The economics of the limited access order

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Abstract

Violence and coercion are key to understanding economic and social interactions in any society. This premise was used by North et al. (2009) to distinguish three 'patterns of social organization' that societies have used to solve the problem of violence. We model one of these, the 'limited access order', that is still dominant today. This order is characterized by an elite coalition that uses coercion to extract economic rents, while restricting violence and containing bandits. Since violence is key, we choose to apply insights from the economic literature on conflict and appropriation. Our model puts structure on the main elements of the limited access order. It allows us to assess some of its characteristics, by identifying conditions under which a sizeable elite emerges that is capable of limiting the activities of bandits and thereby provides order and stability. Our results show large variations in elite size, appropriation, production levels, and welfare across limited access societies due to only minor variations in exogenous model parameters, such as productivity, the cost of conflict, and the decisiveness of conflict. A striking result is that, within the limited access order, unproductive societies are faced with a high tax rate and a large elite, while productive societies are faced with a low tax rate and a small elite. The difference in additional productivity between these societies is offset by increased appropriation by bandits in absence of a strong elite, resulting in welfare being maximized for moderate levels of productivity.

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1 Introduction

In their seminal study of social and economic development, North et al. (2009) provide a novel conceptual framework to interpret the development of economic and political systems throughout history. The salient feature of their analysis is the imminent problem of violence in human interaction, and the different 'patterns of social organization' (i.e. social orders) that emerged to successfully restrain such violence. In this paper we provide economic intuition for this conceptual framework by modelling one of these social orders, the 'limited access order', using insights from the economic literature on conflict and appropriation (cf. Garfinkel and Skaperdas, 2007), in which violence is a central element.

Violence and coercion – the threat of using violence – can be used to appropriate goods and resources. As a result, violence and coercion may deter interaction, exchange, trade, and the benefits of specialization that come with trade, possibly leading to significant welfare losses (Acemoglu and Johnson, 2005).[1] The social orders identified by North et al. (2009) can be interpreted as archetype societies, with specific institutions that emerge because of the necessity to control violence and coercion (Greif, 2006). North et al. (2009) characterize three social orders that differ in their control of organized violence trough their institutions and organizations. We choose to ignore two; the 'foraging order' governed human life until the Neolithic Revolution, approximately 10,000 years ago and the 'open access order' exists in only a smattering of western countries.[2] This leaves the limited access order as the most relevant order for current and historical times and the social order of interest in our paper.

A limited access order *"manages the problem of violence by forming a dominant coalition that limits access to valuable resources – land, labour, and capital – or access to and control of valuable activities – such as trade, worship, and education – to elite groups."* (North et al., 2009).[3] Membership of this coalition is, by construction, constrained to individuals with the capacity to muster organized violence. In the terminology of North et al. (2009) they are 'violence specialists', and we will stick to this term. The elite coalition uses its power to collectively extract rents from the rest of the population, which are used to hold the

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[1]North et al. (2009) are not alone in their emphasis on violence in analysing human history. See also Seabright (2010) and Fukuyama (2011).

[2]Interaction in the *foraging order*, according to North et al. (2009), was largely peaceful and cooperative within bands. To maintain order, however, the size of bands was necessarily limited and interaction between bands was often very violent. The *open access order* is characterized by economic competition, access to political decision-making for all individuals through organizations, and impersonal relations. The army, controlled by the state, has a monopoly on large-scale violence. An elaborate system of rules, and checks and balances on powerful individuals and organizations holds together the open access order.

[3]North et al. (2009) use the terms 'limited access order' and 'natural state' interchangeably. We stick to the first.

coalition together. Although the coalition utilizes its coercive power against the rest of society, it restricts violence. The result is a social order with a strong elite that exercises its coercive power to extract rents from the society at large in order to stay in power. Within this elite, violence specialists compete for the distribution of the rent and they also compete, as a group, with violence specialists outside of the coalition, for control of society's rents. Employing this broad definition of limited access orders, it follows immediately that most contemporaneous societies in the world can be characterized as such.

There is a marked difference between the elite coalition as depicted by North et al. (2009) in their framework of the limited access order, and as depicted in most of the economics literature. In this literature, the elite is generally treated as a *monolithic* entity which maintains order among the rest of the population and levies taxes in return (Baker et al., 2010; Grossman, 2002). In the limited access order, however, the elite emerges out of the pool of violence specialists, and cooperation of violence specialists in the elite coalition is not self-evident. We follow North et al. (2009) by modelling the elite as a *composite* entity. A distinguishing feature of the elite in the limited access order is competition within the coalition (in addition to competition between the coalition and violence specialists in general); competition that is, of course, absent in models that treat the elite as a monolithic entity. This feature drives our choice to model the limited access order using insights from the economic literature on conflict and appropriation. This literature was pioneered by Hirshleifer (1988), Usher (1989), Grossman (1991) and Skaperdas (1992); recent overviews of the literature are by Garfinkel and Skaperdas (2007) and Konrad (2009).

In a nutshell our model is as follows.[4] Violence specialists either join the elite or become a bandit. Depending on their relative size, the elite and bandits each control a share of society, its population, and production. Both elites and bandits use their coercive power to appropriate production, but they do so in distinct ways. The elite resembles a 'stationary bandit', by enforcing a tax on production to support their coalition, taking into account – in the spirit of McGuire and Olson (1996) – that a high tax rate deters production. Bandits do not levy taxes but instead they exploit their violence capacities to appropriate as much production as they can. This advantage of bandits over elite-members in terms of rent extraction is partly mitigated by cooperation of the elite in the coalition. A side-effect is that such cooperation may result in competition over rent distribution within the coalition.

Our three main results are the following. First, we identify conditions under which a sizeable elite emerges, capable of limiting the activities of bandits and thus violence.

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[4]Our model cannot reflect all elements that characterize the limited access order. For reasons of tractability and simplicity we assume homogeneity of violence specialists. As is explained in Section 2, this assumption implies that we can ignore patronage networks, organizations, and the process of entry and exit into the elite coalition.

We find that an elite coalition of substantial size is feasible only when there are strong benefits to cooperation against bandits within the elite, offsetting the natural appropriation advantage of bandits. Second, we identify how production affects the behaviour of violence specialists and vice versa. We find that the tax rate levied by the elite coalition decreases with the productivity of the society.[5] Hence, more productive societies face lower tax rates from the elite coalition, but this implies that more violence specialists will choose to be bandits, increasing the level of appropriation in such productive societies. Third, we assess the interrelations of these outcomes with producer welfare in a limited access society. We find that the benefit of an elite coalition to society is limited, depending on various factors that are exogenous to our model, including the decisiveness of conflict and the cooperative quality of the coalition. Specifically, we find that producer welfare is maximized in limited access societies with moderate productivity levels.

