews the probability of combat victory towards defence, but makes it profitable to defend first and predate later, rather than predate at the outset; defence is a way to eliminate competitors and thus guarantee a bigger payoff for oneself, making it the dominant strategy. The inability to commit to refrain from using co-operation with producers as a way to get rid of each other places specialists in violence in a Prisoner's Dilemma, which the producers can exploit to avoid full predation.

The inability of specialists in violence to commit is a crucial issue in our paper. In modern economies, the ability to commit to agreements arises precisely from the existence of agents who can use their coercive power to punish those who renege on their commitments. But the commitment not to abuse their power is not available to the very agents who perform this enforcement function. Appealing to institutions to generate such commitment merely shifts the burden to the higher level specialists in violence who must support such institutions. This logic leads to an infinite regress where commitment at one level is sustained by commitment at a higher one. We have attempted to find a solution to this problem by using a somewhat different approach. In our model, what underlies the ability of specialists in violence to commit is not other institutions, but simply material forces that govern the success or failure of an attack aimed at expropriation, in other words, forces that shape the nature of the game that specialists in violence play.

2.4. Heterogeneity in strength

In this subsection we extend the model to allow specialists in violence to have differing strengths. This allows us to examine how expropriation changes in response to changes in the distribution of their strengths. In particular we find that total expropriation decreases as the distribution of strengths becomes more equal. This strengthens our main point about the positive impact of competition between specialists in violence.

Suppose that the specialists in violence are indexed by i, where $i = 1, ..., s$, and let each of them have strength x_i, which captures all factors that would contribute to increasing the probability of winning, such as their skill, the level of training, the quality of their equipment, or in case specialists in violence are military leaders, the number of troops they command. Now that they differ in strength, rather than sharing output equally, each successful predator obtains a share of output that is proportional to his strength. In parallel to the discussion of predation in subsection 2.2, this proportional sharing rule is equivalent to the predators engaging in a contest to win the expropriated output where each predator's probability of winning is proportional to his strength. Thus a specialist in violence with strength x who successfully predated with others who have total strength P, would get a share of $\frac{x}{x+P}$ of total output.

Let P and Q be the total strengths of the predators and defenders, respectively. We next prove the counterpart to Lemma 1, showing that defence is a dominant strategy, being strictly dominant if there is at least one predator already.

Lemma 2. *Iff $\delta > 1$, $x > 0$,*

$$\frac{\delta(Q+x)}{P+\delta(Q+x)}\frac{x}{x+\delta Q} \geq \frac{P+x}{P+x+\delta Q}\frac{x}{x+P} \tag{9}$$

with strict inequality if $P > 0$.

Proof. *By inspection.*

We can now prove the analogue of Proposition 1.

Proposition 3. *The unique subgame-perfect Nash equilibrium of the game where each specialist in violence has strength x_i is for producers to offer to each of them a transfer*

$$\bar{t}_i = \frac{x_i}{x_i + \delta \sum_{j \neq i} x_j}\,, \tag{10}$$

and for all specialists in violence to not predate.

Proof. *The proof is the same as that for Proposition 1 but using Lemma 2 to establish that defence is a dominant strategy whenever there is at least one predator, so that producers only need to offer to each specialist in violence their payoff from being the sole predator.*

An interesting feature of the equilibrium is that payoff of each specialist in violence depends not only on his strength, but also on that of all others. It is then natural to ask how the distribution of strengths affects the total expropriation that producers face. The following proposition shows that a more equal distribution leads to lower transfers.

Proposition 4. *Suppose that specialist in violence i and j have strengths $x_i > x_j$. Then reducing i's strength to $x_i - \varepsilon$ and increasing j's to $x_j + \varepsilon$, where $0 < \varepsilon < x_i - x_j$, will reduce total transfers.*

Proof. *Since the redistribution of strength keeps the sum of i and j's strengths constant, the payoff to all other specialists in violence is unaffected. Therefore, it suffices to show that the transfers to i and j, namely $\bar{t}_i + \bar{t}_j$, will fall. Then we need to show that*

$$\begin{aligned}
&\frac{x_i}{x_i + \delta x_j + \delta \sum_{k \neq i,j} x_k} + \frac{x_j}{x_j + \delta x_i + \delta \sum_{k \neq i,j} x_k} \\
&\qquad \geq \frac{x_i - \varepsilon}{x_i - \varepsilon + \delta(x_j + \varepsilon) + \delta \sum_{k \neq i,j} x_k} + \frac{x_j + \varepsilon}{x_j + \varepsilon + \delta(x_i - \varepsilon) + \delta \sum_{k \neq i,j} x_k} \\
&\qquad = \frac{x_i - \varepsilon}{x_i + \delta x_j + (\delta - 1)\varepsilon + \delta \sum_{k \neq i,j} x_k} + \frac{x_j + \varepsilon}{x_j + \delta x_i - (\delta - 1)\varepsilon + \delta \sum_{k \neq i,j} x_k}\,.
\end{aligned} \tag{11}$$

Letting $\sigma_i = x_i + \delta x_j + \delta \sum_{k \neq i,j} x_k$ *and* $\sigma_j = x_j + \delta x_i + \delta \sum_{k \neq i,j} x_k$*, we need to show that*

$$\frac{x_i}{\sigma_i} + \frac{x_j}{\sigma_j} \geq \frac{x_i - \varepsilon}{\sigma_i + (\delta - 1)\varepsilon} + \frac{x_j + \varepsilon}{\sigma_j - (\delta - 1)\varepsilon} \tag{12}$$

$$\Leftrightarrow \frac{x_i\sigma_j + x_j\sigma_i}{\sigma_i\sigma_j} \geq \frac{x_i\sigma_j + x_j\sigma_i - 2(\delta - 1)\varepsilon\big(x_i - x_j - \varepsilon\big)}{\sigma_i\sigma_j + (\delta - 1)^2\varepsilon\big(x_i - x_j - \varepsilon\big)}\,, \tag{13}$$

which is true if $\delta > 1$ *and* $0 < \varepsilon < x_i - x_j$*.*

This proposition shows that a Dalton-transfer of strength from a stronger specialist in violence to a weaker one will reduce total transfers. As a consequence, a more equal distribution of strengths yields lower total transfers, with the minimum being achieved when all specialist in violence are homogeneous.

Remark 2. *Expropriation decreases with more equal distribution of strength among specialists in violence.*

This is in line with the intuitive idea that a balance of power as arising from power being equally spread out over a number of agents helps in preventing predation. A more even distribution of power yields more effective competition, strengthening our main point that competition is the force underlying the ability of specialists in violence to commit. Seen together Remarks 1 and 2 reinforce the positive impact that competition among specialists in violence has on investment incentives in the economy.

2.5. Costly conflict

So far, we have analysed a model with costless conflict. In this section, we argue that the result in Proposition 1 extends naturally to the case where conflict is costly. In particular, the unique equilibrium where all specialists in violence defend persists. However, costs of conflict have distributional consequences – the transfers to specialists in violence decrease, and the producers retain a larger share of the output.

Note firstly that introducing costly conflict among successful predators in the process of dividing up the spoils only strengthens the unique equilibrium in Proposition 1 by making predation less attractive. Moreover, equilibrium transfers are determined by the probability of a lone predator winning. In such a case, after successful predation, there is no further contest to divide expropriated output because there is only one predator. Hence, costly output sharing after successful predation does not affect equilibrium transfers.

There are two potential sources of inefficiency when conflict is triggered. First, the specialist in violence may have to exert potentially costly effort $c \geq 0$ when engaging in conflict. Second, conflict may directly lead to part of the output being destroyed, with only a portion ϕ remaining.

Allowing for these, the equilibrium transfers change to

$$\bar{t}(s; \phi, c) = \frac{\phi}{1 + \delta(s - 1)} - c. \tag{14}$$

It is reasonable to think that ϕ depends on institutional quality. Developed countries (low ϕ) typically rely on production technologies that require inputs such as capital and a highly skilled workforce, both of which are very mobile. It seems plausible that in the unlikely scenario that conflict among specialists in violence is triggered in such an economy, it would lead to a large proportion of output being destroyed due to the flight of capital and high skilled workers. On the other hand, output in under-developed countries relying on agriculture would be less vulnerable to loss during conflict as the inputs are less mobile. In section 3 we construct a model based on this idea that we take to the data in section 4.

3. Modelling short-run expropriation risk

In this section, we take the mechanism from section 2 and embed it in a richer model with occupational choice into specialists in violence and producers, taking into account the level of institutional development

as captured by the amount of output that remains after predation, as in subsection 2.5. This will give us a model with richer testable implications about short-run expropriation risk that we take to the data in section 4.

We model a one-shot game that repeats each period, where a period is defined as one year, in line with our empirical formulation in section 4. The economy is populated with n agents, $\overline{s}$ of whom are *potential* specialists in violence who have the choice of becoming specialists in violence or producers, the remaining $n-\overline{s}$ being producers. A potential specialist in violence is an agent that is endowed with the characteristics, such as ruthlessness or fearlessness, that are required to become an actual specialist in violence. The number of potential specialists in violence $\overline{s}$ is randomly drawn at the beginning of each period such that $\underline{s} \leq \overline{s} \leq n$. The number of *actual* specialists in violence s^* is determined in equilibrium. All agents are risk neutral.

Timing. We make two modifications to the timing in section 2. First, there is now a stage 0 where the number $\overline{s}$ of potential specialists in violence is drawn and each potential specialist in violence decides whether to become specialists in violence or producers. Second, we modify stage 2 of the timing. So far we have assumed that when output is realised, producers offer a transfer to each specialist in violence, and this fraction is determined solely by their option to predate. Now in addition to this, we also allow the transfer to be determined competitively by the role of specialists in violence in providing a public good.

