Asset complementarity, resource shocks, and the political economy of property rights

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Abstract

This paper discusses how the economic structure and asset ownership shape political and institutional outcomes. Using a simple structural model of the productive sector, I provide a theoretical framework in which a commodity price shock, substitutability between productive assets, and inequalities increase the stakes of political competition, and therefore the intensity of the conflict over political power. These results provide a theoretical explanation for the frequent conflicts associated with abundant mineral resources. They are valid in a democratic setting, where this competition is electoral, but also in any other setting, where competition may be of a more violent nature. I then extend this analysis to show that a commodity price shock and substitutability between productive assets negatively influence the willingness of elite groups to invest in property rights institutions, thus providing an economic explanation for why some countries have endogenously developed a context more favorable to business than others.

1 Introduction

Resource-rich developing countries are generally unable to successfully convert their exhaustible resources into peaceful development. Abundance of mineral resources notoriously hinders growth and asset accumulation (see van der Ploeg, 2011, for a recent survey), feeds into more frequent and more violent periods of conflicts (Collier and Hoeffler, 2004; Fearon, 2005), and seems to be associated with poorer institutions (Bates, 2007). In that perspective, mineral extraction can be contrasted with other productive activities. Dube and Vargas (2011) show that in Colombia, a rise in oil prices as well as a *fall* in coffee prices increase conflict locally. Their interpretation is in line with Dal Bó and Dal Bó (2011): they suggest that a price hike in a capital intensive sector will result in more conflict while in a labor intensive one it would have the opposite effect.

One feature of their intuition suggests that they might not have captured all aspects of the story, though. The mechanism they explore does not extend to other categories of capital intensive activities, such as industrial or services

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activities which, if anything, should be associated with less conflict. It is likely that other features of the production technology play a decisive role in sparking or fueling armed conflict and, furthermore, in shaping the incentives to invest in the quality of institutions.

Recent advances in the political economy of development suggest that the distribution of asset ownership, as well as the structural characteristics of the productive sector, indeed have a decisive role in shaping institutions and development outcomes (Acemoglu and Robinson, 2008; Besley and Persson, 2009, 2010; Bourguignon and Verdier, 2009, 2010). For instance, large shares of a country's population can easily be excluded from benefiting from the extraction of point-source resources. Controlling such resources would then entail important profits narrowly distributed in the population. An activity involving economies of scale, on the other hand, would conversely lead to more inclusive redistribution. Since the additional entrant is beneficial to incumbents, they are likely to offer him a higher share of the profits. This is typically the case of industrial endeavors, of firms involved in a network of suppliers and customers, of workers in short supply. In such a context, social heterogeneity may not be an impediment to growth.

This paper formalizes such intuitions to examine the economic determinants of political competition, and of state capacity building. For this purpose I embed a simple model of the productive sector in a contest game. The productive sector is composed of a common productive endeavor described by a constant elasticity of substitution (CES) function, and of linear productive technologies which effectively sets the opportunity cost of each individual to participate in the common endeavor. Two parameters of the CES function provide interesting intuitions: the profitability parameter, which may be thought to capture the export price of a mineral commodity; and the elasticity of substitution, which accounts for the positive spillovers of the investment of an asset on the profitability of investing another. Two individuals are assumed to be in a position where they can mobilize resources, which they can invest either in the common endeavor or using their specific production technologies. They have conflicting interests over the proceeds of the common endeavor, even though they each find the other's investment profitable. Whose sharing preferences prevail is decided through the contest game, which is used to describe several important features of a competitive political process. It models conflict as competing individuals willing to spend in order to have their own sharing preferences prevail. For each contestant, the stake of political power results from the different shares that he and the other would offer.

Actual implementation of the sharing rule is then understood as indicative of the quality of property rights institutions. Once in power, the contest winner has a strong interest in ensuring the other's participation in the common endeavor; but he may fail to convince the other that he would not renege on his promises. With good property rights institution, he is able to commit to upholding the sharing rule he offers. He may thus have an incentive to improve the quality of such property rights institutions, depending on the structural characteristics of the production process.

The model yields six results. First result, an exported commodity price shock increases the intensity of the conflict over political power. The underlying intuition is straightforward: the more the individuals have to gain from being in power, the more they are willing to spend in order to win the contest. It

is reasonable to assume that the amount of wealth spent for the conquest of political power is a good proxy for the intensity of political conflict. In Dube and Vargas (2011), an increase in the price of coffee reduces local conflict, in apparent contradiction with this result. The mechanism they describe relies on the assumption that productive resources can be diverted in the appropriation sector, a crucial assumption if we are to understand the resource curse but also one that conceals other mechanisms that this model uncovers.

Second, the intensity of political power is also raised by more substitutable assets, though this intuition is slightly less straightforward: an asset is complementary with another if its investment increases the profitability of investing the other. The contest winner is willing to offer the other contestant a higher share of the proceeds of the common productive endeavor when the two assets are more complementary, in order to induce him to invest more. Sharing rules offered by both contestants would therefore be increasingly favorable to the other when complementarity increases, thus lowering the stakes of political competition. Third, substitutability and profitability tend to reinforce each other as factors of conflict, thus offering an explanation for the widely different outcomes of different categories of production technologies. Fourth result, taking initial endowment asymmetry as a proxy for inequalities, I show that inequalities also feed into conflict.

Fifth result, commodity price shock, as well as higher substitutability between factors, are also shown to decrease the benefits for the political leader of committing to upholding the sharing rule – indeed to upholding property rights – and thus his incentives to invest in such institutions. As a consequence, the model predicts that property rights protection is more likely to arise at times when and places where assets are complements, and the common endeavor is not so much more profitable than the outside options. In any case, my sixth and last results predicts that both the leader and the other individual benefit from the leader's ability to commit.

As an illustration of the lessons of the model, I confront the mechanisms it uncovers to two particular African success-stories. First, a very specific social context at independence accounts for the unequaled achievement of Botswana, which transformed its huge diamond wealth into a stable democracy and an impressive growth record. Diamond wealth itself predictably led to high inequalities, but the model fails to explain why no contender to the wealthy Tswana elite emerged, and it is likely that the good institutional environment is a result of the lack of threat to the incumbent leaders, a feature which the model does not account for. Second, the textile industry and sugar cultivation transformed ethnic diversity in Mauritius into an opportunity and provided the ground for its peaceful, yet outstanding economic development, against very unfavorable odds at independence. The predictions of the model are consistent with the absence of conflict beyond its democratic expression, as well as with very good property right institutions.

This paper is related to several strands of the literature. Closest to this paper are Bourguignon and Verdier (2009, 2010) and Dal Bó and Dal Bó (2011), which are based on reduced forms of taxation and power shifting on the one hand, and of Haavelmo (1954)'s trade-off between production and appropriation on the other. The former study the effects of the economic structure of society, namely the complementarity of the productive resource controlled by the elite and those controlled by other social groups, on taxation, redistribution, and investment in

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state capacity. But while I share their initial intuition about the essential role of the economic structure of society, the present paper explores different political and institutional outcomes, thanks to a new framework. The latter studies the factor intensity of productive activities on conflict. I extend the analysis to other characteristics of such activities, as well as to institutional outcomes.

A distinguishing feature of this paper is that it provides a full structural model of conflict and institution building. The model has four main building blocks: the productive sector, the sharing rule, the political conflict and the institutional setting. The productive sector is very standard, but the sharing rule is not. I am not aware that any other paper uses the difference of preferences over the sharing rule as the stake of the political competition. Contest games have been studied extensively after the seminal work of Tullock (1980), but have seldom been used to study the economic determinants of political conflict. For that purpose variations on diverse electoral rules are more common. For instance, Robinson et al. (2006); Acemoglu et al. (2004) consider an economic rent accruing to the group in power, which allows them to buy off their competitors or voters. Contest games focus more specifically on the costs and benefits of individuals who derive an economic advantage from political power. To my knowledge, prior to this paper, only Aslaksen and Torvik (2006) used a contest game to model the political competition in a rentier economy. In order to compare civil war with democracy, they claimed that a contest game could only describe an armed civil conflict. This is contentious, however, as some features of contest games may be thought as accounting for any form of political selection process, from elections to outright civil war.

The last feature of the model is related to the growing body of literature on the determinants of state capacity. This literature focuses on one dimension of state capacity: fiscal capacity, defined as the ability to raise taxes (Besley and Persson, 2009; Bourguignon and Verdier, 2009; Cárdenas and Tuzemen, 2011). A notable exception is Besley and Persson (2010): they also consider a regulatory dimension of state capacity. They are *in fine* interested in accounting for property rights, but focus on a rather unorthodox definition of property rights enforcement: the regulatory capacity of the state is presented as the extent to which individuals can pledge their assets as collateral. In this paper, I consider property rights enforcement in a perspective which is more frequent in the literature (Jones, 1981; De Long and Shleifer, 1993; Acemoglu et al., 2001), that is as protection from state predation. In a way, state capacity is here studied as the state's ability to restrain itself.