Our contribution is twofold. First, we offer additional insights to the limited access order, which emerged during the Neolithic Revolution, and is the dominant social order in most of the world still. Adding to North et al. (2009), we find large variations in elite size, appropriation, production levels, and welfare across limited access societies due to only minor variations in exogenous model parameters, such as productivity, the cost of conflict, and the decisiveness of conflict. This implies that outcomes may differ substantially across limited access societies, and even across societies with the same level of 'maturation'. North et al. (2009) differentiate limited access orders by the formal organization of the elite coalition and describe how coalitions mature over time, in that positions within the coalition become more formal, impersonal, and more securely established. Our finding adds to this maturing process, which largely ignores differences in power balance between elite and bandits across limited access orders of similar maturation.[6]

Second, we provide relevant institutional context to the literature on the economics of conflict and appropriation. To the best of our knowledge, we are the first to provide a formal model of the limited access order (or any of the other two social orders). Although our model relates closely to the economic literature on conflict and appropriation (Garfinkel and Skaperdas, 2007), that literature is mostly concerned with analysing the effects of incorporating violent and coercive activities in standard economic analysis, which, generally, assumes a frictionless institutional context and thereby precludes potentially more realistic

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[5]We use the term productivity to refer to the output elasticity of effort, the only input to the production function introduced in Section 3.3.

[6]Although North et al. (2009) warn against a teleological interpretation of this maturing process, their emphasis on the natural progression of limited access orders in the formalization of the elite coalition clearly induces this interpretation. Our results highlight that this teleological approach to the limited access order, as well as to progression of societies toward open access orders, is problematic (cf. van Bavel, 2015).

settings. Studies that do attempt to make a more realistic connection to institutions mostly limit themselves to extreme cases by contrasting pure anarchic with pure hierarchic settings (Baker et al., 2010; Grossman, 2001, 2002; Konrad and Skaperdas, 2012). In our paper we mitigate this contrast by applying a more refined approach to institutions and conflict in a realistic setting.

2   From conceptual framework to a model

The salient feature of the limited access order is the formation of an elite coalition that restrains the imminent problem of violence in human interaction by using coercion to extract economic rents, while restricting violence and containing bandits. This focus on violence is central to our model. Although North et al. (2009) assert that violence is endemic in society, the main source of violence in society comes from the violence specialists themselves, and not from the rest of the population. Therefore, the success of the elite in establishing order and stability mainly depends on the reduction in their own use of violence and their capacity to keep other non-elite specialists (i.e. bandits) at bay. The elites have an incentive to fight off the bandits because these also appropriate part of the production of society. Therefore, the more the elites restrain the bandits, the more production they can capture themselves through taxation. The essential ingredient for a working limited access order is, thus, whether the emergence of an elite of substantial size is feasible. Put differently, the question is whether providing order and stability to extract taxes can be profitable enough to deter specialists from pure banditry. We approach this question by analysing the payoffs to elites and bandits, how they interact with the production of society, and producer incentives.

Our model puts structure on the main elements of the conceptual framework proposed by North et al. (2009). This structure, however, comes at the cost of one important simplification. This simplification is that we consider violence specialists as individuals, and their capacities as homogeneous. Recall that North et al. (2009) consider violence specialists as individuals with the skills to generate and maintain a patronage network of followers that can, in turn, be used to exert violence – or coercion – on others. Our assumption of violence specialists as homogeneous individuals has two main implications.

First, we can now abstract from the specificities of the formation and size of patronage networks as well as organizations, whose main function is to establish existing relations within patronage networks more firmly. North et al. (2009) describe how, in a maturing limited access society, specialists may turn into leaders of formal organizations. As a result, the size and importance of a formal organization become the sources of their power, while

their personal capacities become less important. Ignoring these aspects does not alter the role of violence specialists in a substantial way and opens the way for alternative perspectives on variation across limited access societies, even across societies with the same level of maturation.[7]

Second, we need not explicitly model entry and exit into the elite coalition. North et al. (2009) describe how the most important threat for violence specialists comes from other violence specialists, because they have the capacity to organize force, whereas the rest of society does not. Therefore, cooperation within the elite coalition provides relative security to its members. Nonetheless, (potentially violent) competition over the distribution of rents within the coalition remains. As a result, the composition of the coalition may be continuously changing, as power relations between members change, and because members with negligible contributions are weeded out and, potentially, substituted for new members. With homogeneous violence specialists – and given that our model allows violence specialists to freely choose between joining the elite or banditry – this process of entry and exit can be ignored.

Given these two simplifications, our model allows us to focus on the violence specialists' choice between joining the elite or banditry, and its implications for production levels and producer welfare. The choice between elite and banditry depends on the relative profitability of becoming elite, as has been demonstrated by a.o. Baker et al. (2010), Grossman (2002), Konrad and Skaperdas (2012), and Usher (1989). Whereas these papers focus on the capacity of the elite to deter society from using violence and appropriation, we assert, following North et al. (2009), that violence specialists have a near monopoly on using violence and appropriation. The issue is not only whether the elite can profitably deter others from violence and appropriation, but also whether this is as profitable as becoming bandits; i.e. profitable enough to abstain from using violence themselves. The equilibrating mechanism that we employ to model this choice is that specialists will choose the most profitable 'occupation'. As a result, each equilibrium features a specific distribution of elites and bandits, with payoffs to all violence specialists equalised.

3   Model

Consider a limited access society with a population of a fixed size, denoted by the set N. There are two subsets of individuals in this society: *violence specialists*, denoted by the set V, and the remainder of population that we refer to as *producers*, denoted by its

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[7]Although we acknowledge that it goes at the expense of analysing the possible shift to an open access order.

complement $P = N \setminus V$. The categories are mutually exclusive and collectively exhaustive with respect to N, and in our static model there is no mobility between them. Members of each subset are homogeneous in all relevant aspects.

Violence specialists $i \in V$ can appropriate production from the producers in two different ways, and this appropriation decision is determined by their choice of *occupation*. *Elite-members* cooperate and appropriate by levying a jointly determined tax on their controlled production, while *bandits* appropriate by stealing all of their controlled production. The two occupations exert negative externalities, because the amount of production appropriated by bandits decreases the production available for appropriation by elite-members, and vice versa. As a result, elite-members and bandits compete over the share of total production either side controls. From the side of the elite-members, this can be interpreted as the share of society whereon they effectively impose order, or the extent to which they succeed in establishing order over the entire population.