Public good provision. We enrich the model by allowing specialists in violence to perform a positive role in the economy in addition to the predatory role they perform in section 2. To capture this simply, we assume output $f(i,s)$ is a function of investment i and the number of actual specialists in violence s. In particular we assume that

$$f(i,s) = \begin{cases} i^\alpha & \text{if } s \geq \underline{s} \\ 0 & \text{otherwise,} \end{cases} \tag{15}$$

where $\alpha \in (0,1)$. This formulation implies that the socially beneficial role of specialists in violence is performed as long as there are at least $\underline{s}$ of them in the economy. This formulation is motivated by the idea that a certain number of specialists in violence are required for the provision of basic public goods needed for the economy to function. Although we do not model this explicitly, the demand for such public goods may arise from the need to both eliminate external threats and to deter undesirable behaviour within the economy, e.g., agents reneging from contracts, theft, etc. Since specialists in violence have the capacity to exert coercive power, they are ideally suited to perform this role. This particular formulation of public goods simplifies the analysis but is not central to our results which would hold even if public goods are modelled as a continuous function of the number of specialists in violence, or if public goods entered additively in agents' payoffs.

Payoffs. Assuming that there are enough specialists in violence to ensure positive output, and that each one of the s specialists in violence receives a fraction t of output, the payoff of each producer is

$$u(st) := \max_i \{(1-st)\, i^\alpha - i\} = (1-\alpha)(1-st)\, y^*(st)\,, \tag{16}$$

where i is the amount of investment and individual output is

$$y^*(st) := \alpha^{\frac{\alpha}{1-\alpha}} (1-st)^{\frac{\alpha}{1-\alpha}}\,. \tag{17}$$

On the other hand, the payoff from being one of the s specialists in violence is given by

$$v(s,t) := t(n-s)\, y^*(st)\,, \tag{18}$$

where $(n-s)\, y^*(st)$ is total output. Finally, let $w(s,t)$ be the difference between the payoff of a specialist in violence and a producer, that is,

$$w(s,t) := v(s,t) - u(st) = ((n-\alpha s)t - (1-\alpha))\, y^*(st) \tag{19}$$

and note that the payoff for specialists in violence is higher, equal to or lower than that of a producer iff

$$w(s,t) \gtreqless 0 \iff t \gtreqless \underline{t}(s) := \frac{1-\alpha}{n-\alpha s}\,, \tag{20}$$

where $\underline{t}(s)$ is the transfer that equates the payoff of a specialist in violence and a producer, which is increasing in s. This is because an increase in s decreases output both at the extensive margin, that is through a decrease in $n-s$, and at the intensive margin through an increase in the effective tax rate st. This is greater than drop in the payoff from production which only operates through the intensive margin effect. Consequently an increase in s decreases the relative payoff of a specialist in violence. Hence $\underline{t}(s)$ must increase to ensure that a potential specialist in violence is indifferent between being a producer and a specialist in violence.

Transfers. In section 2.5, the equilibrium transfer was determined solely by the payoff from being the only predator, with each specialist in violence receiving

$$\bar{t}(s;\phi,c) := \phi\frac{1}{1+\delta(s-1)} - c\,, \tag{21}$$

where $1-\phi$ is the proportion of output that is destroyed by predation and c is the cost of conflict, which we argued are inversely related to institutional quality.

In this section, since specialists in violence now provide a public good, we can think of the transfer $\underline{t}(s)$, which equates the payoffs of producers and specialists in violence as the *competitive* transfer for providing the service. We assume that specialists in violence always receive at least $\underline{t}(\underline{s})$ as long as there are at least $\underline{s}$ of them to ensure positive output. Should their number fall below $\underline{s}$ production becomes impossible, and they receive 0 transfers.

Equilibrium. We define a pair s^*, t^* of number of specialists in violence and transfers to them to be an equilibrium if either one of the following holds:

- $w(s^*,t^*)=0$: producers and specialists in violence have equal payoffs[17], so that potential specialists in violence who have become producers do not want to switch to being actual specialists in violence and vice-versa;
- $s^* = \overline{s}$ and $w(\overline{s},t^*)>0$: specialists in violence have strictly higher payoffs than producers so that all potential specialists in violence wish to become actual specialists in violence.

Note also that once the number of actual specialists in violence is decided, the game proceeds as in section 2, so that the equilibrium transfer must be $t^* = \max\{\underline{t}(\underline{s}), \bar{t}(s^*;\phi,c)\}$.

Lastly, before characterising the equilibrium of this game, it will be helpful to define $\underline{\phi}$ as the level of institutional quality such that the predation and competitive transfers are equal when there are $\underline{s}$ specialists in violence, i.e., $\bar{t}(\underline{s};\phi,c) = \underline{t}(\underline{s})$, which implies

$$\underline{\phi} := \left(\frac{(1-\alpha)}{n-\alpha\underline{s}} + c\right)(1+\delta(\underline{s}-1))\,. \tag{22}$$

We can now state our result.

Proposition 5. *For any given c, there is a unique pure strategy equilibrium with positive output where the number of specialists in violence s^* and transfer t^* are given by*

$$s^* = \begin{cases} \min\{\overline{s}, \tilde{s}(\phi)\} & \text{if } \phi > \underline{\phi} \\ \underline{s} & \text{if } \phi \le \underline{\phi} \end{cases} \quad \text{and} \quad t^* = \begin{cases} \bar{t}(s^*;\phi,c) & \text{if } \phi > \underline{\phi} \\ \underline{t}(\underline{s}) & \text{if } \phi \le \underline{\phi} \end{cases}, \tag{23}$$

where $\tilde{s}(\phi)$ is the unique value of s that solves $w(s,\bar{t}(s;\phi,c))=0$.

[17] Strictly speaking, s^* defined in this way need not be an integer. This issue can be addressed by stating the definition in terms of the largest integer not greater than s^* and the smallest integer not less than s^*. This would not substantially change our result and merely makes the exposition considerably more cumbersome.

PROOF. *Firstly, note that by* (20), $w(s, \underline{t}(\underline{s})) < 0$ *for all* $s > \underline{s}$, *so that* $t^* = \underline{t}(\underline{s})$ *implies* $s^* = \underline{s}$.

When $\phi \leq \underline{\phi}$, *for any* $s \geq \underline{s}$, $\overline{t}(s; \phi, c) \leq \overline{t}(s; \underline{\phi}, c) \leq \overline{t}(\underline{s}; \underline{\phi}, c) = \underline{t}(\underline{s})$, *where the last equality follows from the definition of* $\underline{\phi}$. *Hence, in this case,* $t^* = \underline{t}(\underline{s})$ *and* $s^* = \underline{s}$.

Next, consider $\phi > \underline{\phi}$. *In this case,* $\overline{t}(\underline{s}; \phi, c) > \overline{t}(\underline{s}; \underline{\phi}, c) = \underline{t}(\underline{s})$, *so that by* (20), $w(\underline{s}, \overline{t}(\underline{s}; \phi, c)) > 0$ *and* $\underline{s}$ *cannot be the equilibrium number of specialists in violence, and the equilibrium transfer cannot be* $\underline{t}(\underline{s})$. *Instead the equilibrium transfer must be given by* $\overline{t}(s^*; \phi, c)$, *and we need to determine* s^*.

From (20), $w(s, \overline{t}(s; \phi, c)) = 0$ *is equivalent to* $\overline{t}(s; \phi, c) = \underline{t}(s)$, *which has a unique solution for* s *since* $\overline{t}(s; \phi, c)$ *and* $\underline{t}(s)$ *are monotonically decreasing and increasing in* s, *and call this solution* $\tilde{s}$. *If* $\tilde{s} \leq \overline{s}$, *then* $s^* = \tilde{s}$, *otherwise* $s^* = \overline{s}$, *as required.*

Our result illustrates how the nature of the equilibrium varies with our measure ϕ of institutional quality. At low levels of institutional quality, i.e., when $\phi > \underline{\phi}$, transfers to specialists in violence are determined by their predation payoffs, as in section 2. Their number are either determined exogenously when the number of actual specialists in violence equals the number of potential specialists in violence, that is $s^* = \overline{s}$, or endogenously with $s^* = \tilde{s}(\phi)$ so that they are indifferent between choosing to be specialists in violence or producers.

At high levels of institutional quality, i.e., when $\phi \leq \underline{\phi}$, if specialists in violence were given transfers determined by their predation payoffs, not enough of them would choose to become specialists in violence to provide the public good. In such cases, they are instead compensated competitively, that is, they are given transfers that make them indifferent between choosing to become producers instead.

Implication 1. *At low levels of institutional development, the effect of exogenous increase in the number of specialists in violence on short-run expropriation risk is negative and attenuating in institutional quality.*

In our model, when $\phi > \underline{\phi}$, and the number of specialists in violence is determined exogenously by the number of potential specialists in violence such that $s^* = \overline{s}$, the short-run risk of expropriation is given by $\phi \overline{t}(\overline{s})\overline{s}$. The effect of $\overline{s}$ on expropriation risk is

$$\frac{\partial \phi \overline{t}(\overline{s})\overline{s}}{\partial \overline{s}} = -\phi \frac{\delta - 1}{(1 + \delta(\overline{s} - 1))^2} < 0 \tag{24}$$

We observe that the effect is negative and that the magnitude of this effect is increasing in ϕ. This implies that the competition mechanism that is modelled in Proposition 1, which causes short-run expropriation risk to decrease in s, should be supported by the data for countries with low institutional quality.

Historically, institutions were stacked in favour of agents who controlled coercive power. North et al. (2009) describe how institutional development over time unfolded incrementally in a slow and often uneven process that transformed institutions that in their terminology were "natural" or extractive, to ones that are "open access" and conducive to modern economic activity. Our model is consistent with this since the competition mechanism from section 2 is purely of the extractive variety, and its effect on year-on-year expropriation risk is higher for countries with low institutional quality.