More generally, this paper builds upon the relatively recent literature in the field of political economy of development, led by Daron Acemoglu and co-authors. It contributes to the growing body of studies which emphasize the role of institutions in the development process (Hall and Jones, 1999; Acemoglu and Robinson, 2002; Rodrik et al., 2004; Acemoglu et al., 2005), with a focus on institutions designed to protect property rights (Rodrik, 1999). As many papers, it assumes institutions are endogenous to development. For instance, Acemoglu and Robinson (2006b) focus on the economic determinants of regime change, in particular from elite control to democracy, Acemoglu and Robinson (2006a, 2008) offer models of institutional persistence and change and the linkage from political to economic institutions. Acemoglu et al. (2002b); Acemoglu and Johnson (2005) convincingly claim that previous population density and settler's mortality have durably influenced the property rights institutions in former

European colonies; Acemoglu et al. (2002a) go so far as using institutions to shed light on the idiosyncratic development narrative of one country, describing the customary legacy of independent Botswana as crucial in its stability and development.

The outline of the paper is as follows. In the next section I examine a simple productive framework where one individual sets the sharing rule which governs the distribution of the proceeds of a common endeavor; I also provide a normative assessment of his decisions. In section 3, I consider a political contest over the privilege of setting the sharing rule and I derive several predictions concerning the potential for conflict generated by some features of the production technology. In section 4, I introduce the possibility that the individual in power may renege on the promised sharing rule. Since this is anticipated by the other, he may find it profitable to invest in a costly commitment mechanism. In section 5, I consider the history of two outliers of cross-country growth regressions, to illustrate how they fit my story. All proofs are relegated to the appendix.

2   The economic model

The economy, restricted to its productive sector, is composed of two decision-makers A and B. They each control a different productive asset in quantities R_A and R_B. A and B may account for two individuals, in which case one's asset is his own labor, but the model extends to groups who have solved the collective action problem, individuals in a position to mobilize others' assets, as well as to other categories of productive assets, such as capital, skilled vs. unskilled labor etc. A and B are thus assumed to provide a simple description of the economic structure of society. They invest the assets they control in two alternative productive endeavors. One is specific to each individual, and is described by technologies f_A and f_B. The technology f of the other combines both assets. All produce a commensurate consumption good. Total production is therefore $Y = f_A(x_A) + f_B(x_B) + f(x_A, x_B)$, where $(x_A, x_B) \in [0, R_A] \times [0, R_B]$ is invested in the common productive endeavor. The specific productive technologies are used to transform $R_A - x_A$ and $R_B - x_B$ into consumer goods. The specific production functions offer an outside option from the common endeavor to both individuals. They are described by constant returns technologies: $\forall k \in \{A, B\}, f_k(x_k) = \gamma_k(R_k - x_k)$, γ_A and γ_B higher as the outside option is more enticing.

To study the effects of substitution or complementarity, the common productive endeavor is described by a CES function: $f(x_A, x_B) = \gamma \left(\sum_k \mu_k x_k^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$. μ_A and $\mu_B = 1 - \mu_A$ are technological parameters, which correspond to the exponents of the Cobb-Douglas function (when $\sigma \longrightarrow 1$ in the CES function). γ is an index of how profitable the common productive endeavor is, depending for instance on favorable trade conditions, or on the international prices of an extracted commodity. A hike in the price of diamonds will make diamond extraction even more profitable, and will be characterized here by a higher γ, as will an export quota on agricultural commodities or a currency depreciation. Finally $\sigma > 0$ is a substitution parameter[1] between the two factors in the common production technology. Low values of σ correspond to more complementary

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[1] It is the elasticity of substitution $\frac{d \ln(x_B/x_A)}{d \ln(\partial_A f/\partial_B f)}$.

assets; as σ grows, resources are more and more substitutable. For simplicity, I will thereafter only consider assets with an elasticity lower than 2, but the proofs cover the whole range $]0, \infty[$.

Two parameters recurrently arise in the computations. First, $\Gamma_i = (\frac{\gamma}{\gamma_i})^{\sigma-1} \mu_i^{\sigma}$ can be interpreted as the profitability of investing i's asset (implicitly: in the common endeavor) relative to using it for the specific production. For $\sigma > 1$, i's asset is said to be *profitably invested* in the common productive process rather than in i's specific alternative when Γ_i is high. For $\sigma < 1$, i's asset is profitably invested when Γ_i is low. The complementarity between the two assets ensures that investment of one makes the common endeavor more profitable to the other. Γ_i characterizes only the intrinsic profitability of investing i's asset, before taking into consideration investment of the other. Second, endowments are therefore usefully characterized by the parameter $\beta_i = \frac{\mu_i R_i^{\frac{\sigma-1}{\sigma}}}{\sum_k \mu_k R_k^{\frac{\sigma-1}{\sigma}}} \in [0, 1]$. The expressions of β_A and β_B display unintuitive behaviors when σ, $\frac{\mu_A}{\mu_B}$ and $\frac{R_A}{R_B}$ vary, yet those are not interesting in the perspective of our model. Taking the point of view of the production process overseer, a high β_i always means that i's asset is more abundant relative to j's asset.

2.1 Feasible investments

The proceeds of the common endeavor are shared between A and B, according to a sharing rule described by (α_A, α_B), with $\alpha_A + \alpha_B = 1$. The utility of individual i is given by $U_i(x_A, x_B, \alpha_i) = f_i(x_i) + \alpha_i f(x_A, x_B)$. The problem verifies the necessary concavity conditions, and utility maximization provides the expressions of the two individuals' best responses to each other's investment:

$$x_i^*(\alpha_i, x_j) = \min[R_i, \eta_i x_j] \text{ with } \eta_i = \left(\frac{\mu_j}{\mu_i} \frac{\Gamma_i \alpha_i^{\sigma-1}}{1 - \Gamma_i \alpha_i^{\sigma-1}} \right)^{\frac{\sigma}{\sigma-1}}. \quad (1)$$

For a given x_j, η_i increases with Γ_i and with α_i. It decreases with σ. $(0,0)$ is the unique and stable Nash equilibrium iff $\eta_A \eta_B < 1$. Conversely, there is a unique stable equilibrium, non-null, iff $\eta_A \eta_B > 1$. Considering η_A and η_B to be functions of α_A, the equation $\eta_A \eta_B = 1$ can be shown to have 0, 1 or 2 solutions in $[0, 1]$. When it has two solutions, I will refer to them as α_1 and α_2, with $\alpha_1 < \alpha_2$. When it has only one solution, I will refer to it as α_1 or α_2 by continuity. The motivated reader will find more details in the appendix.

Four situations[2] arise from this characterization (cf. Fig n°1), with one stable Nash equilibrium $(x_A^{**}(\alpha), x_B^{**}(\alpha))$ each. Upon choosing α, a social planner may face a choice between implementing several of these equilibria: for instance, a small α_A (and thus big α_B) may lead to full investment of B's asset but partial of A's, while a big α_A may produce the opposite outcome. A range of αs might all implement full investment of both assets. I define *feasibility* of a situation as existence of an α leading to investment decisions by both individuals generating that situation in equilibrium.

Proposition 1. *Feasibility of the various investment equilibria is usefully described by four ranges of parameters, as described in figure n° 2:*

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[2]plus the two situations arising from $\alpha_i \in \{0, 1\}$, which can be defined by continuation and have obvious investment consequences.
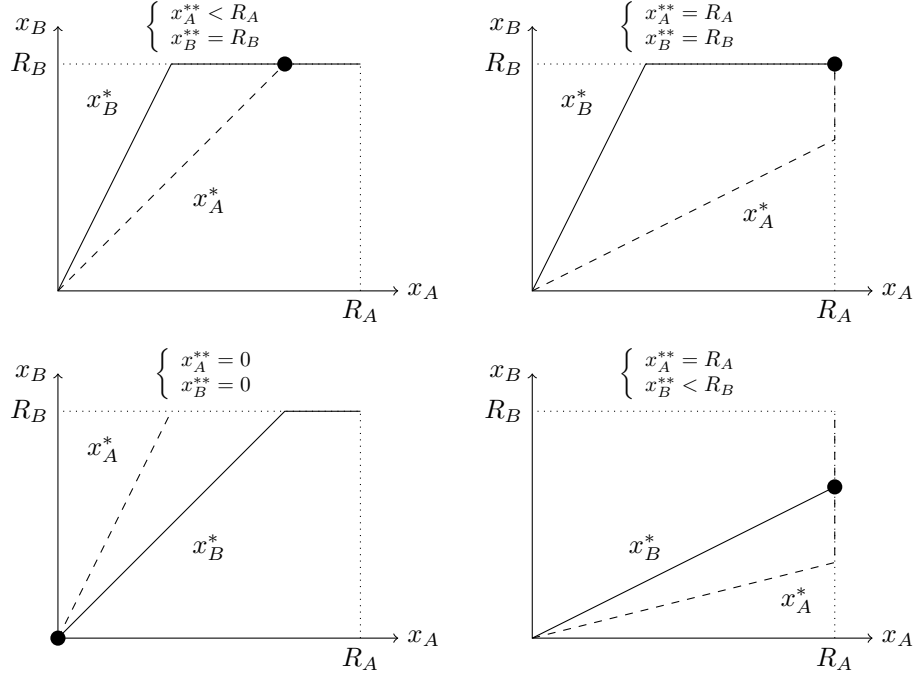
Figure 1: Four possible Nash equilibria resulting
from different values of the parameters.