The occupation choice by violence specialists is the first stage of our model, which consists of four stages. These are shortly described below and worked out in detail in the following sections.

3.1 Occupation choice (Stage 1)

Each violence specialist $i \in V$ decides to join the elite coalition or not. We denote this occupation choice by $\mu_i \in \{1, 0\} \; \forall i \in V$. If $\mu_i = 1$, the specialist joins the elite coalition. If $\mu_i = 0$, the specialist becomes a bandit. The outcome of these decisions is a vector $\mu = (\mu_i : i \in V)$ that partitions the violence specialists in two subsets: the elite coalition $E = \{i : \mu_i = 1\}$ consisting of $e = |E|$ elite-members, and its complement $B = V \setminus E = \{i : \mu_i = 0\}$ consisting of $b = |B|$ bandits.

Control over producers by bandits and elites is given deterministically by the ratio $\frac{e}{b}$. Specifically, a contest success function (CSF) determines the share of total production that is controlled by, respectively, bandits and elites. We choose as a specification for the function $\rho(e, b)$ a modification of the standard ratio-form CSF (Tullock, 1980) inspired by the axiomatic characterization of group CSFs by Münster (2009).

$$\rho(e, b) = \frac{\theta e^m}{\theta e^m + b^m}, \tag{1}$$

with $m \in (0, 1)$ and $\theta \in [1, \infty)$. A few comments on (1) are appropriate here (and see Remark 1 below).

First, m and θ are derived from standard CSFs. Parameter m is conventionally inter-

preted as the decisiveness of conflict, and here we interpret it as the decisiveness of group size, where group refers to either the elite coalition or the aggregate of bandits. Given $m < 1$, there are diminishing marginal returns to group formation. Parameter θ represents a fighting asymmetry (cf. Clark and Riis, 1998) in favour of the elite coalition that we consider to be better organized than bandits. In the context of North et al. (2009) one could interpret θ as the cooperative quality of the coalition being a sign of its maturity, with more mature coalitions capable of efficiently organizing and coordinating power. One implication of this functional form is that the elite may control a larger share of production, even if it is smaller in size than the aggregate of bandits.

Second, note that our interpretation of $\rho(e, b)$ is non-probabilistic in the sense that it represents a share, rather than a winning probability (although the two interpretations are equivalent under the assumption of risk neutrality). For a detailed discussion of CSFs and their interpretations, see Hirshleifer (2000), Garfinkel and Skaperdas (2007), and Konrad (2009).

Third, although we talk freely about the share of production that is controlled by bandits, the degree of cooperation by bandits has not been specified yet. North et al. (2009) are not explicit about cooperative behaviour by bandits, if at all. In the functional form chosen in (1), bandits do work together, but have a fighting disadvantage compared with the elite, through θ.[8]

3.2   Tax (Stage 2)

Given the outcome of Stage 1, the elite controls a share $\rho(e, b)$ and bandits jointly control a share $1 - \rho(e, b)$, which each of them can appropriate as they wish. Following the main features of the limited access society, elite-members collectively determine their tax rate $\tau \in [0, 1]$, while bandits, by definition, choose to appropriate all production under their control.

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[8]The alternative approach is to model bandits as operating alone – using the term $b \times 1^m$ rather than b^m – which would imply $\rho'(e, b) = \frac{\theta e^m}{\theta e^m + b \times 1^m} = \frac{\theta e^m}{\theta e^m + b}$. This specification, however, would give the coalition a fighting disadvantage for any $m < 1$, so that the effects of m and θ may cancel each other out, while $m \geq 1$ is technically undesirable (Skaperdas, 1998). In addition, this specification yields a simple transformation of the equilibrium ratio $\frac{e^*}{b^*}$, derived below in (10). Since this transformation is monotonic of the form $\frac{e'}{b'} = \left(\frac{e^*}{b^*}\right) / \left(|V| - \frac{e^*}{b^*}\right)$ our results are qualitatively similar, and given that this alternative specification may yield discontinuities for $m < 1$, we stick to (1).

3.3 Production (Stage 3)

Given the outcome of Stages 1–2, producers decide on their joint production level. Production Y requires costly effort ϕ. We model production by producers as a process with effort as the only variable input, keeping any other production factors fixed. Aggregate production is given by the following total product function, which exhibits diminishing marginal returns to effort:

$$Y(\phi) = \beta \phi^{\alpha}. \tag{2}$$

Parameter $\alpha \in (0, 1)$ denotes the output elasticity of effort, which, in absence of other variable inputs, we will refer to as *productivity*. Parameter $\beta \in (0, \infty)$ reflects the product of total factor productivity and any other inputs, like land and capital, that we keep fixed. We will refer to β as a *technology* parameter.

Appropriation by bandits and elites reduces the amount of produce available for consumption. Producers maximize their utility C which equals aggregate consumption – production net of appropriation – minus the cost of effort.

$$C = (1 - \tau)\rho(e, b)Y(\phi) - \gamma\phi. \tag{3}$$

with cost parameter $\gamma \in (0, \infty)$. In Section 5 we use C as a proxy for producer welfare.

3.4 Within-coalition conflict (Stage 4)

Given the outcome of Stages 1–3, members of the elite coalition may engage in conflict over the tax rent. We model this conflict using a ratio-form CSF, similar to (1), except that it is not deterministic since its outcome depends on deliberate choices by the elites to invest in conflict. Each elite receives a share $\sigma_i(\mathbf{s})$ of the tax rent, which depends on costly investments in conflict by all elite members, captured in the vector $\mathbf{s} = (s_i : i \in E)$:

$$\sigma_i(\mathbf{s}) = \frac{s_i^n}{\sum_{j \in E} s_j^n}, \tag{4}$$

with $n \in (0, 1)$ being the decisiveness parameter for this conflict.

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With homogeneous violence specialists, payoffs π_i are equal across bandits as well as across elite-members. Incorporating all decisions made in Stages 2–4, this implies the

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following payoff functions:

$$\pi_i = \sigma_i(\mathbf{s})\tau\rho(e,b)Y - s_i \quad \forall i \in E; \tag{5}$$

$$\pi_j = \left(\frac{1}{b}\right)\big(1-\rho(e,b)\big)Y \quad \forall j \in B. \tag{6}$$

The stability concept that we use to evaluate outcomes of the model is a simple equilibrating mechanism that equates payoffs to elites and bandits. That is, in Stage 1 violence specialists choose the most profitable occupation. They make this choice whilst taking into account (i) the optimal tax rate that will be chosen by the elite, (ii) the optimal response in terms of production by producers, and finally, (iii) the severity of conflict within the coalition. Hence, in equilibrium, payoffs to elite members and bandits are equal. If not, then a profitable switch of occupation could be made by at least one violence specialist, while taking into account that changing occupations shifts the balance of power between bandits and the elite coalition with subsequent impacts on the outcomes of Stages 2–4. This equilibrating mechanism is reminiscent of more advanced stability concepts applied in alliance models and non-cooperative models of coalition formation (cf. Skaperdas, 1998; Yi, 2003; Garfinkel, 2004).