Implication 2. *Institutional and economic development are positively correlated.*

It is possible to see that equilibrium output $y(s, \phi)$ is decreasing in ϕ. This is because of the well understood channel of institutional quality having a positive effect on investment.[18] Although there already exists a literature that tests this prediction, our model allows us to test this in a unique way. In particular the link between economic and institutional development implies that we can substitute institutional quality with economic development in Implication 1 above and still find a robust empirical relationship.

[18] See Besley and Ghatak (2010) for an overview of links between expropriation and economic outcomes.

4. Empirics

In this section, we test Implications 1 and 2 from the previous section. The empirical analysis is based on panel data from the World Military Expenditures and Arms Transfers dataset compiled by the US Department of State.[19] The data comprises 168 countries over an 11 year period from 1995 to 2005. This contains data on our main explanatory variable, the number of active troops, together with data on military and government expenditure in 2005 US dollars, which we use as controls.

The empirical analogue of the number of specialists in violence is the number of troops. This is appropriate if we believe that a soldier can unilaterally decide whether to defend producers or to predate. However, if a soldier simply obeys the command of a military leader, then the ideal measure for the number of specialists in violence is the number of military leaders. Since we lack data on the number of military leaders, we will use the number of troops as the regressor for our empirical analysis. In section 4.4 we describe the assumptions under which this is a valid proxy for the case when specialists in violence are military leaders and not soldiers.

We measure the risk of expropriation using the Investment Profile component of the Country Risk measure compiled by Political Risk Services for their International Country Risk Guide (ICRG). The Investment Profile index in the ICRG dataset has been widely used as a measure of the risk of expropriation starting with Knack and Keefer (1995). As noted by Acemoglu et al. (2001), although the variable is designed to capture the risk of expropriation for foreign investment, the correlation with the risk of expropriation for domestic investment is likely to be high. This variable measures the risk of expropriation on a scale from 0 to 12, with a higher score indicating a lower risk. Descriptive statistics for this and all other variables we use are reported in table C.1.

4.1. Baseline results

Our model predicts a negative causal relationship between the number of specialists in violence and the risk of expropriation that is decreasing in magnitude with higher institutional quality. In practice, there are several other factors that affect the strength of property rights in a country that are likely to be conflated with the mechanism we are interested in testing. For instance the literature points to "deep" structural ones such as factor endowments of the country (Engerman and Sokoloff, 2000), legal origins (Djankov et al., 2003), and colonial history (Acemoglu et al., 2001). These could be potential sources of bias in our results. To account for them we test our model in a panel setting with country fixed effects. This absorbs the effect of time invariant factors and allows us to analyse whether the mechanism we model can explain the short-run within-country variation in the strength of property rights. We start with the following simple specification

$$y_{it} = \alpha_i + \beta_t + \gamma \ln AT_{it} + X'_{it}\eta + \varepsilon_{it}\,, \tag{25}$$

which is a restricted version of (26) where λ is assumed to be zero. Here, y_{it} is a measure of short-run protection from expropriation[20], α_i and β_t are country and time fixed effects, AT_{it} is the number of active troops, and X_{it} is a vector of time-varying country-level controls that include per capita income, government and military spending, population, indices for the rule of law and levels of internal and external conflict. Table C.2 reports the results of this regression. We observe that the estimate of γ is close to zero and statistically insignificant in all specifications.

However, given Implication 1, we expect competition among specialists in violence to have a different effect at different levels of development, with the relationship being stronger for countries with lower institutional quality. Therefore to test the relationship between the strength of property rights and the number

[19] The data is available at http://www.state.gov/t/avc/rls/rpt/wmeat/2005/index.htm

[20] Our paper is not the first paper to exploit the short-run variation in institutions using the ICRG dataset Busse and Hefeker (2007) also use a fixed effects specification to estimate the effect of short-run institutional fluctuations on foreign direct investment. There are two key differences, first in this paper these short-run fluctuations are the dependent variable, and second we only use the investment profile index in the ICRG dataset (rather than the aggregate of all ICRG components) since it closely matches our model. The robustness of our results to using the aggregate ICRG index over all components is shown in table C.6.

of specialists in violence we propose the following specification:

$$y_{it} = \alpha_i + \beta_t + \gamma \ln AT_{it} + \lambda(1-\phi_i) \cdot \ln AT_{it} \ + X'_{it}\eta + \varepsilon_{it}\,, \tag{26}$$

where $1-\phi_i$ is institutional quality in country i. Given Implication 1, we expect the sign on γ to be positive and λ to be negative. Any other result, such as positive γ and λ implying that the positive effect of specialists in violence becomes stronger with development, would lead us to conclude that there is little support for our model in the data. To test this, we regress the specification in (26) where we proxy for $1-\phi_i$ by the mean of the Revised Polity IV variable for the period between 1990-1994. This measures the average constraint faced by the executive within a country.

In line with our model in section 3 we prefer to use a time invariant ϕ_i since we wish to capture long-run "deep" institutional quality through this variable. As we show in section 4.4, the use of time-invariant measure of development also allows us to address the potential measurement error induced by the use of the number armed forces as a proxy for specialists in violence. Moreover taking the average between 1990-94, before our sample begins, implies that this variable is less likely to be endogenously determined with short-run fluctuations in expropriation risk between 1995-2005. None the less in section 4.2 we show that our empirical results are robust to letting ϕ_i vary over time. Finally, the use of mean Polity IV averaged over five years before 1995, which is the starting point for the rest of our sample, helps mitigate the concern that this variable is in fact affected by short-run changes in expropriation risk, which is our dependent variable. We discuss the concern of endogeneity in more detail in section 4.5.

Note that in the model from section 3, the equilibrium number of specialists in violence is either equal to the number of potential specialists in violence $\overline{s}$, which is exogenous, or $\tilde{s}(\phi)$. Since institutional quality $1-\phi$ is assumed to be time invariant within a country, the effect of $\tilde{s}(\phi)$ on expropriation risk is absorbed in the country fixed effects and this allows us to empirically focus on the competition effect by observing the changes in the expropriation risk induced by exogenous variation in $\overline{s}$.

Table C.3 reports the results. Although the estimate of γ is positive and significant, this in itself is not confirmation of our hypothesis because the interaction term implies that the marginal effect $\gamma+\lambda\cdot\overline{PolityIV}_i$ is a function of the level of average institutional development. In particular, γ is the effect when average Polity IV variable is zero, whereas a negative λ indicates that this effect is declining in institutional development.

Assuming for the sake of illustration that these effects are causal, the estimates suggest that in a country like Syria that has a mean Polity IV score of -9 for the period 1990–5 (in the lowest decile), a one percent fall in the number of troops would decrease protection against expropriation by $(0.638-0.229\times-9)/100 = 0.027$ points. To put this number in perspective, between the years 2003 and 2004, Syrian armed forces decreased in size from 325,000 to 315,000, a 3% decrease. Our estimates predict a corresponding fall in protection against expropriation by 0.081 points, which accounts for about one fifth of the actual fall of 0.375.

Figure 1 illustrates the marginal effect[21] of an increase in the log of the number of troops at all Polity IV percentiles in the sample, with 90%, 95% and 99% confidence intervals computed using the method explained in appendix Appendix B.

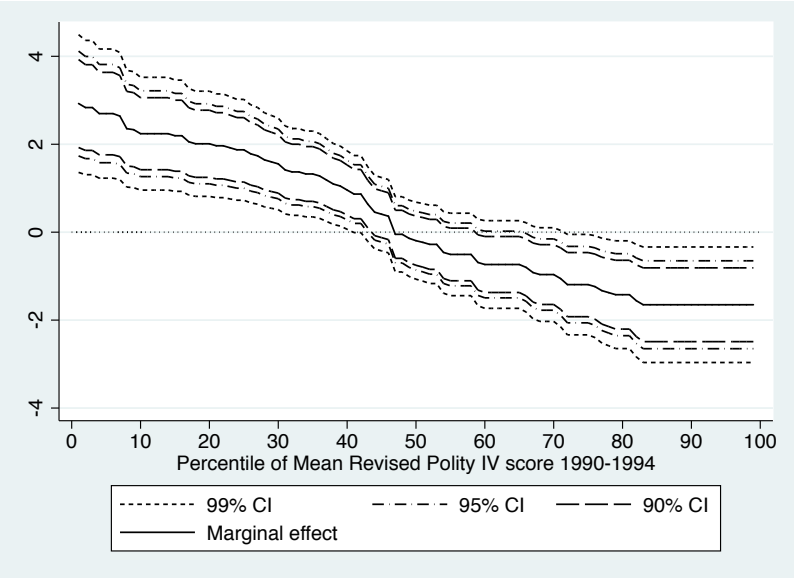
The effect thresholds in each specification indicate the percentile of average income below which the estimated marginal effect $\hat{\gamma} + \hat{\lambda} \cdot \ln \overline{PolityIV}_i$ is positive and significant at the 1%, 5%, and 10% level. For instance, the number 0.423 for the 5% effect threshold in column (6) indicates that this effect is significant at the 5% level for countries that are below the 42.3 percentile of the Polity IV distribution. Looking at these numbers across all specifications we can say that the competition effect seems to be significant for countries that are below the 40th percentile of the Polity IV distribution.

Column (1) from table C.3 reports the results of the regression where we only control for per-capita income and government spending. Since we control for both country and time fixed effects in all our specifications, any source of bias must arise from factors that vary over time within a country.

In contrast to the story captured in the model in section 3, it is possible that the size of the army is instead determined in a constrained optimisation problem for the state. As a result, the observed variation in the size of the armed forces could reflect exogenous shocks to the state's constraints. The government's

[21] Note that although the marginal effect is linear in Polity IV, it is not linear in the corresponding percentiles.

Figure 1: Marginal effect of Active Troops on Expropriation Risk against percentiles of Mean Polity IV



legal taxation capacity could be such a constraint, and one that might be negatively correlated with the short-run risk of expropriation (see for example Besley and Persson (2010)). To address this we control for government spending in column (1) and military spending in column (2). In section 4.2 we make more attempts to address this concern.