- *in the range F_{AB} where both assets are profitably invested in the common
  endeavor, full investment of both assets $\begin{cases} x_A^{**} = R_A \\ x_B^{**} = R_B \end{cases}$ is feasible. In this
  range, full investment of either asset and partial investment of the other
  $\begin{cases} x_i^{**} = R_i \\ x_j^{**} < R_j \end{cases}$ is always feasible;*

- *in the range O_{AB} where neither asset is profitably invested, no sharing
  rule can lead to any investment in the common endeavor $\begin{cases} x_A^{**} = 0 \\ x_B^{**} = 0 \end{cases}$;*

- *the two previous cases define tangent ranges, and unambiguously define
  two complementary adjacent ranges P_A and P_B. Either B's asset is prof-
  itably invested and not A's (P_A) or the converse (P_B). In the correspond-
  ing range, only full investment of the former asset and partial of the latter
  is feasible ($\begin{cases} x_A^{**} < R_A \\ x_B^{**} = R_B \end{cases}$ and $\begin{cases} x_A^{**} = R_A \\ x_B^{**} < R_B \end{cases}$).*

Proposition n°1 characterizes the domain of implementation of each equilib-
rium. The first range F_{AB} can be characterized by the *full investment thresh-
old:* $\sum_k \frac{\beta_k}{\Gamma_k}^{\frac{1}{\sigma-1}} \leq 1$, and the second O_{AB} by the *no investment threshold:*
$\sum_k \Gamma_k^{\frac{1}{2-\sigma}} \geq 1$. The two thresholds are tangent for $\frac{\Gamma_j}{\Gamma_i} = \frac{\beta_i \sum_k \Gamma_k^{\frac{1}{2-\sigma}}}{\Gamma_j^{\frac{1}{\sigma-2}}}$.[3] This

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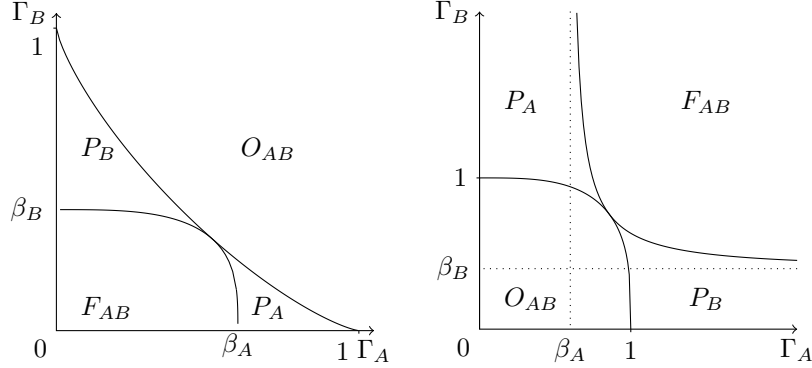[3]The case where $\sigma > 2$ gives rise to slightly more complex considerations. The following

Figure 2: Feasibility of the various investment situations (left: $\sigma < 1$, right: $\sigma \in]1, 2[$)

proposition provides interesting insights. Rather obviously, i's asset is more readily fully invested when i finds the common endeavor profitable (for $\sigma > 1$, Γ_i high enough, and the converse for $\sigma < 1$). Investment of one asset makes investment of the other more profitable. This positive spillover is higher if the two assets are more complementary. As a consequence, as complementarity increases, the share that each individual demands in order to fully invest decreases, and the range of parameters for which both assets are fully invested increases. Conversely, the more the two assets are substitutable, the higher the share one individual demands in order to fully invest.

2.2 Optimal sharing rule

Assume it is one of the two individuals' privilege – A's for instance – to set the sharing rule. He faces a trade-off between enticing B with a fair share of the common endeavor and keeping as much for himself as possible. Formally, his program can be written:

$$\max_{\alpha_A, \alpha_B, x_A} U_A(x_A, x_B, \alpha_A)$$

$$\text{s.t.} \begin{cases} \alpha_A \in [0, 1] \\ \alpha_B = 1 - \alpha_A \\ x_B = x_B^*(\alpha_B, x_A) \end{cases}$$

With the help of the previous proposition, A's program can be simplified to:

$$\max_{\alpha_A = 1 - \alpha_B \in [0,1]} V_A(\alpha) = f_A(x_A^{**}(\alpha)) + \alpha_A f(x_A^{**}(\alpha), x_B^{**}(\alpha)) \tag{2}$$

His indirect utility V_A is a nonconstant continuous function in $[0, 1]$, in which it therefore has a maximum U_A^A, with maximand $\alpha^A = (\alpha_A^A, \alpha_B^A)$. B's indirect utility, as resulting from α_A, is U_B^A.

results remain valid, and all cases are considered in the appendix: my purpose is to simplify the presentation of the results.

Proposition 2. *A's optimal sharing rule is usefully described by the four ranges of parameters of proposition n°1, as illustrated by figure n°2:*

- *in F_{AB}, A offers $\alpha_B = \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}$, which results in $\begin{cases} x_A^{**} = R_A \\ x_B^{**} = R_B \end{cases}$;*

- *in P_A, A offers $\alpha_B = 1 - \alpha_2$. He thus induces $\begin{cases} x_A^{**} < R_A \\ x_B^{**} = R_B \end{cases}$;*

- *in P_B, A offers $\alpha_B = 1 - \alpha_1$ for Γ_B over a threshold, and $\alpha_B < 1 - \alpha_1$ under it. He thus induces $\begin{cases} x_A^{**} = R_A \\ x_B^{**} < R_B \end{cases}$;*

- *in O_{AB}, A cannot induce any investment: $\begin{cases} x_A^{**} = 0 \\ x_B^{**} = 0 \end{cases}$.*

Proposition n°2 characterizes A's choice of sharing rule for any value of the parameters. When Γ_B is high enough, A finds it profitable to offer B with a sufficient share of the common endeavor so he invests his whole asset. Conditionally on inducing full investment from B, he maximizes his own share.

When B's asset is not profitably invested, setting a sharing rule only makes sense if A's asset is. Assuming it is, A always wishes to fully invest his own asset and sets the sharing rule accordingly. But he still wants to benefit from the positive externality of B's investment.[4] If the complementarity between their assets is high enough ($\sigma \leq 1$), his best option is in fact to offer B the highest share possible, conditionally on still having the appropriate incentive to invest himself. The complementarity motive is stronger than the appropriation motive in that case. If the complementarity is intermediate ($\sigma \in]1, 2[$), he still generally offers B the highest share available, but if Γ_B is too low, and endowments are asymmetric enough, A may find maximizing B's share too costly at some point. Instead, he offers him an intermediate share.

A corollary to proposition n°2 is that investment of both assets, as a result of A's choice of sharing rule, is nonincreasing in σ and nondecreasing in γ.

2.3 Normative benchmarks

How does A's offer compare to a hypothetical social planner's program? A social planner with full control of asset allocation would simultaneously choose x_A and x_B to maximize Y. Formally, her program can be written:

$$\max_{x_A, x_B} Y(x_A, x_B)$$

$$\text{s.t.} \begin{cases} x_A \in [0, R_A] \\ x_B \in [0, R_B] \end{cases} \tag{3}$$

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[4]For higher values of σ ($\sigma > 2$), low Γ_B and asymmetric endowments, A may not wish to share the benefits of the common endeavor at all: the cost of motivating B is too high relative to its benefits. In that range, he sets his own share to 1; this discourages the other from investing at all. But since investing in the common technology (even though he is alone) is more beneficial than investing in his own specific production opportunity, he invests all his own asset. He is less willing to sacrifice a share of the production as substitutability increases or as the other asset becomes scarcer, since the additional benefit anticipated from its investment decreases. In that case, the appropriation motive is stronger than the complementarity motive.