Note that the combination of Stage 1 and Stage 4 resembles models of sequential inter- and intra-group resource contest (Wärneryd, 1998; Esteban and Sákovics, 2003; Garfinkel, 2004). To these, we add two stages in which the interaction between elite and producers is modelled in terms of the tax rate and production levels. To the best of our knowledge, we are the first to model (i) production by a separate (set of) agent(s) as well as (ii) their interaction with the contesting agents in an economic model of conflict and appropriation.

We apply sub-game perfection and solve the model backwards.

Remark 1. Unlike the Stage 4 contest, the Stage 2 contest deviates from the standard approach in the economic literature on conflict and appropriation. Most importantly, this contest is deterministic in the sense that the outcome of the contest depends only on the ratio $\frac{e}{b}$. Notably, it does not depend on costly investments in violence. That is, in the Stage 2 contest, elite-members and bandits do not explicitly choose their violence level as is conventional in models that feature a trade-off between own production and appropriation (e.g. Hirshleifer, 1988, 1995; Skaperdas, 1992; Grossman and Kim, 1995) or in rent-seeking models (Nitzan, 1994). In a limited access society, however, violence is restricted to violence specialists, while production is the domain of the separate subset of producers. As a result, violence specialists are not confronted with this trade-off between own production and appropriation. In addition, motivated by the homogeneity of violence

specialists, the only effect of *not* ignoring costly investments in violence would be that payoffs of violence specialists would be reduced in the symmetric outcome of such a model, without any qualitative impacts on model results.

4   Results from a toy version

To gain basic insights into the model results, we first consider a simplified version of the model in which the tax rate τ and production Y are given exogenously and within-coalition conflict is absent. Doing so, we remove any anticipation of behaviour in Stages 2–4 from the occupation choice by violence specialists in Stage 1. This has two consequences. First, in absence of within-coalition conflict, we have $s_i = 0$ for all $i \in E$ and we assume $\sigma_i(\mathbf{s}) = \frac{1}{e}$. Second, given exogenous production there is no effect of the tax rate on production. Therefore, it is always optimal for the elite to set the maximum tax rate, i.e. $\tau = 1$. We will simply ignore this model feature and proceed to assess comparative statics with respect to the tax rate, acknowledging that both the tax rate as well as production will be endogenized in the next section.

Following our simplifying assumptions, payoff functions (5) and (6) can be updated to:

$$\pi_i = \left(\frac{1}{e}\right)\tau\rho(e,b)Y \qquad \forall i \in E; \tag{7}$$

$$\pi_j = \left(\frac{1}{b}\right)\big(1-\rho(e,b)\big)Y \quad \forall j \in B. \tag{8}$$

Applying our stability concept, we equate payoffs to bandits and elite in (7) and (8) to find the equilibrium ratio of elites and bandits, which is independent from production Y:

$$\frac{e}{b} = \frac{\tau\rho(e,b)}{1-\rho(e,b)}. \tag{9}$$

By the specification of $\rho(e,b)$ in (1), the size of the elite-controlled production depends positively on the ratio of elite-members to bandits. Since our limited access society has a population of fixed size and does not allow mobility between violence specialists and producers, the number of violence specialists is also fixed. We have $|V| = e + b$: an increase in e implies a decrease in b of equal size and vice versa. We use this model feature and also substitute (1) for $\rho(e,b)$ in the equilibrium ratio (9). After simplification we obtain the equilibrium ratio of elites to bandits as a function of parameters m, θ, and τ, and, by
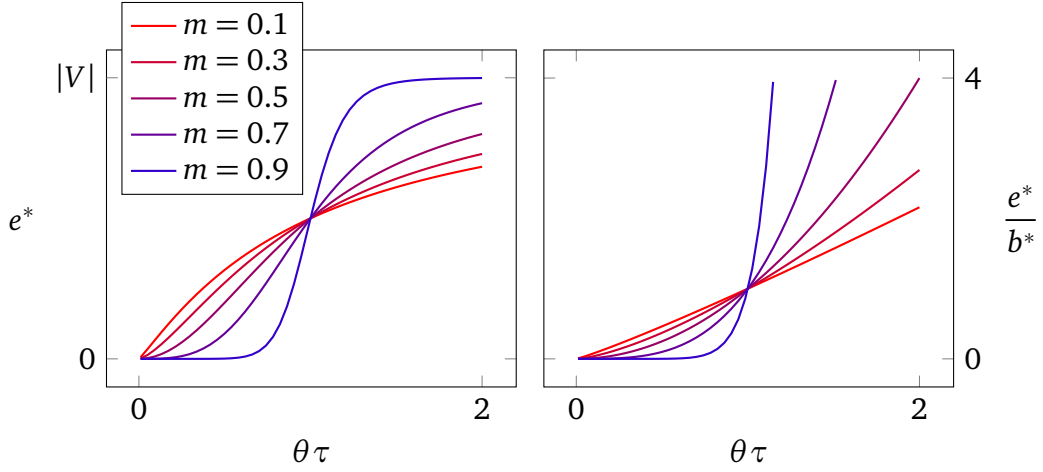
Figure 1: Toy model results: Equilibrium size of the elite coalition e^* and equilibrium elite-bandit ratio $\frac{e^*}{b^*}$ as a function of $\theta\tau$ for different values of parameter m.

substituting $b^* = |V| - e^*$ in (10), we also obtain e^* and b^* separately:

$$\frac{e}{b} = \frac{\tau\theta e^m/(\theta e^m + b^m)}{1 - \theta e^m/(\theta e^m + b^m)} \quad \Rightarrow \quad \frac{e^*}{b^*} = (\theta\tau)^{\frac{1}{1-m}}, \tag{10}$$

$$e^* = \frac{|V|}{(\theta\tau)^{\frac{-1}{1-m}} + 1}, \tag{11}$$

$$b^* = \frac{|V|(\theta\tau)^{\frac{-1}{1-m}}}{(\theta\tau)^{\frac{-1}{1-m}} + 1}. \tag{12}$$

The elite-bandit ratio (10) increases with the tax rate and in τ. It also increases with m if and only if $\frac{e^*}{b^*} > 1$ which holds if $\theta\tau > 1$. In this case, the elite has an advantage in generating rents as a combined effect of controlling and taxing production. Given $m < 1$, profit per occupation, in both occupations, decreases with the size of the group. Therefore, equilibrium group size can be interpreted as the relative profitability of an occupation, with the larger group having an advantage in generating rents.