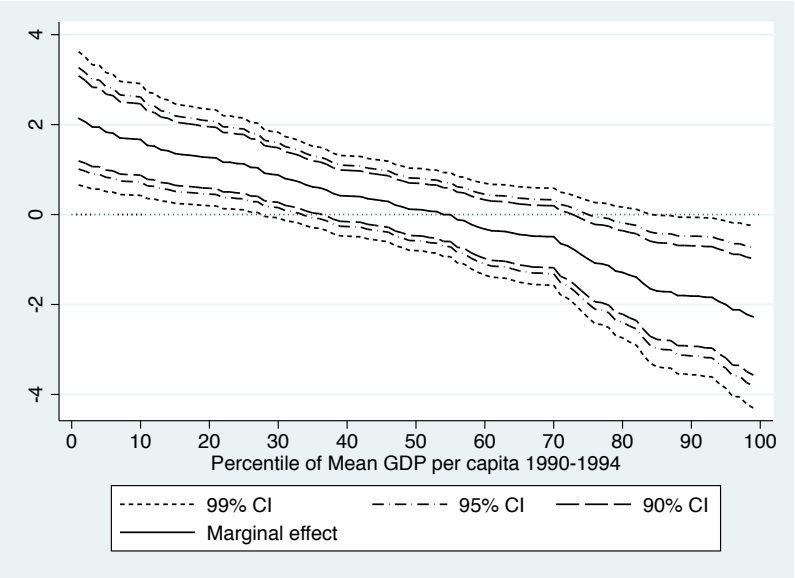
In our model we assume that producers make take it or leave it offers to the specialists in violence which implies that producers have all the bargaining power. If we relax this assumption, the risk of expropriation would vary with changes in the bargaining power. Our estimates may be biased if the variation in the bargaining power within a country is correlated with the number of troops. To address this concern, in column (2) we control for military expenditure and in column (3) an index that measures the influence of military in politics with the hope that these capture changes in the bargaining power of the military relative to the producers. This is consistent with Bove and Nisticò (2014b) who argue that the presence of military in politics is closely related to the civilian-military relationship.

Another concern is that the risk of expropriation and the number of troops could be correlated with factors such as the presence of internal and external conflict. It is reasonable to assume that the presence of fewer troops may lead to an inadequate response to conflict and this could have an impact on the risk of expropriation. To address this concern we include two indices in column (5) that attempt to capture the level of internal and external conflict each year within a country. Another related concern is that the presence of more troops could affect the risk of expropriation through better provision of law and order and lower crime. To address this we control for an index that captures the law and order situation in a country in a given year. The effect thresholds remain stable in all specifications.

So far we have used mean Polity IV as a proxy for $1 - \phi_i$. However, given Implication 2 of the model, our results should go through when we use economic development instead of institutional development as the interacting variable. In particular we use the mean of the log of mean GDP between 1990-94. Figure 2 plots the marginal effect for the regression in column (6). The effects thresholds and our estimates of γ and λ remain stable and significant across these specifications.

Inspecting figures 1 and 2 we observe that the marginal effect of the number of troops is negative and significant for countries at the top of the distribution of institutional and economic development. This is inconsistent with our model which predicts that the marginal effect should be effectively zero for institu-

Figure 2: Marginal effect of Active Troops on Expropriation Risk against percentiles of Mean GDP per capita



tionally and economically developed countries. The negative effect at the top of the distributions in figures 1 and 2 may arise because the interaction term forces the marginal effect of troops to be linear in the level of development. On the other hand the negative effect may be an empirical feature for developed countries, a feature that is inconsistent with our model in section 3. To investigate this further we test the following specification

$$y_{it} = \alpha_i + \beta_t + \gamma D(\underline{\phi})_i \cdot \ln AT_{it} + \lambda(1 - D(\underline{\phi})_i) \cdot \ln AT_{it} \; + X'_{it}\eta + \varepsilon_{it}\,, \tag{27}$$

where $D(\underline{\phi})_i$ is a dummy variable that takes value 1 for countries with low institutional quality and 0 otherwise. Since we use $\overline{PolityIV}_i$ as our proxy for $1 - \phi_i$, the dummy variable $D(\underline{\phi})_i$ takes value 1 for countries with $\overline{PolityIV}_i$ below a certain threshold and 0 for countries above the threshold. To conclude that there is support for Implication 1 we should observe that the estimate for γ is positive and significant and the estimate for λ is insignificant. This will allow us to conclude that the competition effect we model applies to countries with low institutional quality and is non-existent for countries with high institutional quality.

Table C.5 reports the results from regressing this specification. Since we do not observe the value of $\underline{\phi}$, we try different thresholds. In columns (1) – (6) we use -5, -4, -3, -2, -1, and 0 as the thresholds for $\overline{PolityIV}_i$ below which the dummy variable $D(\underline{\phi})_i$ takes value 1. In confirmation of our model we find that across all specifications the estimates for γ are positive and significant and the estimates for λ are insignificant indicating that the competition effect is relevant for countries with low institutional quality and the number of troops does not affect expropriation risk for countries with high institutional quality. This indicates that we can ignore the significant negative effect we observe for developed countries in figures 1 and 2 which appears to be an artefact of the linear structure imposed on the marginal effect by the interaction term in equation (26).

4.2. Robustness checks

The results from tables C.3 and C.4 indicate that the effect of competition within the military is consistent with the data for countries at a lower level of institutional and economic development. Polity IV and GDP per capita averaged over 1990–1994 are our preferred proxies for a few reasons. Averaging over from 1990–1994, which is a period before our sample begins, is likely to ease concerns about the endogeneity of

these measures. At the same time, since this time period is contiguous to our sample period (1995–2005), the measures would accurately capture the levels of economic and institutional development in this period. Moreover, averaging over a five year period implies that the resulting measures are unlikely to be affected by short-run macroeconomic factors within a country. Finally, as we will show in section 4.4, since this measure does not vary over time within a country, it allows us to rule out certain sources of measurement error.

None the less in the first four columns of table C.6 we use other proxies for the level of development to see whether our results are robust to alternative formulations of the interaction term. Column (1) reports the results when we interact the number of troops with GDP per capita averaged over our sample period of 1995–2005. Similarly, column (2) reports the results when interact the number of troops with mean Polity IV averaged over 1995–2005. Once again, the effect thresholds indicate that the competition is significant for a large proportion of countries. In column (3) we interact the number of troops with a dummy for whether the country is a member of the OECD. Note that since OECD membership is a binary variable, the coefficient of active troops captures the competition effect for non-OECD countries, which we find to be significant.[22]

So far we have used the Investment Profile component from the ICRG as our dependent variable. In columns (4) and (5) of table C.6 we use the aggregate ICRG Country Risk index[23] to check whether our results are robust to alternative measures of the risk of expropriation. Although Investment Profile is the most accurate and appropriate measure of the risk of expropriation, the effect thresholds in the last two columns of table C.6 show that our results still hold when we use the more general risk measure. Note that since Military in Politics, Internal and External Conflict, and Law and Order are subcomponents of this index we cannot control for these independently.

The current empirical strategy tries to overcome the concern about state capacity being correlated with the number of troops to some extent by controlling for the government's budget constraint in the form of government and military spending. However, it is still possible that the budget constraint affects the short-run risk of expropriation through its interaction with the size of the armed forces. If this is true, the interaction between the number of active troops and institutional quality may be proxying for omitted variables such as the effect of the interaction of armed forces with government spending or the effect of armed forces with military spending. To address this we include these additional interactions in our specification. We find that the estimates for γ and λ are unchanged. These results are reported in table C.8.

Another concern is that each country has a separate trajectory along which short-run expropriation risk evolves over time. If these country specific variations in the trends of short-run expropriation risk are correlated with the interaction between the size of the armed forces and institutional quality, our results would be biased. In an attempt to address this concern we include country specific linear time trends in our model. Table C.9 shows that the results remain robust to their introduction.

4.3. Coup-proofing and counterbalancing

Belkin and Schofer (2005) and Belkin (2012) argue that high coup risk tends to prompt leaders to divide their forces into rival organisations that check and balance each other. This is closely related to our argument but suggests that changes to the number of rival organisations are strategically engineered by leaders to reduce the risk of being overthrown.

To address this issue, we control for different measures of coup-proofing in our regressions interacting them with mean Polity IV. These results are reported in table C.7. Column (1) is our main specification from equation (26) that is included for comparison. In column (2) we control for the ratio of paramilitary

[22] Consequently, unlike the other regressions, there is no corresponding effect threshold to be reported in column (3) of table C.6.

[23] The ICRG Country Risk index is composed of twelve subcomponents. In addition to Investment Profile which measures the risk of expropriation, there is Government Stability, Socioeconomic Conditions, Internal Conflict, External Conflict, Corruption, Military in Politics, Religion in Politics, Law and Order, Ethnic Tensions, Democratic Accountability, and Bureaucracy Quality. The first six of these are scored between 0-12 and the last six between 0-6 with a higher score indicating a more conducive investment environment. As a result the aggregate index takes values between 0-100. See the summary statistics in table C.1 for more details.

to total (regular and paramilitary) military forces and its interaction. This is the measure used by Belkin and Schofer (2005) as one of their proxies for counterbalancing[24]. Another measure for counterbalancing in the literature was constructed by Pilster and Böhmelt (2011), and Pilster and Böhmelt (2012). They measure the effective number of ground combat-capable military organisations as $\frac{1}{\sum_j s_{jit}^2}$, where s_{jit} is the personnel share of military or paramilitary organization j in country i in year t. In column (3) we include this measure and its interaction, and in column (4) we include both measures and their interactions. We find that our results remain robust to their inclusion. In fact, controlling for the two proxies in column (4) appears to strengthen our coefficient estimates.