Proposition 3. *"First-best efficient" asset allocation*
   The social planner's investment decision can be characterized by four ranges of parameters, as illustrated by figure n° 3:

- *she invests nothing ($x_A = x_B = 0$) if the two assets are jointly not profitably invested (range O_{AB}^s);*

- *she invests fully both assets ($x_A = R_A, x_B = R_B$) if they both are sufficiently profitably invested (range F_{AB}^s);*

- *otherwise, one asset i is profitably invested (range P_j^s). She invests this asset fully ($x_i = R_i$), and the other partially ($x_j = \left(\frac{\mu_i}{\mu_j} \frac{\Gamma_j}{1-\Gamma_j} \right)^{\frac{\sigma}{\sigma-1}} R_i$).*

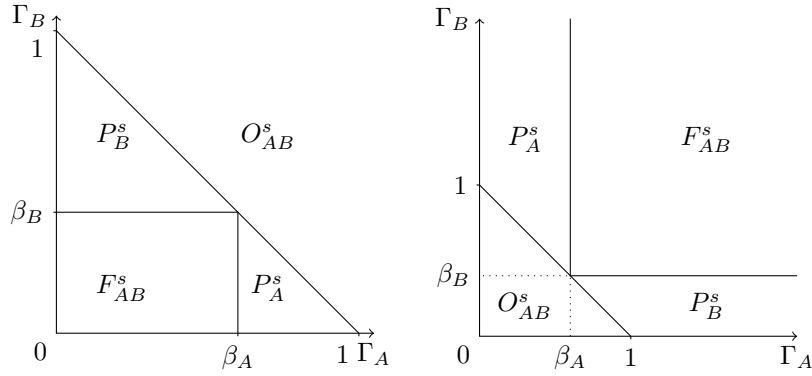Figure 3: First-best efficient asset allocation (left: $\sigma < 1$, right: $\sigma > 1$).

   Proposition n°3 characterizes the Y-maximizing program of a unique individual in control of both assets (the social planner). This individual's investment decisions replicate A's investment program (as described by proposition n°2) when and only when $\sigma = 1$, and actually, for any σ, the ranges F_{AB}^s, O_{AB}^s, P_A^s and P_B^s correspond respectively to the ranges F_{AB}, O_{AB}, P_A and P_B at $\sigma = 1$. The no-investment threshold is described by the equation $\sum_k \Gamma_k = 1$; and the full-investment threshold by $\min_k \frac{\Gamma_k}{\beta_k} = 1$.
   Except when $\sigma = 1$, decentralized investment decisions are inefficient (in terms of production maximization) for several ranges of parameters. There are two separate factors which generate this inefficiency: first, as there are no transfers here, the Coase theorem does not apply, and A's interest may sometimes not coincide with production maximizing. Second, even in the perspective of production maximization, when investment decisions are decentralized, each agent does not value the positive spillovers his investment generates on the other's. To study the latter factor, let me examine the (already simplified) program of a social planner who would control the sharing rule, and not directly asset allocation. He takes into consideration these spillovers, which the individual does not:

$$\max_{\alpha_A \in [0,1]} Y(x_A^{**}(\alpha), x_B^{**}(\alpha)) \tag{4}$$

Proposition 4. *"Second-best constrained" asset allocation*

The social planner's choice of sharing rule can be characterized by the previous four ranges of parameters, as illustrated by figure n° 2:

- *in F_{AB}, she sets $\alpha_A \in [\frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}}, 1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}]$ to induce full investment of both. She is indifferent between sharing rules in that range;*

- *in O_{AB}, setting the sharing rule is pointless ($x_A^{**} = x_B^{**} = 0$ anyway);*

- *in P_B, she sets $\alpha_A = \alpha_1$ and thus induces $\begin{cases} x_A^{**} = R_A \\ x_B^{**} < R_B \end{cases}$;*

- *in P_A, conversely, she sets $\alpha = \alpha_2$ and thus induces $\begin{cases} x_A^{**} < R_A \\ x_B^{**} = R_B \end{cases}$.*

Proposition n°4 characterizes the Y-maximizing program of a social planner hypothetically in charge of setting the sharing rule. Comparison with proposition n°3 illustrates how the introduction of property rights, in other words how decentralizing investment decisions, constrained the possible investment outcomes whenever $\sigma \neq 1$. It obviously captures most of the inefficiency previously discussed. For $\sigma \neq 1$, the social planner will only be able to reach the first-best investments for limited ranges of parameters (specifically, under the first-best no-investment threshold: $\begin{cases} x_A^{**} = 0 \\ x_B^{**} = 0 \end{cases}$), and over the second-best, or decentralized, full-investment threshold: $\begin{cases} x_A^{**} = R_A \\ x_B^{**} = R_B \end{cases}$). Both too much and not enough complementarity between the two assets may be a source of inefficiency, and constrain the feasible investments.

As predicted, comparison with proposition n°2 illustrates that A's program entails one additional source of inefficiency relative to the program of a production-maximizing social planner: he is sometimes in a position to increase his utility (appropriation motive) at the cost of some overall production (complementarity motive). For $\sigma > 1$ and Γ_B low enough (B's asset is not so profitably invested), A would offer B a lower share than the social planner would.[5] B's investment is therefore suboptimal from the social planner's point of view.

Finally, when a range of αs generate the same investment strategies (in this instance, this occurs only for the full-investment case), while the social planner may be indifferent over redistributive issues, A obviously is not, and maximizes his own share. Redistribution is not considered by the social planner here.

3 The political model

3.1 The stakes of political power

For the reasons just outlined (asymmetric profitability of investing the assets, redistributive issues), A and B often do not set the same sharing rules. While for

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[5]In fact, for $\sigma > 2$ (little complementarity) and low Γ_B (high outside option for B), A would even keep the whole proceeds of the common endeavor for himself ($\alpha_A = 1$), thus effectively excluding B from the formal sector. Attracting B's investment (complementarity motive) would be too costly relative to the gains (appropriation motive).

a given state of the world A would set $\alpha^A = (\alpha_A^A, \alpha_B^A)$, B favors $\alpha^B = (\alpha_A^B, \alpha_B^B)$ and would set it if in power. The indirect utilities resulting from such sharing rules are $U_A^A = V_A(\alpha^A)$ and $U_B^A = V_B(\alpha^A)$ on the one hand, $U_A^B = V_A(\alpha^B)$ and $U_B^B = V_B(\alpha^B)$ on the other. Let me define $v_A = U_A^A - U_A^B$ and $v_B = U_B^B - U_B^A$: since α^i maximizes V_i, v_i is necessarily nonnegative. These scalars fully capture the economic value for A and B associated with being in control of the sharing rule, the *stakes* of competition for political power.

Proposition 5. *Commodity price increase and the propensity for conflict:*
The stakes of political competition are higher when the profitability of the common endeavor increases. In other words, v_A and v_B are increasing in γ:

$$\forall k \in \{A, B\}, \frac{dv_k}{d\gamma} \geq 0.$$

The interpretation of proposition n°5 is straightforward. An increase in the world price of an exported commodity, a currency depreciation as well as any mechanism which increases the profitability γ of the common endeavor would increase the potential value of its production. Investment of both assets has been shown to be nondecreasing in γ: the value created through the common productive endeavor increases through both channels. Meanwhile, the share each individual needs to offer the other to motivate his investment decreases with γ. Those effects combine themselves to increase the stakes of political competition.

Beyond this result, the model offers more insightful conclusions.

Proposition 6. *Complementarity and propensity for conflict:*
The stakes of political competition are higher for more substitutable assets. In other words, v_A and v_B are nondecreasing in σ:

$$\forall k \in \{A, B\}, \frac{dv_k}{d\sigma} \geq 0.$$

Proposition n°6 is key in addressing the question raised in this paper: why different activities, even if they are similarly efficient, can have vastly different political economic outcomes. Mineral extraction, in particular, is associated with high returns and low complementarity between individuals in a position to manage it. As a consequence, there is little incentive to redistribute widely its proceeds, which raises the stakes of controlling the extractive process. As already mentioned in the introduction, proposition n°6 is intuitive once the true nature of the complementary of substitutable assets has been grasped. If A is in power, he will find it more profitable to involve B in the common productive endeavor if their assets are complementary rather than substitutes, and as a consequence, he is likely to offer him a higher share of its proceeds. If B is in power, the reasoning is similar. As a consequence, when σ decreases, one expects the gap between the two alternative sharing rules to diminish, thus reducing the stakes of political power. For all the simplicity of the idea, the proof is rather tedious, as shown in the appendix. The following result comes as an easy corollary, though.

Proposition 7. *Comparative statics:*
The cross derivatives $\frac{d^2 v_A}{d\sigma d\gamma}$ and $\frac{d^2 v_B}{d\sigma d\gamma}$ are positive.

Proposition n°7 shows that while profitability and substitutability are both at the heart of the possible conflict between A and B, they tend to in fact reinforce one another as factors of discord. An activity with high profitability, but which is characterized by high complementarity between factors, does not have the same potential for conflict as an activity with both high profitability and high substitutability. Proposition n°5 suggested that any highly profitable activity might have the potential to lead to conflict. But highly profitable activities, for instance highly technology-intensive activities in developed countries, do not have the same outcomes as mineral extraction activities. Technology-intensive activities tend to associate many different branches of activity, individuals with complementary human capital, and to involve high sunk costs which would effectively translate into high complementarity in the model here. Proposition n°7 therefore provides a tentative explanation for the differences between profitable activities in terms of political outcomes.