For $\theta = 1$, the elite-bandit ratio can be at most 1, and only in the special case that the tax rate equals 1. Put differently, the number of elite-members is never larger than the number of bandits in absence of an elite fighting advantage. This is a necessary consequence of the fact that bandits fully appropriate their controlled production, whereas elite-members do not necessarily. Hence, elite-members, by construction, have a disadvantage in terms of their capacity to generate rents, which can be offset only by their fighting advantage in case $\theta > 1$.

In Figure 1 we plot (11), the equilibrium number of elites e^*, and (10), the equilibrium elite-bandit ratio, as a function of $\theta\tau$ for different values of parameter m. The figure

illustrates the possibility of an empty elite coalition for low values of $\theta\tau$ and high m. It also illustrates the possibility of an elite coalition that contains all violence specialists for high values of $\theta\tau$ and high m. Note that, by the exponent $\frac{-1}{1-m}$ in (11) and (12), these are limit results for $\theta\tau$ going to zero or infinity. Both e^* and b^* converge to, but will never reach, 0 or $|V|$. Note that this difference is trivial since both are to be interpreted as non-negative integers.

The results of this simplified version of our model illustrates that the presence of a sizeable elite coalition, and thereby, more generally, the emergence of a limited access society, is not trivial. In interpreting equations (10)–(12) as well as Figure 1, however, recall that they represent results from a simplified version of our model in which the tax rate τ and production Y are given exogenously and within-coalition conflict is absent. Nevertheless, the results from this toy version happen to coincide with a limit case of the full model that we develop in the next section.

5 Results from the full model

In this section we present the results of our full model, including all four stages as presented in Section 3. Specifically, we extend the analysis of the toy version of our model in Section 4 with an endogenous tax rate, endogenous production, and within-coalition conflict.

Solving the model backwards, we analyse each of the four stages consecutively.

5.1 Within-coalition conflict (Stage 4)

Given outcomes of Stages 1–3, each elite member chooses s_i to maximize his payoff as given by (5):

$$\frac{\partial \pi_i}{\partial s_i} = \frac{\partial \sigma_i(\mathbf{s})}{\partial s_i}\tau\rho(e,b)Y - 1 = 0 \quad \forall i \in E. \tag{13}$$

Note that we exclude the peaceful outcome where $s_i = 0$ for each agent. Such a peaceful outcome cannot be an equilibrium to the conflict since one elite member j could secure the complete resource with a small investment in conflict $s_j > 0$ (Garfinkel and Skaperdas, 2007). This opportunity would not be left unexploited in equilibrium, which is why we exclude it from our analysis.

By (4) we have:

$$\frac{\partial \sigma_i(\mathbf{s})}{\partial s_i} = \frac{n s_i^{n-1} \sum_{j \in E \setminus \{i\}} s_j^n}{\left(\sum_{j \in E} s_j^n \right)^2}. \tag{14}$$

With homogeneous violence specialists, such that $s_i = s$ for each $i \in E$, we can simplify this derivative to

$$\frac{\partial \sigma_i(\mathbf{s})}{\partial s_i} = \frac{n(e-1)}{se^2}. \tag{15}$$

Substituting this simplified derivative into (13) and solving for s, we obtain:

$$s^* = \left(\frac{e-1}{e^2} \right) n \tau \rho(e, b) Y. \tag{16}$$

From (16) follows our first result.

Proposition 1. *In equilibrium, within-coalition investments in costly conflict s^* are:*
  (i) decreasing with the size of the elite coalition e if and only if $e > 2$;
  (ii) increasing with the decisiveness of conflict n;
 (iii) increasing with the tax rent $\tau \rho(e, b) Y$.

Proof. The results follow directly from the relevant first order conditions to (16).   □

Although part (*i*) of the proposition states that *individual* investments in costly conflict *s* generally decrease in *e,* we have that *aggregate* investments in costly conflict *es* increase in *e*. Complete rent dissipation with increasing *e* is only mitigated through the dampening effect of the decisiveness parameter *n*.

An implication of Proposition 1 is that a decrease in the tax rent per elite member $(\tau \rho(e, b) Y)/e$ tends to decrease investments in conflict. One interpretation of this relation is that the coalition is rather stable in the face of adverse shocks. We use the term stable to indicate that, when tax rents per elite member are low, conflict within the coalition is also low. Although this result is intuitive and straightforward (fighting for a smaller rent or with more opponents simply decreases expected payoffs), it may not hold under more general conditions. For instance, one could consider threshold payoffs to elites – such as subsistence levels, or the minimum payoff required to maintain a patronage network – below which elite-members will fight ferociously for small gains in payoff.

5.2 Production (Stage 3)

Given outcomes of Stages 1–2, producers choose ϕ to maximize their utility (3):

$$\frac{\partial C}{\partial \phi} = (1-\tau)\rho(e,b)\frac{\partial Y(\phi)}{\partial \phi} - \gamma = 0 \tag{17}$$

By the production function in (2) we have

$$\frac{\partial Y(\phi)}{\partial \phi} = \alpha\beta\phi^{\alpha-1} \tag{18}$$

Substituting this derivative into (17) and solving for ϕ, we obtain:

$$\phi^* = \left((1-\tau)\rho(e,b)\frac{\alpha\beta}{\gamma}\right)^{\frac{1}{1-\alpha}}. \tag{19}$$

Substituting this equilibrium level of effort into (2) and solving for Y, we obtain:

$$Y^* = \beta\left((1-\tau)\rho(e,b)\frac{\alpha\beta}{\gamma}\right)^{\frac{\alpha}{1-\alpha}}. \tag{20}$$

From (20) follows our second result.

Proposition 2. *In equilibrium, production Y^* is:*
  (i) decreasing with the tax rate τ;
  (ii) increasing with the share of production controlled by the elite $\rho(e,b)$;
  (iii) increasing with the technology-cost ratio $\frac{\beta}{\gamma}$;
  (iv) increasing with productivity α if and only if $\phi > 0.37$.