Moreover, the literature on counterbalancing offers an alternative explanation of our results. This literature argues that incumbents in countries with low institutional development may coup-proof themselves through higher military spending. Bove and Nisticò (2014a) present evidence that suggests that the threat of a coup may lead to an increase in military spending as incumbents attempt to counterbalance military actors through diverting more resources both to suppress and placate them. Since it is reasonable to assume that the threat of a coup affects the risk of expropriation, and military spending may be correlated with the size of the armed forces, our estimates may be biased. Although we control for military spending in our regressions, this doesn't address the possibility of the marginal effect of military spending being different at different levels of institutional development.

To address this issue, we regress our specification controlling for military spending and its interaction with mean Polity IV. Controlling for the interaction helps us rule out the possibility that our interaction of number of troops with mean Polity IV is actually absorbing the effect of counterbalancing at different levels of institutional development on expropriation risk. The results of this regression presented in column (2) of table C.8 indicate that our estimates remain robust to this inclusion.

4.4. Proxying for military leaders

Our use of the number of troops as the empirical counterpart to specialists in violence in our model is based on the premise that each soldier unilaterally decides whether to predate or defend. If instead this decision is made by a military leader, and individual soldiers simply obey the command to predate or defend, then the use of this measure may be questionable. Who should be considered a military leader depends on the structure of the military within each country. In a military where the chain of command is weak, it may be appropriate to consider a lieutenant controlling a platoon consisting of a few soldiers as a military leader. On the other hand, in a military where the chain of command is firmly entrenched, a military leader could be a general controlling an army command consisting of thousands of soldiers. If the number of military leaders is the correct empirical analogue for the specialists in violence in our model then using the number of troops as our explanatory variable may be problematic. In what follows we show that the number of troops is still a valid proxy as long as the ratio of military leaders to active troops remains constant within a country, that is, as long as the structure of military leadership within a country remains the same over time.

To see that the proxy works under this assumption, let θ_i be the time invariant ratio of military leaders to active troops in country i. The number of military leaders in country i at time t is simply $s_{it} = \theta_i \cdot AT_{it}$. Using this as the regressor, the regression specification we proposed in equation (26) modifies to

$$\begin{aligned} y_{it} &= \alpha_i + \beta_t + \gamma \ln(\theta_i \cdot AT_{it}) + \lambda(1-\phi_i) \cdot \ln(\theta_i \cdot AT_{it}) + X'_{it}\eta + \varepsilon_{it}. \\ &= \alpha_i + \beta_t + (\gamma + \lambda(1-\phi_i)) \ln \theta_i + \gamma \ln AT_{it} + \lambda(1-\phi_i) \cdot \ln AT_{it} + X'_{it}\eta + \varepsilon_{it}. \end{aligned}$$

Since the term $(\gamma + \lambda(1-\phi_i)) \ln \theta_i$ varies across countries but is constant over time within a country, it is absorbed by the country fixed effects and the estimates for γ and λ, when we use the log of active troops as our regressor, are consistent. Note that for this to be true, $(1-\phi_i)$, which represents the level of institutional development in country i, must be time invariant. This is why we use the mean Polity IV during the five

[24]The other proxy they use is the number of military organisations. We also control for this using the Pilster and Böhmelt (2011) measure of the effective number of military organisations which is a refinement of the Belkin and Schofer (2005) measure.

years preceding the sample period as our proxy for the level of institutional development. This argument applies *mutatis mutandis* to the regressions where we use the average of GDP as our proxy for the level of economic development.

An alternative proxy for the number of specialists in violence is the effective number of military organisations constructed by Pilster and Böhmelt (2011), as discussed in section 4.3. In column (3) of table C.7, we run a regression using both our measure and this proxy and find that while the coefficients for our proxy (the number of troops) remain significant, the coefficients for Pilster and Böhmelt (2011)'s proxy (the effective number of organisations) are insignificant and close to zero. This may be driven by the fact that the Pilster and Böhmelt (2011) measure captures changes in the effective number of specialists in violence at a very high level in the military hierarchy, whereas expropriation risk may be affected by changes in the number of lower level specialists in violence. As shown above, our proxy allows us to remain agnostic about this issue as long as the structure of the military within a country stays constant within a country during our sample period.

If the ratio of active troops to military leaders is not constant within a country, then this may cause our explanatory variables to be measured incorrectly causing the estimates to be biased. The presence of the interaction term implies that the measurement error that is induced is not of the classical variety. Consequently the direction of bias is difficult to predict analytically.

In an attempt to address this concern we also ran all our regressions omitting all countries that underwent a fundamental polity change during the sample period, as recorded in the Polity IV dataset. In particular, we excluded countries that experienced periods of foreign occupation, collapse of central political authority or political transition during which new institutions were planned, legally constituted, and put into effect.[25] This is because during such periods it is likely that there were structural changes in military leadership, which could lead to changes in the ratio of troops to military leaders. Excluding these countries did not change our results.[26]

To ensure that our results are not driven by measurement error in the number of troops, we regress our main specification in (26) using data on the number of troops from the Military Balance rather than the US State Department data. Column (6) in table C.7 reports the results of this regression and indicates that our results are unaffected by this change.

4.5. Endogeneity

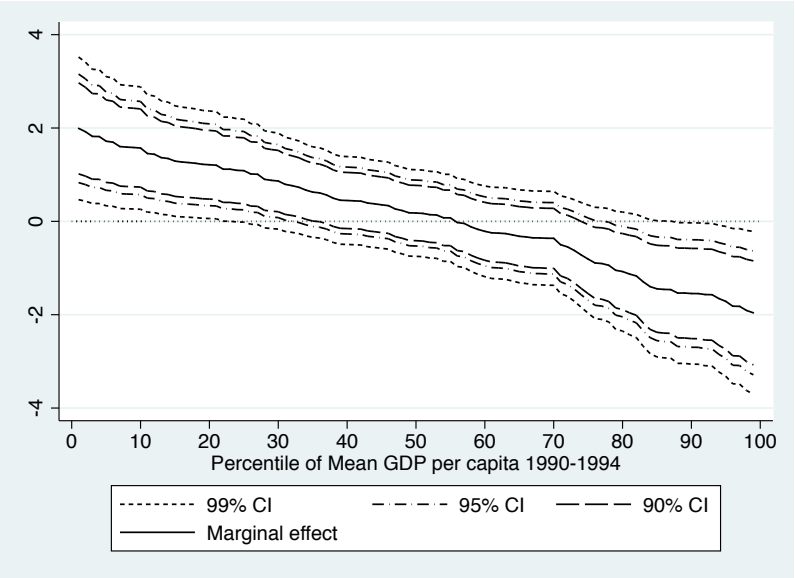
A concern about the results we have presented so far is that the risk of expropriation is simultaneously determined along with our explanatory variables. The use of mean levels of development from 1990 to 1994, i.e., before our sample period, mitigates this concern. However, since the controls remain necessarily contemporaneous, their endogeneity could still be an issue. Although we attempt to address this concern in this section, we should point out that it is difficult to make a water-tight case for the variation in our explanatory variables being completely exogenous. Consequently our empirical results should be seen more as robust correlations that indicate that the mechanism we model is consistent with the data.

To address the concern that contemporaneous values of our explanatory variables are likely to be simultaneously determined with the risk of expropriation, we run the specification in equation (26) where each regressor is instrumented by the lags of all. Table C.10 reports the results. As shown by the Cragg-Donald F-statistic reported in table C.10, the first stage is significant at the 0.1% level for all specifications. We can see that the point estimates of the IV regressions are very close to the OLS regressions with controls. Moreover the effect thresholds indicate that the results of the instrumental variable regression follow the same pattern as before. The marginal effect and its confidence intervals from column (6) presented in figure 3 confirm this.

[25]The Polity IV variable records these transitions as "Interruption Periods", "Interregnum Periods" and "Transition Periods", respectively. The countries that were excluded are Afghanistan, Angola, Bosnia and Herzegovina, Burundi, Democratic Republic of Congo, Croatia, Fiji, Guinea-Bissau, Haiti, Iraq, Ivory Coast, Lebanon, Lesotho, Liberia, Nigeria, Peru, Sierra Leone, Somalia.

[26]The results of these additional regressions are available on request.

Figure 3: Marginal effect of Active Troops on Expropriation Risk against percentiles of Mean GDP per capita estimated using Instrumental Variables



5. Conclusion

We have presented a model that attempts to explain how agents with control over coercive power can commit not to expropriate from producers. The insight that we formalise here is that this form of commitment should not be seen as an additional strategy that may or may not be available to specialists in violence as a result of exogenous institutional arrangements. Instead, we have argued that commitment should be seen as a feature of an equilibrium arising in a game played between more than one specialist in violence. The model predicts that the equilibrium rate of expropriation is decreasing in the number of specialists in violence and also as the distribution of their strengths becomes less heterogeneous. These predictions are in line with the notion that creating a balance between more than one centers of power leads to checks and balances against abuse of power. This mechanism supplies an alternative to the Olsonian view that concentration of power in the hands of a few leads to reduction in expropriation.

Embedding this mechanism in a richer model with occupational choice we find that this competition effect on short-run expropriation risk attenuates in institutional quality as costs of predation increase. We have attempted to test this prediction using a cross-country panel dataset. We find that increasing the number of specialists in violence is associated with a reduction in the short-run risk of expropriation, and this effect is strongest for countries with low long-run institutional quality and low economic development. This indicates that the link between short-run expropriation risk and the power of agents who control the means of coercion is more salient at lower levels of institutional and economic development. Our results suggest that in addition to the long-run component of institutions there may also be a short-run component that fluctuates with the changes in the degree of competition among agents who underpin these institutions through the control of coercive power.