Finally, the model is not so adequate to discuss the effect of inequalities on conflict. Resources do not reflect wealth in themselves, though an individual with a high γ_i and abundant R_i could be considered to have a high potential wealth if only thanks to his specific activity. But this model is intended to study the common activity, for which the relevant parameters to describe inequalities would be the profitability of investing Γ_i and the endowment parameter β_i. For the purpose of considering the role of endowment inequalities on the stakes of political competition. I hold Γ_A and Γ_B, as well as σ, constant, and to avoid having to consider more parameters, I restrict my attention to F_{AB}, the range of parameters where both assets are profitably invested. In that range, I also work holding constant $\gamma(\sum_k \mu_k R_k^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma}{\sigma-1}}$, the total value produced.

Proposition 8. *Endowment asymmetry and propensity for conflict:*

In F_{AB}, when assets are complementary, higher inequalities raise the stakes of political competition. In other words, $\alpha_A^A - \alpha_A^B = \alpha_B^B - \alpha_B^A$ increases with β_A when β_A is high enough, and decreases with β_A otherwise:

$$\text{if } \sigma < 2 \text{ and } \Gamma_A = \Gamma_B, (\beta_A - \beta_B)\frac{d(\alpha_A^A - \alpha_A^B)}{d\beta_A} > 0.$$

Proposition n°8 provides a picture whereby endowment asymmetry, the best available proxy to account for inequalities in the simplified framework I consider, raises the stakes of political competition. When $\Gamma_A = \Gamma_B$, increasing endowment inequalities strictly speaking imply higher stakes of political competition. In other words, if β_A is over the threshold $\frac{1}{2}$ and increases, the stakes increase, and if $\beta_A < \frac{1}{2}$ decreases, the stakes increase. When $\Gamma_A \neq \Gamma_B$, the considerations become only slightly more complex. If A's outside option is more enticing than B's ($\Gamma_A < \Gamma_B$), the threshold is lower: for β_A sufficiently high, even for values below $\frac{1}{2}$, an increasing β_A implies increasing stakes. Conversely, if A's outside option is less enticing, the threshold is higher than $\frac{1}{2}$.

3.2 Political competition

So far, the model does not include a mechanism to select who gets to decide. Political competition is here modeled as a contest game. Each contestant k provides an outlay b_k in order to win a prize. The prize is here the utility gain he would derive from setting the sharing rule, rather than the other setting it.

The probability of him winning increases with his own outlay and decreases with the other's. Outlays are sunk costs, which can be considered as pledges on the future proceeds of the common productive endeavor on financial markets (which are not explicitly modeled).[6]

An extensive literature has identified numerous contest success functions (the technology that translates the individual efforts into probabilities of winning the contest). The most common are the perfect discrimination (the highest outlay wins) and the Tullock contest: player i provides an outlay b_i with probability of winning $\frac{b_i^r}{b_A^r + b_B^r}$. Parameter $r > 0$ characterizes the contest technology, with increasing returns (high r) or decreasing returns (low r). Both settings offer the same insight: Tullock (1980); Hillman and Riley (1989) have previously shown that equilibrium outlays (b_A^*, b_B^*) increase with the value of the prize, indeed that individual outlays increase as each individual values the prize more.[7] Thanks to Props. n°5 to 8, we immediately obtain that:

Proposition 9. *Actual conflict:*

The intensity of the conflict for political power increases with the profitability of the common endeavor, decreases with the complementarity of the assets and increases with inequalities. In other words, b_A and b_B are increasing in γ, nondecreasing in σ, increasing in β_A when β_A is high enough and in $\beta_B = 1 - \beta_A$ when β_B is high enough:

$$
\begin{cases}
\forall k \in \{A, B\}, \frac{db_k^*}{d\gamma} > 0 \\
\forall k \in \{A, B\}, \frac{db_k^*}{d\sigma} \geq 0 \\
\forall k \in \{A, B\}, \ if \ \Gamma_A = \Gamma_B, (\beta_A - \beta_B) \frac{db_k^*}{d\beta_A} \geq 0.
\end{cases}
$$

Additionally, the cross derivatives $\frac{d^2 b_A^*}{d\sigma d\gamma}$ and $\frac{d^2 b_B^*}{d\sigma d\gamma}$ are positive.

Proposition n°9 summarizes the effect of several factors of the model on conflict, and provides many testable assumptions. Even though the gains from setting the sharing rule, v_A and v_B, cannot formally be labeled as a political rent, they have the same characteristics: they are benefits from being in power which are not linked to any activity beneficial to the economy as a whole. On the contrary, they are sometimes extracted at the cost of reaching a suboptimal level of production. It is therefore useful to think of them as a rent derived from political power. Another way to formulate proposition n°9, therefore, is that higher profitability, substitutability and inequality results into more rent dissipation.

Proposition n°9 first concludes that the intensity of the conflict for political power (measured here as the amount of resources spent in the political process) increases with an exported commodity price increase. Dal Bó and Dal Bó

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[6]This assumption is essential to understand why the model fails to account for the resource curse. Conflict involves no destruction of productive assets here. If I had assumed the outlay came at a cost in terms of assets, rather than of the final good, indeed the model would also have accounted for the resource curse. There would have been little interest in doing that, however, as this mechanism has been underscored elsewhere (such as Dal Bó and Dal Bó, 2011). Furthermore, under such an assumption, the equilibrium investments and outlays could only be given implicit expressions, involving very heavy computations and little insight.

[7]They provide explicit expressions of the outlays. Those depend on the contest technology, on the asymmetry between the stakes for each player. Moreover, given the asymmetry and the technology, outlays are proportional to one's stake in the contest.

(2011) derive a similar result from their different framework. An increase in the price of the capital intensive good (which corresponds in the framework under consideration to the common endeavor) results in higher conflict, as formalized in their proposition n°9. Our mechanisms are different, but should be thought as complementary rather than competing explanations. Indeed theirs crucially depends on the diversion of labor from the productive sector; mine focuses only on the negotiating position of the individual in power, increased when the profitability of the common endeavor increases.

Similarly, conflictuality decreases with the complementarity of assets: a technological change involving new complementarity between actors would lower the stakes of political competition and thus limit the potential of a destructive conflict. Since profitability and substitutability tend to reinforce one another as causes of conflict, this model thus offers a tentative explanation of why different productive technologies tend to have widely differing outcomes in terms of civil conflicts. In two countries with different profitable common endeavors, the endeavor involving the highest level of complementarity is less likely to generate violent or intense conflict than the other one.

Finally, while remaining cautious in its interpretation, I also show that endowment inequalities increase the intensity of the fight for political control, for given levels of aggregate production and of each individual's interest in investment.

It is interesting to consider the effect of the contest technology on the intensity of conflict. At the end of the game A and B derive together a utility which is total production minus the pledges made on this production and spent as outlays. If we assume a Tullock contest characterized by parameter r, in the range F_{AB}, the expression of the resulting aggregate utility is $Y\left(1 - \frac{r}{2}(\alpha_A^A - \alpha_A^B)\right)$, as first derived in Hillman and Riley (1989). This expression is easily shown to be affine and nondecreasing in γ. For $r < 2$, it is in fact increasing in γ. No commodity price increase leaves the individuals worse off in this model, even though it does not necessarily makes them better off either (for $r \geq 2$). This model can therefore not be thought to account for the resource curse. To account for the resource curse, the productive assets would have to be adversely impacted by the conflict over political power, for instance if the individuals could not pledge future wealth to provide outlays, but instead faced a trade-off in using their asset to fight or to produce. However, this assumption would make the whole model intractable, and the mechanism has now been known for over half a century (to my knowledge, the appropriation vs. production trade-off dates back to Haavelmo, 1954). However, the mechanism outlined here shows that even without destruction of productive assets, and no trade-off between fighting and producing, the additional profits derived from a profitable common endeavor or a price shock can be wasted in their totality in the competition over political power. It is easy to see how this trade-off would only reinforce the mechanism under scrutiny here.

4 Property rights institutions

I have so far assumed that once set, any sharing rule is enforced with certainty. The individual in power never reneged on his offer once production had taken place. In other words, I have implicitly assumed perfect protection from the

predation of the state. This makes especially sense when involvement in the production process is renegotiable anytime, as between several groups of workers or competing firms. Some assets, however, do not display such flexibility. Physical capital, once invested, can be easily grabbed. There is indeed a growing consensus among economists, that expropriation by the government or powerful elites is a decisive hindrance to development. Checks against state predation – in other words, institutions of property rights protection – have indeed been shown to be good predictors of long run economic development (Acemoglu et al., 2001, 2002b; Acemoglu and Johnson, 2005). While the previous section examined the political features of a simple productive framework, this one relaxes the assumption of perfect property rights or, equivalently, of effective enforcement of the sharing rule. These two sections are independent. From now on, one individual is assumed to be in power; how he reached that position is of no consequence. In particular, I do not consider how the prospect of having to invest in property rights institutions may affect the stakes of winning the contest game introduced in the previous section.