Proof. The results for parts (i)–(iii) follow directly from the relevant first order conditions to (20). For part (iv), the first order condition is more involved:

$$\frac{\partial Y}{\partial \alpha} = \frac{\beta\big(\ln(\alpha G)+1-\alpha\big)}{(\alpha-1)^2(\alpha G)^{\frac{\alpha}{\alpha-1}}}, \tag{21}$$

with $G = (1-\tau)\rho(e,b)\beta/\gamma$. The denominator is strictly positive. For $\frac{\partial Y}{\partial \alpha} > 0$ to occur, the numerator needs to be strictly positive too. This is the case if and only if $\ln(\alpha G) > \alpha - 1$. Since $\alpha G = \phi^{1-\alpha}$, we can write $\ln(\alpha G) = (1-\alpha)\ln(\phi)$ and therefore

$$\ln(\alpha G) > \alpha - 1 \quad \Leftrightarrow \quad \ln(\phi) > -1 \quad \Leftrightarrow \quad \phi > \frac{1}{e} \approx 0.37, \tag{22}$$

where Euler's number e should not be confused with the size of the elite coalition e. $\qquad\square$

5.3 Tax (Stage 2)

Given the outcome of Stage 1, the elite coalition jointly chooses the tax rate τ to maximize the coalition payoff. With homogeneous violence specialist, this coalition payoff π_E equals e times individual elite payoff (5), substituting (16) for s_i and (20) for Y:

$$
\begin{aligned}
\pi_E &= e\big(\sigma_i(\mathbf{s})\tau\rho(e,b)Y - s_i\big) \\
&= e\left(\frac{e+n-en}{e^2}\right)\tau\rho(e,b)Y \\
&= \left(\frac{e+n-en}{e}\right)\tau\rho(e,b)\beta\left((1-\tau)\rho(e,b)\frac{\alpha\beta}{\gamma}\right)^{\frac{\alpha}{1-\alpha}}
\end{aligned}
\tag{23}
$$

We can now solve for τ to find:

$$
\tau^* = 1 - \alpha.
\tag{24}
$$

Our third result follows directly.

Proposition 3. *In equilibrium, the tax rate τ^* decreases linearly in productivity α.*

Given $\alpha < 1$, the equilibrium tax rate is strictly smaller than 1. The elite coalition abstains from fully taxing away its controlled production. When α is low the effect of the tax rate on production is small and hence, it is optimal to set a high tax rate. The opposite holds when α is high.

5.4 Occupation choice (Stage 1)

Each violence specialist chooses his occupation $\mu \in \{0,1\}$ to maximize his payoff as given by (5) and (6), taking into account the effects of occupation choice on payoffs via (1) on the Stage 2 tax rate, Stage 3 production, and Stage 4 within-coalition conflict. Recall our equilibrating mechanism of equal payoffs to both occupations such that $\pi_i = \pi$ for all $i \in V$. Applying this mechanism, we equate (5) and (6), whilst substituting (16) for s_i and we obtain:

$$
\left(\frac{1-n+n/e}{e}\right)\tau\rho(e,b) = \left(\frac{1}{b}\right)\big(1-\rho(e,b)\big).
\tag{25}
$$

We can now rearrange terms to find the equilibrium ratio of elites to bandits, which is independent from production Y:

$$
\frac{e}{b} = \frac{(1-n+n/e)\,\tau\rho(e,b)}{1-\rho(e,b)}.
\tag{26}
$$

We substitute (1) for $\rho(e, b)$ and (20) for τ in the equilibrium ratio (26). After simplification we obtain the following ratio of elites to bandits as a function of parameters m, n, θ, and α:

$$\frac{e}{b} = \left((1 - n + n/e)(1 - \alpha)\theta \right)^{\frac{1}{1-m}} \tag{27}$$

Note that e enters the RHS of this ratio, which cannot be solved analytically. Comparing (26) with the related ratio in the toy version of our model (9), we see that an additional term $1 + n\left(\frac{1}{e} - 1\right)$ has entered the solution (in addition to τ being replaced by its equilibrium value $1 - \alpha$). This term is driven by the anticipation of conflict in the fourth stage of the model (recall n is the decisiveness parameter for within-coalition conflict). The limit values for this term on the domain $n \in (0, 1)$, are:

$$\lim_{n \to 0} \left[1 + n\left(\frac{1}{e} - 1\right) \right] = 1 \quad \Rightarrow \quad \frac{e}{b} = \left((1 - \alpha)\theta \right)^{\frac{1}{1-m}}, \tag{28}$$

$$\lim_{n \to 1} \left[1 + n\left(\frac{1}{e} - 1\right) \right] = 1/e \quad \Rightarrow \quad \frac{e}{b} = \left((1 - \alpha)\theta/e \right)^{\frac{1}{1-m}}. \tag{29}$$

For $n \to 0$, there is no effect of Stage 4 within-coalition conflict on Stage 1 occupation choice. The ratio $\frac{e^*}{b^*}$ converges to the ratio (9) of the toy version of our model. For $n \to 1$, however, the effect of within-coalition conflict is apparent through the factor $1/e$. Since the exponent $1/(1-m) > 1$, this factor decreases both the equilibrium coalition size and the ratio $\frac{e}{b}$ compared to the toy version of our model. For intermediate values of n and $e \geq 1$, we have $1/e < 1 + n\left(\frac{1}{e} - 1\right) < 1$ with resulting ratios $\frac{e}{b}$ in between the two limit cases presented by (28)–(29).

We know from the toy version of our model and from Figure 1 how the ratio $\frac{e}{b}$ behaves when $n \to 0$. Hence, we focus here on the limit where $n \to 1$ and the effect of within-coalition conflict is high. We illustrate our full model results by presenting this limit case in Figure 2 and comparing to Figure 1. Values for e^* and $\frac{e^*}{b^*}$ in Figure 2 are computed by solving (29) numerically using the Newton-Raphson method. Comparison of both figures shows that the limit case of the full model with $n \to 1$ implies smaller elite coalitions in equilibrium. Choosing the elite occupation has become less attractive compared to the toy version of our model, both because producers now respond to the tax rate and because of the prospect of within-coalition conflict.

From (27)–(29) and Figure 2 follows our fourth result.