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Appendix A. Case studies

Appendix A.1. Consuls in the Roman Republic

In this section, we examine a particular institutional arrangement from ancient Rome that resonates quite cleanly with the mechanics of our baseline model. Consuls were the military and civil heads of the state during the Roman republic. The *fasti consulares*, a listing of the names and tenure of consuls, dates its first entry to 509 BC. The time period that fits our model most closely is from 509 BC when the office was established to around 89 BC.[27] Although the office of the two consuls persisted well after the establishment of imperial rule in Rome, the concentration of the *imperium* in two consuls, that is their status as the joint heads of the executive, diminished gradually once Sulla assumed dictatorial control in 89 BC. This decline continued under the appointment of Julius Caesar as a perpetual dictator in 44 BC and thereafter under the establishment of imperial rule under Augustus in 27 BC.

Two consuls were elected every year and jointly held the *imperium*. Any decision made by a consul, such as a declaration of war, was subject to veto by the other consul. As the military heads, consuls were expected to lead Roman armies in the event of a war. In case both consuls were in the battlefield at the same time, they would share the command of the army, alternating as the head on a day to day basis. The election of the consuls was held by an assembly of soldiers known as the *centuria*.[28] The fact that consuls were elected from within the military and by the military confirms the primacy of their role as the heads of military. Indeed, their roles as the civilian heads can be seen as arising from the control they wielded over the military. It is therefore appropriate to think of them as analogous to the specialists in violence in the model.

The crucial assumption that we make in the model is $\delta > 1$. This ensures that when the specialists in violence are evenly divided on both sides in a battle, the side supporting the producers has at least a marginal advantage. This assumption seems valid in this setting. During this period in Roman history, a potential soldier needed to prove ownership of a certain amount of property to be eligible for recruitment in the military. This meant that the soldiers tended to have close family who were typically engaged in productive activities such as agriculture. Consequently, if the two consuls disagreed on an order to predate, the military was at least marginally more likely to obey the order for protection of the producers over an order for predation. Knowing this both consuls would have preferred protecting the producers leading to the Prisoner's Dilemma that we highlight. It is interesting to note that the property requirement for recruitment into the army was finally relaxed in 107 BC. This was followed closely by the transition of the republic into a dictatorship first under Sulla in 89 BC followed later by Julius Caesar and eventually the establishment of a monarchy under Augustus in 27 BC.

This institutional arrangement points to the belief that two military heads would effectively balance each other out. Since together they enjoyed absolute power, there was nothing preventing them from colluding with each other, other than the architecture of the game itself. The possibility of collusion can arise either through infinite repetition of the one shot game or through the possibility of contracting. It is possible to identify the institutional features that precluded these. Yearly elections ensured a finite time horizon for the consuls. Consuls were barred from seeking re-elections immediately after serving a year in office.

[27] A consul's power was superseded only in case of military emergency when a dictator was appointed. The instances of appointment of a dictator were few and short lived in this period. The exception to the rule of two consuls was the period of 426-367 BC which is known as 'the conflict of the orders' when consular power was often shared between three or more military tribunes. This does not affect our story since the results of our model are preserved as long as the number of specialists in violence is strictly greater than 1. We have relied on Hornblower and Spawforth (2003) as a reference for the historical material used in this case study.

[28] The assembly had 193 voting units, each unit representing a century, that is a group of one hundred soldiers. The assembly was composed of 18 centuries of *equites* that is the cavalry, 170 centuries of *pedites* that is the infantry and 5 centuries of non-combatants such as the horn blowers, artisans, etc. The voting order was the *equites* first followed by the *pedites* and lastly the non-combatants. See Taylor (2003) for a detailed exposition of the voting procedure in the *centuria*.

Usually a period of ten years was expected before they could seek the office again. This term limit preserved the one-shot nature of the game. Second, there was no possibility of contracting since there was no higher authority than the consuls that could enforce any such contract. It appears that the consuls were locked in a game where the unique equilibrium was that they did not predate.

Appendix A.2. Egypt and India

In this section, we look at two examples, one from Egypt and the other from India, that appear to be consistent with the mechanism in our model.

The recent history of Egypt under Mubarak provides an interesting example highlighting how the mechanics of our model may have been at play there. Our model predicts that competition within the army would reduce the risk of expropriation for countries with low level of institutional development. Egypt in our sample period has a mean Polity score of -7, indicating that the competition effect should apply there. Consequently we would expect the Egyptian political elite to be attentive to the degree of competition within the military.

It seems that this was indeed the case. Blair and Warrell (2011) reported that, "Far from being a monolithic entity, the notoriously opaque army is described as being riven by factionalism and mistrust, with Hosni Mubarak, president, acting to contain the power of individual generals." Quoting from the WikiLeaks cables, it notes that "Mubarak has no single confidante or adviser who can truly speak for him and he has prevented any of his main advisers from operating outside their strictly circumscribed spheres of power". The case of Egypt towards the end of Mubarak's rule suggests that he was clearly aware that increasing competition within the military, by factionalising it, was a way to consolidate his own power. This idea is consistent with our model, which showcases how increasing the numbers and homogenising the strength of military leaders would be an effective way of reducing their strength.

Similarly, Pilster et al. (2014) argue that "more differentiated security forces, that is, forces that are composed of a higher number of independent paramilitary and military organizations, are likely to act as a restraint factor in the process leading to state-sponsored mass-killings." Their argument is very similar to ours, other than the fact that the dependent variable they analyse is genocides. They present the case of India as an example, arguing that although India has faced several episodes of insurgent threats since the 1950s, Indian security forces have been more restrained than their South-Asian counterparts, as seen the absence of large-scale mass killings of civilians. They argue that "one reason behind this is likely to be that the Indian security force structure is strongly differentiated, that is, composed of a high number of different paramilitary and regular military organizations. In fact, India has invested in the continuous expansion of multiple paramilitary security forces specializing in various domestic security and counterinsurgency functions since the 1950s."

This case study is consistent with our model in that it suggests that competition within specialists in violence is an effective way of containing undesirable outcomes. In this paper we have focused on the risk of expropriation, but the empirical results in Pilster et al. (2014) suggest that exploring how other outcomes are affected by the same underlying mechanism may be an interesting avenue for future work.

Appendix B. Calculation of marginal effects

Ignoring country and time subscripts, the estimated marginal effect of $\ln s$ on the risk of expropriation in our main specification (26) is given by

$$\phi(W) \stackrel{\text{def}}{=} \hat{\gamma} + \hat{\lambda} W \,, \tag{B.1}$$

where $\hat{\gamma}$ and $\hat{\lambda}$ are the estimators of γ and λ, respectively, and W is the level of development, e.g., mean GDP per capita (Table C.4) or mean Polity IV (Table C.3), which is interacted with s. Let X be the matrix of all regressors, including W. Then, the variance of ϕ conditional on X is

$$\operatorname{Var}(\phi(W)|X) = \operatorname{Var}(\hat{\gamma}|X) + 2W \operatorname{Cov}(\hat{\gamma}, \hat{\lambda}|X) + W^2 \operatorname{Var}(\hat{\lambda}|X) \,, \tag{B.2}$$

so that the asymptotic confidence interval for $\phi(W)$ is given by

$$\hat{\gamma} + \hat{\lambda}W \pm z\sqrt{\hat{\sigma}_{\gamma}^2 + 2W\hat{\sigma}_{\gamma,\lambda} + W^2\hat{\sigma}_{\lambda}^2}\,, \tag{B.3}$$

where z is the appropriate normal critical value, and $\hat{\sigma}_{\gamma}^2$, $\hat{\sigma}_{\gamma,\lambda}$ and $\hat{\sigma}_{\lambda}^2$ are the estimates of $\mathrm{Var}(\hat{\gamma}|X)$, $\mathrm{Cov}(\hat{\gamma}, \hat{\lambda}|X)$ and $\mathrm{Var}(\hat{\lambda}|X)$, respectively. Figures 2, 1 and 3 are then drawn by computing these confidence intervals against percentiles of W using the critical values of z at the 10%, 5% and 1% significance levels.

In order to find the value of W at which the lower bound of the confidence interval is zero, we set equation (B.3) equal to zero and solve

$$\hat{\gamma} + \hat{\lambda}W - z\sqrt{\hat{\sigma}_{\gamma}^2 + 2W\hat{\sigma}_{\gamma,\lambda} + W^2\hat{\sigma}_{\lambda}^2} = 0 \tag{B.4}$$

$$\iff \big(\hat{\lambda}^2 - z^2\hat{\sigma}_{\lambda}^2\big)W^2 + 2\big(\hat{\gamma}\hat{\lambda} - z^2\hat{\sigma}_{\gamma,\lambda}\big)W + \big(\hat{\gamma}^2 - z^2\hat{\sigma}_{\gamma}^2\big) = 0 \tag{B.5}$$

for W, being careful to pick the appropriate solution through inspection of the graph of marginal effects with respect to W. The effect thresholds reported in Tables C.4 to C.10 are then computed by finding the percentiles of W corresponding to the solutions for the 10%, 5% and 1% significance levels.