If there is no property rights protection, assuming A is in power, he cannot be counted upon to meet his commitment once production has taken place. B expects that whatever sharing rule A offers he will in fact get nothing. Without credible enforcement of the sharing rule, there can therefore be no common production.

If property rights protection is imperfectly enforced, B now expects A to renege on the initial offer with probability p. In this case, he gets only his own specific production. With probability $1-p$, though, the sharing rule is effectively enforced. This situation corresponds for instance to an uncertain judicial or political environment: A may be able to corrupt the judge or the politician (but he cannot count upon successfully doing so), or maybe the enforcement scheme is itself found lacking. Such a scheme can also rely on an exterior third actor, such as in the case of conditional development aid: in that case reneging on the contract may provoke the interruption of financial disbursements and thus entail immediately adverse consequences in terms of A's utility. Anyway, a high p means poor property rights enforcement, and a low p good property rights. If A offers the sharing rule $\alpha^{Ar} = (\alpha_A^{Ar}, \alpha_B^{Ar})$ (r standing for 'reneging'), B gets an expected share of $(1-p)\alpha_B^{Ar}$, and A $(1-p)\alpha_A^{Ar} + p$.

Writing $V(\alpha) = f_A(x_A^{**}(\alpha)) + \alpha_A f(x_A^{**}(\alpha), x_B^{**}(\alpha))$ the indirect utility derived by A from offering sharing rule α under perfect property rights protection, A would set α^{Ar} such that it maximizes $V_A((1-p)\alpha + p)$. Let me write α^A the sharing rule he would have implemented under perfect property rights protection (as derived from proposition n°2). Whenever possible, he would set $\alpha^{Ar} = (\frac{\alpha_A^A - p}{1-p}, \frac{\alpha_B^A}{1-p})$. With no constraint on the sharing rules, partial property rights protection entails uncertainty on the utilities of the players, but A can still fully compensate B. He expectedly reaches the same outcome as with perfect property rights protection: $V_A^r(p) = V_A(\alpha_A^A)$ (constant in p).

Suppose $\alpha_A^A \geq p$, then A can offer B $\alpha_B^{Ar} \in]0, 1]$: he is able to fully compensate him for his own inability to commit.[8] Now suppose $\alpha_A^A < p$, A cannot offer $\alpha_B^{Ar} > 1$. He can possibly offer $\alpha_B^{Ar} = 1$: he retains ownership of the common endeavor if he successfully reneges, with probability p, and relinquishes

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[8]Agents are risk neutral; risk-averse agents would request a risk premium as a compensation for the insecurity of the sharing rule, which would only reinforce the mechanism under scrutiny.

everything if he does not, with probability $1 - p$. Possibly if p is high enough the resulting investment leaves A worse off than if he retained the full common production, even at the cost of B's participation. Let me define $\bar{p}$ the threshold above which $V_A^r(p) \leq V_A^r(\alpha_A^{Ar} = 0) = V_A(\alpha_A^A = 0)$. Notice that $\bar{p}$ is possibly 1.

V_A^r, considered as a function of p, is nonincreasing, constant equal to $V_A(\alpha_A^A)$ for $p \leq \alpha_A^A$, constant equal to $V_A(1)$ for $p \geq \bar{p}$, and decreasing in between. It is continuous everywhere. As expected, a higher p has therefore an increasingly adverse impact on A's utility. Figure n°4 illustrates the sharing rule resulting from A's inability to commit, and the utility he derives from it. The set of the Nash investment equilibria feasible for a given set of parameters is a subset of those which were previously derived with perfect property rights protection; some equilibria, however, may not be feasible any more.
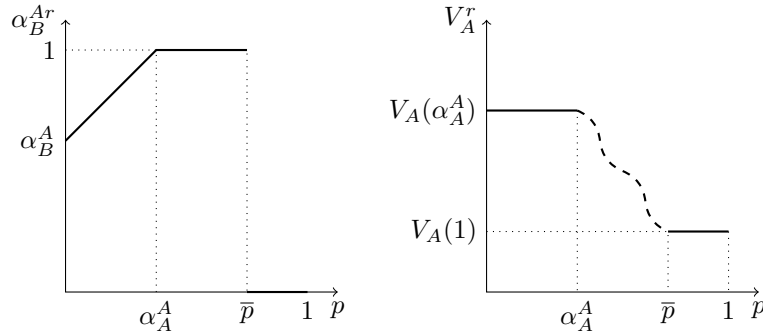

Figure 4: A's optimal offer with imperfect commitment (left) and his resulting utility (right), as functions of p.

The utility derived by B from A being in power but constrained by p also is nondecreasing in p. The following result is not so much a result as a property of the model, which still deserves a mention for its role in the economic literature. Mehlum et al. (2006) asserted that the quality of institutions is decisive in taking advantage of a mineral resources for growth.

Proposition 10. *Property rights institutions and growth*

The aggregate utility of both individuals increase with the quality of institutions. In other words $V_A^r + V_B^r$ is nonincreasing when p increases:

$$\frac{d(V_A^r + V_B^r)}{dp} \leq 0.$$

Proposition n°10 states that the model is consistent with Mehlum et al. (2006)'s finding that good property rights institutions (in their typology, producer friendly institutions, as opposed to grabber friendly institutions) increase the aggregate utility in the country. In a dynamic model, this would mean a higher level of growth. This property is straightforward, but it is in fact key in understanding what may be the motives for a political leader to invest in property rights institutions.

I have until now considered institutions as exogenous. Let me now consider the incentives to invest or possibly disinvest in such institutions. Assume that

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it is possible to invest in the commitment capacity of the state. Formally, the state commits to restrain itself from predation. To increase the credibility of the professed sharing rule, A reduces the likelihood of himself reneging by investing in an external commitment mechanism. To reach a level p, he pays a cost $C(p)$, nondecreasing: a higher commitment involves higher costs. This typically may correspond to the cost of an independent judicial system. One could also thing of conditionalities attached to development aid, which associates a cost with a breach of property rights, even though such a scheme would be best accounted for by a liability contingent upon reneging. It is unlikely, however, that the results would substantially differ even in that instance. Formally, his full program can thus be written:

$$\max_{\alpha_A^r, \alpha_B^r, x_A, p} U_A(x_A, x_B, \alpha_A^r) - C(p)$$

$$s.t. \begin{cases} \alpha_A^r \in [0,1] \\ \alpha_B^r = 1 - \alpha_A^r \\ x_B = x_B^* \left((1-p)\alpha_B^r, x_A\right) \end{cases} \tag{5}$$

The model, however, rests on the assumption that the specific productions of each individual cannot be taxed or otherwise captured. In other words, the liability of A and B is limited to their participation in the common endeavor. No sharing rule outside $[0,1]$ can be offered credibly. Previous computations remain valid, and A's final valuation can be written $W_A(p) = V_A^r(p) - C(p)$. A's program can thus be simplified into:

$$\max_{p \in [0,1]} W_A(p) \tag{6}$$

W_A is increasing in p over $[0, \alpha_A^A]$ and over $[\bar{p}, 1]$. Since I have made so little assumptions about $C(p)$, W_A is not necessarily monotonic in between. Once in power, A sets $p_A^* \in [\alpha_A^A, \bar{p}] \cup \{1\}$ as the maximand of W_i. It is possible that he has no incentive to invest in such a scheme (resulting in $p_A^* = 1$); but it is not hard to see that any choice outside that set would be dominated by another within it. p_A^* can be interpreted as the optimal static level of property rights protection from A's point of view, once the cost of investing in the commitment mechanism is taken into account. The following results focus on this optimal level of property rights protection:

Proposition 11. *Commodity price increase, complementarity and contract-enforcing institutions*
The political leader's investment in property rights institutions increases with both the complementarity of assets and the profitability of the common endeavor. In other words p_A^* and p_B^* are nondecreasing in σ and γ. Whenever the derivatives exist:

$$\forall k \in \{A, B\}, \frac{dp_k^*}{d\sigma} \geq 0$$
$$\forall k \in \{A, B\}, \frac{dp_k^*}{d\gamma} \geq 0.$$

Proposition n°11 offers two essential conclusions. First, an individual in power has a higher incentive to commit to upholding his sharing rule offer (lower p_A^*) for more complementary assets (lower σ). He expects to profit from the additional investment it would induce from the other, thus making him

more willing to invest in a costly p-reducing scheme. Different activities, characterized by the level of complementarity they entail, lead to different outcomes in terms of property rights institutions. Property rights institutions have been shown empirically to display a lot of inertia, a puzzle in the economic literature. This mechanism uncovers what is likely to contribute to that story: countries endowed with mineral wealth have remained characterized by high substitutability between assets over decades and even centuries, despite technological progress in the extraction process. The persistence of institutions is usually interpreted as reflecting cultural traits as exemplified by the settler mortality story (Acemoglu and Johnson, 2005). A competing explanation, however, is that the incentives to develop property rights institutions remained constant as a result of a largely unchanged economic structure of the society.