Proposition 4. *In equilibrium, the elite-bandit ratio $\frac{e^*}{b^*}$ is:*
   (i) decreasing with productivity α;
   (ii) decreasing with the number of violence specialists $|V|$;
   (iii) decreasing with the decisiveness of conflict n;
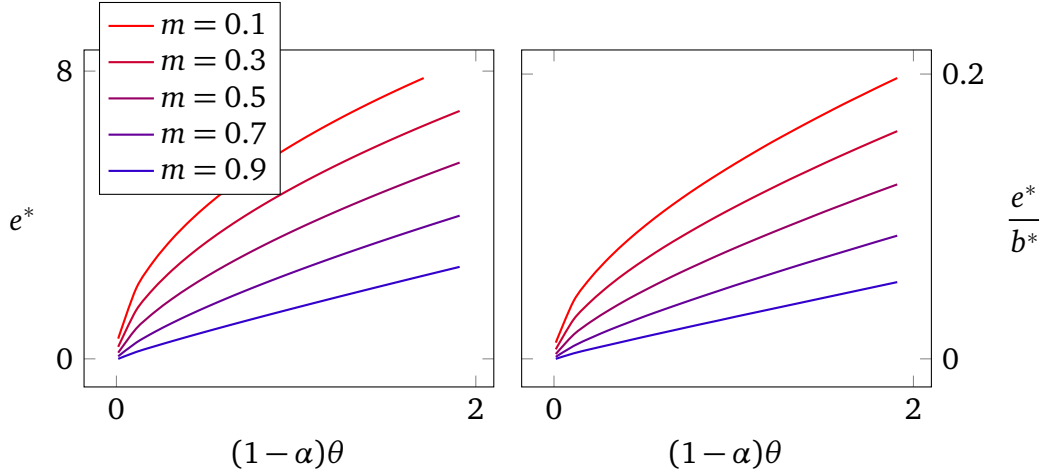
Figure 2: Full model results: Equilibrium size of the elite coalition e^* and equilibrium elite-bandit ratio $\frac{e^*}{b^*}$ as a function of $(1-\alpha)\theta$ for $n = 1$, $|V| = 50$, and different values of parameter m.

(iv) decreasing with the decisiveness of conflict m if and only if $(1-n+n/e)(1-\alpha)\theta < 1$;

(v) increasing with elite fighting advantage θ;

Proof. The results for parts (i) and (iii)–(v) follow directly from (27)–(29). To prove part (ii), we solve (29) numerically using the Newton-Raphson method for a wide range of values for $(1-\alpha)\theta$, m, and n. An example plot is given in Figure 3. □
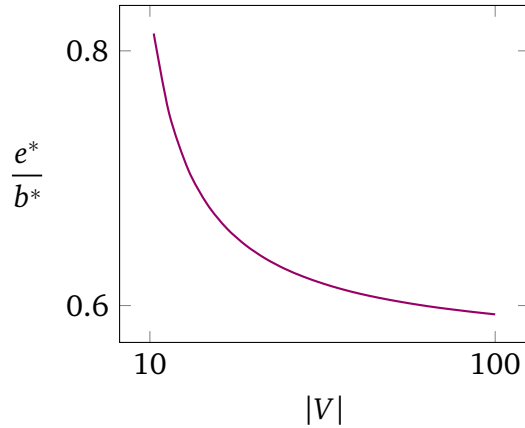

Figure 3: Full model results: Equilibrium elite-bandit ratio $\frac{e^*}{b^*}$ as a function of $|V|$; an example plot for $(1-\alpha)\theta = 1.5$, $m = 0.5$, and $n = 0.5$.

18

5.5 Producer welfare (Back to Stage 3)

The negative relation between productivity α and the equilibrium elite-bandit ratio naturally results in the question whether and when producers benefit from the presence of a large elite coalition. Our results show a couple of countervailing effects, for instance with respect to α. Higher α results in lower tax rates (see Proposition 3), which increases production indirectly. There is also a combined effect of α on production, which may be positive or negative, depending on the effort level (see Proposition 2). By Proposition 4, finally, higher α leads to a lower elite-bandit ratio, implying more appropriation by bandits. We assess this combination of effects on production by evaluating the equilibrium production level through substitution of the equilibrium elite-bandit ratio and the equilibrium tax rate. From this equilibrium production level, we can then proceed to determine producer utility (3), which we use as a proxy for producer welfare.

We first rewrite the CSF in (1) in terms of the elite-bandit ratio by multiplying both RHS fraction terms with $(\theta e^m)^{-1}$:

$$\rho(e, b) = \left(1 + \left(\frac{1}{\theta}\right)\left(\frac{b}{e}\right)^m\right)^{-1}. \tag{30}$$

We then proceed by substituting (24) for τ and (28) for $\frac{e}{b}$ in the equilibrium production level (20). Note that for $\frac{e}{b}$ we choose the limit case where $n \to 0$ since α does not directly affect within-coalition conflict and by using this limit case we avoid a numerical proof for three out of four results in Proposition 5 below.

$$Y^* = \beta \left(\frac{\alpha^2 \beta}{\gamma}\right)^{\frac{\alpha}{1-\alpha}} \left(1 + \left(\frac{1}{\theta}\right)\left[(1-\alpha)\theta\right]^{\frac{m}{m-1}}\right)^{\frac{\alpha}{\alpha-1}}. \tag{31}$$

Substituting (31) for Y and (19) for ϕ in the producers' utility function (3), we obtain, after substantial simplification:

$$C^* = \left[\alpha\beta\left(\frac{\alpha^2\beta}{\gamma}\right)^{\frac{\alpha}{1-\alpha}} - \gamma\left(\frac{\alpha^2\beta}{\gamma}\right)^{\frac{1}{1-\alpha}}\right]\left(1 + \left(\frac{1}{\theta}\right)\left((1-\alpha)\theta\right)^{\frac{m}{m-1}}\right)^{\frac{1}{\alpha-1}}, \tag{32}$$

which is strictly positive under our parameter assumptions.[9]

Based on (32), the effects of model parameters on producer welfare, as measured by C, are summarized in our next result.

Proposition 5. *In equilibrium, producer welfare is:*

---

[9]Specifically, the term between square brackets is strictly positive for $\alpha < 1$

(i)   *increasing with the technology-cost ratio $\frac{\beta}{\gamma}$;*
(ii) *increasing with elite fighting advantage θ;*
(iii) *decreasing with the decisiveness of conflict m if and only if $(1-\alpha)\theta < 1$;*
(iv) *hump-shaped in productivity α.*

Proof. The results for parts (i)–(iii) follow directly from the relevant first order conditions to (32). To prove part (iv), we evaluate (32) for a wide range of values for β, γ, θ, and m. An example plot is given in Figure 4. □
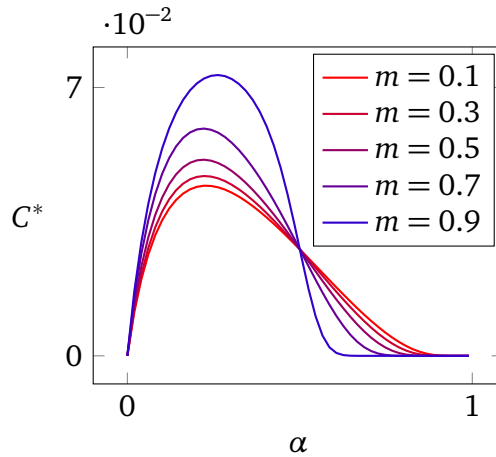

Figure 4: Full model results: Equilibrium utility level C^* as a function of α; an example plot for $\beta = 1$, $\gamma = 1$, $\theta = 2$, and different values of parameter m.