Appendix C. Tables

Table C.1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
ICRG Investment Profile	7.797	2.402	0	12	1443
ICRG Country Risk	67.337	13.641	22.458	96.083	1443
Log Active Troops	3.511	1.696	0	7.983	1754
Log GDP per capita in 2005 US dollars	7.797	1.651	4.413	11.296	1787
Log Population	2.142	1.639	-2.303	7.178	1815
Log Government Spending in 2005 US dollars	8.579	2.236	3.367	14.79	1745
Log Military Spending in 2005 US dollar	6.088	2.337	0	13.128	1735
ICRG Military in Politics	10.200	1.639	2.125	12	1443
ICRG Internal Conflict	3.828	1.738	0	6	1443
ICRG External Conflict	3.809	1.820	0	6	1443
ICRG Law and Order	4.179	1.367	0	6	1443
Revised Combined Polity IV score (POLITY2)	2.843	6.704	-10	10	1698

POLITY2 and ICRG variables are indices

Table C.2: No interaction with level of development

	(1)	(2)	(3)	(4)	(5)	(6)
Log Active Troops	0.201	0.128	0.0963	0.123	0.0910	0.278
	(0.433)	(0.452)	(0.439)	(0.410)	(0.411)	(0.433)
Polity IV	0.0122	0.00820	0.00526	−0.0351	−0.0326	−0.0319
	(0.0589)	(0.0599)	(0.0591)	(0.0577)	(0.0570)	(0.0569)
Log GDP p.c.	4.417***	4.298***	4.222***	4.213***	4.203***	3.853***
	(0.706)	(0.683)	(0.669)	(0.650)	(0.652)	(0.717)
Log Gov. Spending	−1.128***	−1.256***	−1.277***	−1.360***	−1.381***	−1.227***
	(0.387)	(0.399)	(0.397)	(0.396)	(0.390)	(0.403)
Log Mil. Spending		0.426	0.431	0.398	0.408	0.385
		(0.273)	(0.274)	(0.268)	(0.270)	(0.269)
Military in Politics			0.0639	0.0317	0.0280	0.0414
			(0.0736)	(0.0715)	(0.0723)	(0.0727)
Internal Conflict				0.262***	0.254***	0.251***
				(0.0841)	(0.0875)	(0.0872)
External Conflict				0.0772	0.0740	0.0775
				(0.143)	(0.143)	(0.143)
Law and Order					0.0786	0.114
					(0.104)	(0.0990)
Log Population						−2.716
						(1.855)
N	1301	1297	1297	1297	1297	1297
R^2	0.562	0.565	0.566	0.576	0.576	0.579

Dependent variable is Investment Profile from ICRG. Standard errors clustered at the country level are shown in parentheses. All specifications include country and year fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.3: Interacting Active troops with mean Polity IV 1990–1994

	(1)	(2)	(3)	(4)	(5)	(6)
Log Active Troops	0.832***	0.766**	0.734**	0.729**	0.692**	0.728**
	(0.288)	(0.306)	(0.298)	(0.283)	(0.289)	(0.323)
Mean Polity IV 1990–1994	−0.262***	−0.259***	−0.259***	−0.247***	−0.251***	−0.243***
× Log Active Troops	(0.0481)	(0.0490)	(0.0484)	(0.0457)	(0.0455)	(0.0453)
Polity IV	−0.00110	−0.00512	−0.00802	−0.0438	−0.0403	−0.0398
	(0.0588)	(0.0599)	(0.0592)	(0.0582)	(0.0576)	(0.0577)
Log GDP p.c.	4.223***	4.131***	4.056***	4.051***	4.033***	3.938***
	(0.642)	(0.623)	(0.612)	(0.604)	(0.607)	(0.682)
Log Gov. Spending	−1.084***	−1.196***	−1.216***	−1.293***	−1.323***	−1.280***
	(0.384)	(0.388)	(0.389)	(0.387)	(0.382)	(0.401)
Log Mil. Spending		0.359	0.365	0.339	0.353	0.348
		(0.251)	(0.249)	(0.248)	(0.250)	(0.251)
Military in Politics			0.0630	0.0338	0.0282	0.0320
			(0.0681)	(0.0674)	(0.0683)	(0.0693)
Internal Conflict				0.232***	0.219**	0.220**
				(0.0807)	(0.0854)	(0.0855)
External Conflict				0.0758	0.0709	0.0720
				(0.135)	(0.135)	(0.135)
Law and Order					0.119	0.128
					(0.103)	(0.0987)
Log Population						−0.776
						(1.881)
N	1300	1296	1296	1296	1296	1296
R^2	0.585	0.587	0.588	0.596	0.597	0.597
Effect threshold at 10%	0.462	0.455	0.455	0.455	0.449	0.449
Effect threshold at 5%	0.455	0.436	0.436	0.436	0.436	0.436
Effect threshold at 1%	0.436	0.423	0.423	0.423	0.423	0.423

Dependent variable is Investment Profile from ICRG. Standard errors clustered at the country level are shown in parentheses. All specifications include country and year fixed effects. The effect threshold is the percentile of Mean Polity IV 1990–1994 below which the marginal effect of Active Troops is positive and significant at the corresponding significance level.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.4: Interacting Active troops with mean GDP per capita 1990–1994

	(1)	(2)	(3)	(4)	(5)	(6)
Log Active Troops	7.470***	7.223***	7.255***	7.237***	7.261***	7.078***
	(1.349)	(1.475)	(1.465)	(1.402)	(1.393)	(1.437)
Log Mean GDP p.c. 1990–1994	−1.027***	−1.000***	−1.006***	−1.001***	−1.010***	−0.961***
× Log Active Troops	(0.181)	(0.192)	(0.192)	(0.185)	(0.184)	(0.194)
Polity IV	0.00524	0.00196	0.000832	−0.0318	−0.0290	−0.0282
	(0.0635)	(0.0649)	(0.0647)	(0.0617)	(0.0612)	(0.0611)
Log GDP p.c.	4.024***	3.929***	3.916***	3.902***	3.885***	3.508***
	(0.679)	(0.663)	(0.661)	(0.674)	(0.682)	(0.724)
Log Gov. Spending	−1.061***	−1.151***	−1.155***	−1.229***	−1.256***	−1.124***
	(0.400)	(0.412)	(0.412)	(0.412)	(0.407)	(0.407)
Log Mil. Spending		0.304	0.302	0.271	0.286	0.281
		(0.279)	(0.276)	(0.284)	(0.284)	(0.278)
Military in Politics			0.0183	−0.00884	−0.0131	−0.00359
			(0.0652)	(0.0645)	(0.0652)	(0.0663)
Internal Conflict				0.267***	0.259***	0.256***
				(0.0833)	(0.0874)	(0.0873)
External Conflict				0.000436	−0.000148	−0.00159
				(0.145)	(0.146)	(0.147)
Law and Order					0.0825	0.114
					(0.108)	(0.105)
Log Population						−2.504
						(1.850)
N	1224	1220	1220	1220	1220	1220
R^2	0.593	0.594	0.594	0.604	0.604	0.606
Effect threshold at 10%	0.347	0.333	0.333	0.333	0.333	0.347
Effect threshold at 5%	0.333	0.306	0.306	0.313	0.306	0.333
Effect threshold at 1%	0.285	0.251	0.258	0.272	0.265	0.279

Dependent variable is Investment Profile from ICRG. Standard errors clustered at the country level are shown in parentheses. All specifications include country and year fixed effects. The effect threshold is the percentile of Mean GDP per capita 1990–1994 below which the marginal effect of Active Troops is positive and significant at the corresponding significance level.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.5: Allowing different effects of active troops for mean Polity IV below and above a threshold

	(1)	(2)	(3)	(4)	(5)	(6)
Mean Polity IV threshold	−5	−4	−3	−2	−1	0
Log Active Troops	2.254***	2.198***	1.989***	1.584***	1.599***	1.520***
for Mean Polity IV < threshold	(0.664)	(0.666)	(0.534)	(0.604)	(0.599)	(0.521)
Log Active Troops	−0.253	−0.249	−0.428	−0.363	−0.371	−0.527
for Mean Polity IV ≥ threshold	(0.423)	(0.424)	(0.448)	(0.462)	(0.462)	(0.492)
Polity IV	−0.0441	−0.0436	−0.0450	−0.0401	−0.0401	−0.0388
	(0.0592)	(0.0592)	(0.0587)	(0.0580)	(0.0580)	(0.0577)
Log GDP p.c.	3.794***	3.774***	3.934***	3.913***	3.919***	3.963***
	(0.721)	(0.722)	(0.679)	(0.684)	(0.683)	(0.685)
Log Gov. Spending	−1.286***	−1.291***	−1.328***	−1.311***	−1.306***	−1.307***
	(0.403)	(0.402)	(0.398)	(0.397)	(0.396)	(0.400)
Log Mil. Spending	0.472*	0.479*	0.488*	0.458*	0.455*	0.321
	(0.271)	(0.271)	(0.275)	(0.274)	(0.274)	(0.251)
Military in Politics	0.0218	0.0225	0.0247	0.0291	0.0295	0.0485
	(0.0740)	(0.0738)	(0.0738)	(0.0737)	(0.0737)	(0.0695)
Internal Conflict	0.230***	0.232***	0.240***	0.244***	0.244***	0.236***
	(0.0872)	(0.0873)	(0.0866)	(0.0865)	(0.0865)	(0.0867)
External Conflict	0.0691	0.0681	0.0583	0.0628	0.0629	0.0564
	(0.139)	(0.139)	(0.140)	(0.141)	(0.141)	(0.141)
Law and Order	0.0951	0.0975	0.111	0.114	0.114	0.124
	(0.0978)	(0.0981)	(0.0996)	(0.0994)	(0.0993)	(0.101)
Log Population	−1.846	−1.851	−1.634	−1.792	−1.794	−1.700
	(1.894)	(1.893)	(1.891)	(1.884)	(1.883)	(1.865)
N	1297	1297	1297	1297	1297	1297
R^2	0.587	0.587	0.589	0.586	0.586	0.587

Dependent variable is Investment Profile from ICRG. Standard errors clustered at the country level are shown in parentheses. All specifications include country and year fixed effects.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.6: Robustness checks