Second, a positive profitability shock may reduce the incentive of the individual in power to commit to upholding his sharing rule offer. The more profitable the common activity is, the less likely the emergence of good property rights. Examples of successful businesses taken over by relatives of the ruling elites abound in developing countries. Yet the story does not end there. Though this paper does not claim to provide systematic empirical proof of proposition n°11, there is anecdotal evidence of the story even in countries apparently unconcerned by property rights issues. Consider the Oil Taxation Act, introduced in 1975 in the UK in the wake of the 1973 oil crisis: taxes on profits derived from hydrocarbon extraction, which can be thought as taxes extracted on oil companies for the benefit of the wider population, rose when international oil prices rose. The rate of taxation on the profits of oil companies subsequently followed oil prices. The Petroleum Revenue Tax was abolished in 1993, when they reached their minimum in a decade; but the profits on oil were subjected in 2002 to a supplementary corporation tax charge. Initially of 10%, this supplementary tax increased as prices increased, until they reached 32% in 2011. These stylized facts all show how the state (for which the individual in power accounts) has a tendency to increase rent-extracting as an activity becomes more profitable, and on the contrary to reduce it as it becomes less so.

Notice that the mechanisms which are highlighted here are not only very intuitive, they are also static. Previous works have highlighted other possible motives to invest or disinvest in institutional quality (Bourguignon and Verdier, 2009, 2010; Besley and Persson, 2010) in a dynamic context. It is interesting, however, that a static framework is already sufficient to provide some important insights into these motives.

5   Country case studies

The previous theoretical results offer new insights into the stylized facts mentioned in the introduction: mineral resources tend to be associated with more conflict (identified as one of the major factors to account for the resource curse) and with less state capacity. A secondary puzzle of Barro (1991)'s cross-country growth regressions is the astonishing development of some countries, such as Botswana and Mauritius which, based on their demographical and geographical characteristics, on their resource endowments, and on average development outcomes in comparable countries, should have remained poor and marred by civil conflicts. Not only did they achieve very high and sustained levels of growth

since their independence, but all indicators of governance, competitiveness, and democracy position them in the top spots in Africa. To the day, there has been very few successful attempts to explain the peculiarity of these success-stories (Silve, 2012, provides a review of the literature on both countries, and offers a more detailed assessment of their success); the theoretical results of this paper shed some light on some factors that underline their seemingly odd development trajectories. Even though, they still give rise to puzzling considerations which pave the way for further research.

5.1 Mauritius

Mauritius is a densely populated, fertile island in the Indian Ocean, with no known mineral resources. At independence, in 1968, its economy was among the poorest of the world, with a central role of sugar cultivation, which represented as much as 20% of its GDP and 60% of export receipts. Commissioned by the government of Mauritius to study the development prospects of the country, Meade (1961) pointed that ethnic heterogeneity would prove the most important obstacle to growth. Indeed, even though recent studies have nuanced this view, ethnic heterogeneity usually acts as an impediment to growth (Alesina and La Ferrara, 2005).

Sugar cultivation and textile production were the two very profitable sectors instrumental in initiating forty years of very dynamic growth in Mauritius. These productive sectors / common endeavors were unskilled labor-intensive. They also displayed both a moderately high profitability and a high complementarity between different groups of workers. Proposition n°6 predicts that conflict should be limited in Mauritius, and indeed its economy managed to grow fast for a long time and to avoid the social conflicts that some believed would be inevitable in such an ethnically diverse polity. Other countries with similar endowments are not particularly prone to conflicts either; Mauritius managed to grow faster than them, though, thanks to the exceptionally favorable terms it was granted in the sugar sector by the Lomé convention, and in the textile sector by the Multi Fibre Agreement. Proposition n°5 would predict that such favorable terms might actually have created the potential for a conflict over the appropriation of the rents, but it seems that the complementarity between workers hindered that effect. It is possible to argue that this illustrates proposition n°7, as it predicts that conflicts should arise especially as a consequence of a common endeavor displaying both high profitability and high substitutability between workers. Neither sugar cultivation nor the textile industry generated these levels of substitutability. Actually, the following steps of the Mauritian development are well-known: tourism, export-processing zone, offshore business and finally an outsourcing industry were all characterized by a high complementarity between workers. In this context, ethnic diversity had no reason to be a hindrance to political stability and economic prosperity. Proposition n°6 predicts the political conflict entails low stakes, proposition n°9 that the conflict was unlikely to become violent, and proposition n°11 that complementarity would be an incentive to invest in the regulatory capacity of the state. How do those predictions compare to the facts?

First, growth in Mauritius has remained very inclusive over the years, and as a result inequalities are low from an international perspective. Second, according to the Economic Intelligence Unit, a London-based company within The

Economist Group which publishes an index of democracy around the world, Mauritius is ranked first in Africa for the quality of its democratic process, on par with most OECD countries. Power has already been peacefully transferred several times between competing political parties since independence, a unique achievement among countries in Africa and in the Indian Ocean. Third, prominent indicators of institutional quality (Doing Business and World Governance Indicators of the World Bank, Global Competitiveness indicator of the World Economic Forum and the Ibrahim index of governance) all position Mauritius within the first three spots in Africa. Overall, Mauritius took advantage of a productive process made artificially profitable by the trade policies of the European Union and of the United States, which made available assets complementary one to another. This created good conditions for a peaceful development and good regulatory institutions.

5.2 Botswana

Botswana is a landlocked country in Southern Africa, largely covered by the Kalahari desert, with abundant diamond resources discovered after independence (in 1966). Diamonds in Botswana were found in kimberlite pipes (Orapa, Jwaneng, Letlhakane, Damtchaa), very early shown to be among the most important in the world. Point-source resources are often quoted as the surest predictor of the resource curse; even relative to its neighbors with alluvial diamonds, such as the Democratic Republic of Congo, all factors pointed toward violent conflict. Yet Botswana has been able to successfully transform its huge diamond wealth into a stable democracy and an impressive growth record over the past forty years, a unique achievement among diamond-rich countries (Harvey and Lewis, 1990; Tsie, 1995).

That is not to say that there was no potential for conflict in Botswana. Indeed diamonds did raise the stakes of political competition, as proposition n°5, 6 and 7 predict. Inequalities there are among the highest in the world, and the ethnic minority remains extremely poor to the day[9] (the population of Botswana is small and relatively homogeneous: 79% describe themselves as belonging to the Tswana ethnic group). Moreover, democracy in Botswana, even though never caught out, is often described as "flawed", as it has never been tested by a majority change. Why outright conflict did not erupt in Botswana, as proposition n°9 predicts, remains however apparently paradoxical at this stage.

What differentiated Botswana from its neighbors stems from the economic structure of the society at the time of independence. Seretse Khama had been the heir to the customary chiefship, wealthiest and most powerful among the leading class of cattle-owners in Bechuanaland; he had renounced his customary rights in order to negotiate Botswana's independence from the British colonial power, and he had been elected with an overwhelming majority president of the newly independent Botswana. Finally, the lands where diamonds had been discovered were under his authority, yet he had nationalized them.[10] In no other

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[9]Income inequalities are the only measurable inequalities. But inequalities in Botswana would need to be nuanced to take into account non-income redistribution, for instance through a reputable health care system.

[10]Khama's legitimacy was further reinforced by several factors which are best described in Acemoglu et al. (2002a).

country were so much evidence gathered to support the rights of one group to manage the extraction of one resource and indeed, the political party he had formed remains in power to this day in Botswana. One essential assumption of proposition n°9 is that the two individuals who compete in the political arena are also those in a position to mobilize resources (or to solve the collective action problem). This assumption is not very far-fetched, as political competition is here modeled as having only economic stakes; but it is far-reaching. In newly independent Botswana, as in Norway or the US when they discovered oil, there was virtually no economic or political actor in a position to dispute the legitimacy of the state, neither internal nor external. This is quite obvious in the case of more advanced nations, and the evidence gathered shows that it was also the case in Botswana. Conflict remained exclusively democratic in Botswana, and never became violent, thanks to the absence of any contender in a position to mobilize resources for conflict. This was not the case in neighboring DRC. In that country and in others, where a contender could arise, the result was systematically violent civil conflict.

6 Conclusion

Mineral extraction is indeed, in this paper's perspective, a common productive endeavor characterized by high substitutability and, in times of high market prices, high profitability. I have provided a mechanism whereby abundant mineral resources tend to be associated with more frequent and more violent conflicts, as well as a new intuition for why mineral-rich countries did not develop good property rights institutions and, more generally, regulatory state capacity. Political competition is essentially motivated by the gain of sharing the proceeds of the common production according to one's own interests, a gain which is lower when the productive assets are more complementary. Since conflicts are costly, mineral wealth may be hard to take advantage of, and this mechanism goes so far as explaining why additional wealth created as the result of an exported commodity price increase may be wasted entirely. Going one step further, if the conflict is destructive or if, as is likely, there is a trade-off between fighting and producing, the resource curse appears immediately: a price increase might indeed result in a reduced social welfare for certain contest technologies. A decreasing-returns contest technology is unlikely to produce that result, thus explaining why countries with democratic institutions may be better at taking advantage of a mineral resource, while an increasing-returns technology such as civil warfare might lead to total waste of the resource.