The combination of direct and indirect effects of α on utility – as discussed in the beginning of this section – is illustrated in Figure 4. This figure shows that producer welfare follows a hump-shaped pattern in productivity α. Utility is low for both low α – implying low production levels – and high α – implying high appropriation levels. Maximal welfare levels are reached for moderate values of α. This result implies high tax rates (recall $\tau^* = 1 - \alpha$) by relatively large elite coalitions, as can be seen from Figures 1 and 2.

6   Conclusion

In this paper we provide economic intuition for the limited access order, using insights from the economic literature on conflict and appropriation. Our results highlight a couple of relevant findings that put the conceptual framework by North et al. (2009) in a broader perspective.

First, one central question of this paper is under what conditions the emergence of sizeable elite coalitions can be expected. We find that this depends to a large extent on

the parameter θ that we interpret as the cooperative quality of the elite coalition, which gives it a fighting advantage over the bandits. Without this advantage, elite-bandit ratios higher than one are not possible. Even in the presence of this advantage, high elite-bandit ratios can only be expected for substantial levels of the tax rate. This finding supports the emphasis placed by North et al. (2009) on the joining of forces by elite members to fight off adversaries and to maintain order and stability. The relative advantage in fighting capacity compensates elite-members both for their disadvantage in terms of generating rents and for their costly investments in conflict to distribute the tax rent within the coalition. As a result of this advantage, we even find elite coalitions that control the greater part of production, even when they are outnumbered by bandits.

Second, an important element in our model is the interaction between occupation choice by violence specialists and the production level. Our propositions reveal that competition among violence specialists entails a fundamental trade-off between the incentive to reduce appropriation and to maintain stability. On the one hand, elite-members have an incentive to reduce the tax rate because this increases the production level and, thus, their profit. On the other hand, a low tax rate makes the occupation of elite-member relatively less attractive. As a result, a sizeable coalition only emerges when it levies a sufficiently high tax rate. By Proposition 3 and illustrated by Figures 1 and 2, this is the case when productivity is low.

Third, we find that producer welfare is maximized in limited access societies with moderate productivity levels. Unproductive societies are faced with a high tax rate and a large elite, while productive societies are faced with a low tax rate and a small elite. The difference in additional productivity between these societies is offset by increased appropriation in absence of a strong elite, resulting in welfare being maximized for moderate levels of productivity. By now we know that such societies are characterized by a high tax rate and relatively large coalitions. This result, once again, confirms the claim by North et al. (2009), that society benefits from order and stability introduced and maintained by the elite coalition.

In general, we find large variations in the size of elite coalitions, appropriation, production levels, and welfare across limited access societies, due to only minor variations in exogenous model parameters α, β, γ, θ, m, and n. Adding to the analysis by North et al. (2009), this result implies that we can expect to find a wide variety of outcomes within the class of limited access societies. The characteristics of a specific limited access order in a given country at a given moment in time will depend on the power balance between elite and bandits, all other factors equal.

In addition to the simplifications discussed in Section 2, several caveats are in place.

First, we have modelled one-dimensional relations between the tax rate, production, and within-coalition conflict. These relations are likely to be more involved in practice. For instance, taxation and within-coalition conflict both require effort from the patronage networks of the elite coalition. One consequence is that within-coalition conflict could have detrimental effects on the tax rate that the coalition, as a group, can enforce onto producers. Another consequence is that the decision on a tax rate could be the source of substantial conflict within the coalition. These, and other, complicating factors are not considered here, since this would require a more explicit consideration of coalition decision-making, where the size and composition of the coalition are endogenous to the decision-making itself, which is beyond the scope of this paper.

Second, the model developed in this paper is a stylized representation of a limited access order and, as a result, does not elaborate on how both elites and bandits exercise control over producers and production. Our interpretation is that the size of the elite-controlled production is simply a measure of the elite's success in imposing order and stability. A more realistic interpretation would be that elites and bandits each have a share of territory under control, possibly tied to their patronage network. An implication of this alternative interpretation is that one should take into account migration of producers and model distinct production decisions on territory controlled by elites and bandits respectively. For simplicity, we abstract from such considerations.

Third, we have ignored the changing nature of societies by treating society, its size, and the distribution of capacities as constants.

Despite these caveats, our model is capable to answer, at least partially, why societies with extractive elites emerge and persist. The traditional answer to this question is that the elite is better off in an extractive and exclusive regime and powerful enough to maintain it (Sokoloff and Engerman, 2000; Acemoglu and Robinson, 2008). In contrast, North et al. (2009) start from the assertion that violence is an endemic threat to the stability of societies, arguing that a society with a small and extractive elite – the limited access order – is a natural social order since it guarantees a certain degree of order and stability. In contrast to most of the literature, the elite coalition considered by North et al. (2009) and modelled in this paper, is not a monolithic entity with absolute power. Instead, it consists of individuals who compete amongst each other, each having specific but limited power. As a result, the elite coalition is fragile, and the behaviour of individual elite-members is constrained by the threat of other elite-members as well as bandits.

This perspective undermines theories that treat the elite as a powerful monolithic entity, capable of reorganizing society. For instance, Grossman (2002) states that the ruler of a society can induce the population to provide such a level of defence that all violence

and appropriation is deterred. In the limited access order, however, no elite-member has such power, and the decision-making of the coalition as a whole is much more complex. Also, Acemoglu and Robinson (2008, 2012) stress that extractive hierarchies are persistent because the monolithic elite will obstruct any change that might undermine its power. In the limited access order, however, the elite is not monolithic but elite-members and the rest of society are constrained in their behaviour by the rigidity of the social order.

Our contribution to the analysis by North et al. (2009) is that we have investigated the conditions that determine whether violence specialists willingly choose to enforce order and stability, whereas they are just as capable in purely violent appropriation. In addition, we identified implications for tax, production, within-coalition conflict, and producer welfare. This contribution strengthens the more abstract reasoning by North et al. (2009) and supports its alternative answer to the question raised above.

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