	(1)	(2)	(3)	(4)	(5)
Dependent variable	Investment Profile	Investment Profile	Investment Profile	Country Risk	Country Risk
Interaction variable	Log Mean GDP p.c. 1995–2005	Mean Polity IV 1995–2005	OECD member	Log Mean GDP p.c. 1990–1994	Mean Polity IV 1990–1994
Log Active Troops	6.408***	1.260**	0.984***	17.12**	4.188***
	(0.981)	(0.503)	(0.376)	(6.825)	(1.236)
Interaction	−0.841***	−0.250***	−3.211***	−1.997**	−0.710***
	(0.139)	(0.0678)	(0.619)	(0.854)	(0.196)
Polity IV	−0.0349	−0.0266	−0.0229	0.150	0.149
	(0.0559)	(0.0563)	(0.0561)	(0.219)	(0.205)
Log GDP p.c.	3.859***	4.117***	3.963***	12.26***	13.71***
	(0.683)	(0.686)	(0.690)	(3.164)	(3.026)
Log Gov. Spending	−1.236***	−1.232***	−1.232***	−0.657	−0.868
	(0.385)	(0.402)	(0.385)	(1.837)	(1.715)
Log Mil. Spending	0.258	0.357	0.304	0.836	0.881
	(0.259)	(0.257)	(0.260)	(1.403)	(1.197)
Military in Politics	0.0559	0.0296	0.0403		
	(0.0678)	(0.0685)	(0.0703)		
Internal Conflict	0.246***	0.207**	0.226***		
	(0.0854)	(0.0839)	(0.0848)		
External Conflict	0.0294	0.0749	0.0781		
	(0.138)	(0.137)	(0.139)		
Law and Order	0.131	0.135	0.138		
	(0.102)	(0.100)	(0.102)		
Log Population	−1.460	−1.258	−1.233	7.429	15.58**
	(1.787)	(1.853)	(1.891)	(5.394)	(6.080)
N	1297	1297	1297	1220	1296
R^2	0.600	0.592	0.597	0.161	0.185
Effect threshold at 10%	0.380	0.417		0.531	0.487
Effect threshold at 5%	0.331	0.397		0.462	0.462
Effect threshold at 1%	0.294	0.340		0.0679	0.462

Standard errors clustered at the country level are shown in parentheses. The interaction variable is interacted with Log Active Troops. All specifications include country and year fixed effects.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.7: Coup-proofing and counterbalancing

	(1)	(2)	(3)	(4)	(5)	(6)
Log Active Troops	0.728**	0.518	1.913**	4.819***	0.753**	0.340
	(0.323)	(0.462)	(0.850)	(0.965)	(0.321)	(0.287)
Mean Polity IV 1990–1994	−0.243***	−0.243***	−0.288**	−0.616***	−0.242***	−0.145***
× Log Active Troops	(0.0453)	(0.0589)	(0.114)	(0.158)	(0.0438)	(0.0445)
Paramilitary ratio		−0.0198		−0.160		
		(0.555)		(1.077)		
Mean Polity IV 1990–1994		0.0541		0.0735		
× Paramilitary ratio		(0.0852)		(0.185)		
Effective number			−0.0565	−0.166		
			(0.244)	(0.248)		
Mean Polity IV 1990–1994			0.0229	−0.00485		
× Effective number			(0.0281)	(0.0348)		
Mean Polity IV 1990–1994					0.0805*	
× Log Military Spending					(0.0467)	
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	1296	909	600	435	1296	1052
R^2	0.597	0.482	0.565	0.482	0.600	0.498
Effect threshold at 10%	0.449	0.404	0.468	0.654	0.449	0.404
Effect threshold at 5%	0.436	0.385	0.462	0.596	0.436	0.372
Effect threshold at 1%	0.423	0.308	0.179	0.583	0.423	0.224

Dependent variable is Investment Profile from ICRG. Standard errors clustered at the country level are shown in parentheses. All specifications include country and year fixed effects. Log Active Troops in column (6) is from the Military Balance. The effect threshold is the percentile of Mean Polity IV 1990–1994 below which the marginal effect of Active Troops is positive and significant at the corresponding significance level. Controls are Polity IV, log GDP per capita, log government spending, log military spending, Military in Politics, Internal Conflict, External Conflict, Law and Order, and log population.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.8: Interacting government/military spending with active troops and/or level of development

	(1)	(2)	(3)
Log Active Troops	3.447***	2.284***	3.475***
	(0.829)	(0.585)	(0.839)
Mean Polity IV 1990–1994	−0.144***	−0.189***	−0.144***
× Log Active Troops	(0.0536)	(0.0495)	(0.0544)
Log Gov. Spending	−0.361***		−0.277*
× Log Active Troops	(0.118)		(0.147)
Log Mil. Spending		−0.300**	−0.127
× Log Active Troops		(0.116)	(0.136)
Log Gov. Spending	0.223	−1.163***	−0.0772
	(0.616)	(0.395)	(0.723)
Log Mil. Spending	0.405	1.419***	0.847*
	(0.258)	(0.477)	(0.501)
Controls	Yes	Yes	Yes
N	1296	1296	1296
R^2	0.605	0.603	0.605
Effect threshold at 10%		0.583	
Effect threshold at 5%	0.763	0.545	0.763
Effect threshold at 1%	0.583	0.487	0.583

Dependent variable is Investment Profile from ICRG. Standard errors clustered at the country level are shown in parentheses. All specifications include country and year fixed effects. The effect threshold is the percentile of Mean Polity IV below which the marginal effect of Active Troops is positive and significant at the corresponding significance level. Controls are Polity IV, log GDP per capita, Military in Politics, Internal Conflict, External Conflict, Law and Order, and log population.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.9: Including country-specific linear time trends

	(1)	(2)	(3)	(4)	(5)	(6)
Log Active Troops	1.067***	0.875***	0.872**	0.726**	0.734**	0.723**
	(0.372)	(0.332)	(0.334)	(0.331)	(0.334)	(0.336)
Mean Polity IV 1990–1994	−0.136**	−0.134**	−0.134**	−0.115**	−0.113**	−0.110**
× Log Active Troops	(0.0598)	(0.0591)	(0.0580)	(0.0550)	(0.0550)	(0.0550)
Polity IV	0.00598	0.0000275	−0.00457	−0.0352	−0.0328	−0.0328
	(0.0436)	(0.0423)	(0.0389)	(0.0395)	(0.0402)	(0.0402)
Log GDP p.c.	5.254***	4.830***	4.786***	4.584***	4.515***	4.573***
	(0.938)	(0.922)	(0.889)	(0.858)	(0.866)	(0.891)
Log Gov. Spending	−0.138	−0.388	−0.379	−0.365	−0.378	−0.388
	(0.362)	(0.362)	(0.358)	(0.363)	(0.358)	(0.361)
Log Mil. Spending		0.679**	0.691**	0.652*	0.653*	0.650*
		(0.323)	(0.333)	(0.332)	(0.330)	(0.332)
Military in Politics			0.120	0.0934	0.0909	0.0912
			(0.0891)	(0.0932)	(0.0936)	(0.0937)
Internal Conflict				0.226**	0.216**	0.214**
				(0.0872)	(0.0905)	(0.0914)
External Conflict				0.100	0.0908	0.0877
				(0.145)	(0.144)	(0.144)
Law and Order					0.0985	0.0952
					(0.101)	(0.101)
Log Population						1.592
						(2.624)
N	1300	1296	1296	1296	1296	1296
R^2	0.746	0.749	0.751	0.756	0.757	0.757
Effect threshold at 10%	0.487	0.462	0.462	0.462	0.462	0.462
Effect threshold at 5%	0.462	0.462	0.462	0.436	0.436	0.436
Effect threshold at 1%	0.449	0.436	0.436	0.391	0.391	0.385

Dependent variable is Investment Profile from ICRG. Standard errors clustered at the country level are shown in parentheses. All specifications include country and year fixed effects and country-specific linear time trends.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.10: Instrumental variables

	(1)	(2)	(3)	(4)	(5)	(6)
Log Active Troops	7.132***	6.395***	6.407***	6.643***	6.634***	6.505***
	(1.321)	(1.400)	(1.400)	(1.401)	(1.402)	(1.398)
Log Mean GDP p.c. 1990–1994	−0.968***	−0.890***	−0.894***	−0.927***	−0.927***	−0.885***
× Log Active Troops	(0.177)	(0.183)	(0.184)	(0.184)	(0.184)	(0.185)
Log GDP p.c.	4.741***	4.377***	4.363***	4.563***	4.554***	4.199***
	(0.642)	(0.690)	(0.692)	(0.703)	(0.706)	(0.733)
Polity IV	0.0157	0.0104	0.00886	0.000176	0.00116	0.00217
	(0.0333)	(0.0346)	(0.0351)	(0.0398)	(0.0404)	(0.0402)
Log Gov. Spending	−2.259***	−2.393***	−2.404***	−2.475***	−2.484***	−2.325***
	(0.457)	(0.466)	(0.467)	(0.468)	(0.471)	(0.478)
Log Mil. Spending		0.735*	0.726	0.634	0.644	0.616
		(0.446)	(0.447)	(0.448)	(0.453)	(0.451)
Military in Politics			0.0194	0.0228	0.0214	0.0389
			(0.0712)	(0.0735)	(0.0741)	(0.0745)
Internal Conflict				0.147	0.144	0.144
				(0.0968)	(0.0989)	(0.0985)
External Conflict				−0.149	−0.148	−0.153
				(0.117)	(0.117)	(0.116)
Law and Order					0.0179	0.0622
					(0.121)	(0.123)
Log Population						−2.247*
						(1.316)
N	1102	1099	1099	1099	1099	1099
R^2	0.496	0.496	0.496	0.501	0.501	0.506
First stage F-statistic	47.51	28.10	28.09	27.86	26.65	26.63
Effect threshold at 10%	0.374	0.313	0.306	0.313	0.306	0.333
Effect threshold at 5%	0.347	0.279	0.279	0.285	0.279	0.306
Effect threshold at 1%	0.306	0.211	0.211	0.217	0.211	0.258

Dependent variable is Investment Profile from ICRG. Standard errors are shown in parentheses. All specifications include country and year fixed effects. Each regressor has been instrumented by the lags of Log Active Troops, Log Active Troops × Log Mean GDP p.c. 1990–1994, Polity IV, Log GDP p.c., Log Gov. Spending, Log Mil. Spending, Military in Politics, Internal Conflict, External Conflict, Law and Order and Log Population. The first-stage F-statistic reports the Cragg-Donald Wald F-statistic for weak identification.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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