The mechanism extends to encompass any kind of formal activity, which it characterizes by the level of complementarity it implies between available productive resources. The history of Mauritius illustrated how labor-intensive activities, with high complementarity within initially abundant unskilled labor, promote inclusive growth, a peaceful democratic process and good property rights institutions. On the contrary, diamond extraction in Botswana did raise the stakes of political competition, which did not develop into civil conflict thanks to a very centralized polity. One implicit assumption, that of the economic structure of society, has been key throughout that paper, and should be further explored: individuals who compete in the political arena are also those in a position to mobilize resources. It differentiates diamond-rich Botswana

from countries with similar endowments, and it explains why, even though ethnic division had been thought to be a very likely source of conflict and a major impediment to growth in Mauritius, a peaceful polity naturally arose.

7   Acknowledgments

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Appendix

A   Feasible investments (proof of Prop. n°1)

If there exists an α such that $\eta_A \eta_B \geq 1$, then investment in the common endeavor by both asset holders is feasible (use Fig. n°1 for an illustration). Let me define the function $g(\alpha_A) = \sum_k \Gamma_k \alpha_k^{\sigma-1}$: when $\sigma > 1$ (resp. $\sigma < 1$), I have $\eta_A \eta_B \geq 1 \iff g(\alpha_A) \geq 1$ (resp. $\leq$). For $\sigma \neq 2$, the interior extremum of g is $\left(\sum_k \Gamma_k^{\frac{1}{2-\sigma}} \right)^{2-\sigma}$, reached for $\alpha_A = \dfrac{\Gamma_B^{\frac{1}{\sigma-2}}}{\sum_k \Gamma_k^{\frac{1}{2-\sigma}}}$. For $\sigma = 2$, g is a straight line and has no interior extremum.

$\forall k \in \{A, B\}, x_k = R_k$ is attained for α such that $\frac{1}{\eta_A} \leq \frac{R_B}{R_A} \leq \eta_B$. There exists such an α iff $\sum_k \frac{\beta_k}{\Gamma_k}^{\frac{1}{\sigma-1}} \leq 1$.

$\begin{cases} x_i < R_i \\ x_j = R_j \end{cases}$ is reached for α such that both $\eta_A \eta_B \geq 1$ (some production is feasible) and $\eta_i < \frac{R_i}{R_j}$ (production would involve partial investment of i's asset):

- the first condition defines the empty set when $\sigma < 1$ iff $\sum_k \Gamma_k^{\frac{1}{\sigma-2}} > 1$, when $\sigma \in \{1, 2\}$ iff $\sum_k \Gamma_k^{\frac{1}{\sigma-2}} < 1$, and when $\sigma > 2$ iff $\forall k, \Gamma_k < 1$. If it does not, it defines a range with bounds $[\alpha_1, \alpha_2]$. $\alpha_{1/2}$ are the (ordered) solutions to equation $g(\alpha) = 1$ when they exist, and respectively 0 and 1 when the corresponding solution does not;

- the second condition defines the range $\left[0, \max[\frac{\beta_k}{\Gamma_k}^{\frac{1}{\sigma-1}}, 1] \right]$.

The latter conditions fully characterize feasible investments and are therefore sufficient to prove Prop. n°1.

B A's program (proof of Prop. n°2)

Let me first compute the utility derived by A for any given sharing rule $\alpha = (\alpha_A, \alpha_B)$ in the various resulting equilibria.

When the sharing rule induces no investment, the resulting utilities are:

$$\left. \begin{matrix} x_A^{**} = 0 \\ x_B^{**} = 0 \end{matrix} \right\} \longleftrightarrow \forall k, V_k = \gamma_k R_k. \tag{B.1}$$

When the sharing rule induces full investment, A's resulting utility is:

$$V_A(\alpha) = \alpha_A \gamma \left(\sum_k \mu_k R_k^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

where V_A grows with α_A. The binding constraint for A while in that situation is therefore the threshold between B fully and partially investing his asset, in which case:

$$\left.\begin{array}{l} \alpha_A = 1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}} \\ x_A^{**} = R_A \\ x_B^{**} = R_B \end{array}\right\} \longleftrightarrow \left\{\begin{array}{l} V_A = \gamma \left(\sum_k \mu_k R_k^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} - \frac{\gamma_B R_B}{\beta_B} \\ V_B = \frac{\gamma_B R_B}{\beta_B}. \end{array}\right. \qquad (B.2)$$

When the sharing rule induces $\left\{\begin{array}{l} x_A^{**} = \eta_A R_B < R_A \\ x_B^{**} = R_B \end{array}\right.$, A's utility is:

$$V_A(\alpha) = \gamma_A R_A + \gamma_B R_B \Gamma_B^{\frac{1}{\sigma-1}} \frac{\alpha_A}{(1 - \Gamma_A \alpha_A^{\sigma-1})^{\frac{1}{\sigma-1}}}.$$

which grows with α_A. If $\left\{\begin{array}{l} x_A^{**} = R_A \\ x_B^{**} = R_B \end{array}\right.$ is feasible, A always favors it; otherwise, his binding constraint is $\eta_A \eta_B \geq 1$: when $\sigma < 2$ he sets $\alpha = (\alpha_2, 1 - \alpha_2)$; when $\sigma > 2$, he set $\alpha = (\alpha_1, 1 - \alpha_1)$. Using the properties of $\alpha_{1/2}$, the utilities derived can be written:

$$\left.\begin{array}{l} \alpha_A = \alpha_{1/2} \\ x_A^{**} < R_A \\ x_B^{**} = R_B \end{array}\right\} \longleftrightarrow \left\{\begin{array}{l} V_A = \gamma_A R_A + \gamma_B R_B \frac{\alpha_{1/2}}{1-\alpha_{1/2}} \\ V_B = \frac{\gamma_B R_B}{\Gamma_B(1-\alpha_{1/2})^{\sigma-1}}. \end{array}\right. \qquad (B.3)$$

Notice that $\left\{\begin{array}{l} x_A^{**} = R_A \\ x_B^{**} < R_B \end{array}\right.$ may be simultaneously feasible; in that case I still have to compare A's derived utilities in both situations.

When the sharing induces $\left\{\begin{array}{l} x_A^{**} = R_A \\ x_B^{**} = \eta_B R_A < R_B \end{array}\right.$, A's resulting utility is:

$$V_A(\alpha) = \gamma_A R_A \frac{\alpha_A \Gamma_A^{\frac{1}{\sigma-1}}}{(1 - \Gamma_B \alpha_B^{\sigma-1})^{\frac{\sigma}{\sigma-1}}},$$

which is not always monotonic in α_A anymore: by increasing his own share, A also reduces B's investment. Additionally, I have to take into consideration ranges of implementation which are not necessarily convex anymore. $V_A'(\alpha_A)$ has the same sign as $1 - \Gamma_B(1 - \alpha_A)^{\sigma-2}(1 + \alpha_A(\sigma - 1))$. I need to distinguish several cases.

If $\left\{\begin{array}{l} x_A^{**} = R_A \\ x_B^{**} = \eta_B R_A < R_B \end{array}\right.$, $\sigma < 2$ and $\Gamma_B > 1$, V_A can be defined by extension over $]1 - \frac{1}{\Gamma_B}^{\frac{1}{\sigma-1}}, 1]$ over which it is decreasing: A would therefore set the minimum α_A available, thus coming back to the $\left\{\begin{array}{l} x_A^{**} = R_A \\ x_B^{**} = R_B \end{array}\right.$ equilibrium.

If $\left\{\begin{array}{l} x_A^{**} = R_A \\ x_B^{**} = \eta_B R_A < R_B \end{array}\right.$, $\sigma < 2$ and $\Gamma_B < 1$, V_A can be defined by extension over $[0, 1]$. It increases from 0 in 0 until it reaches a maximum, then it decreases until it reaches $\gamma_A R_A \Gamma_A^{\frac{1}{\sigma-1}}$ in 1. The investment equilibrium would be implemented for α_A in the following ranges

- $[\alpha_1, 1]$ when $\Gamma_A > 1$ and $1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}} < \frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}} < \alpha_1$,

- $[\alpha_1, \alpha_2]$ when $\Gamma_A < 1$ and $1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}} < \frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}} < \alpha_1$,

- $[1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}, 1]$ when $\Gamma_A > 1$ and $\alpha_1 < \frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}} < 1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}$, and

- $[1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}, \alpha_2]$ when $\Gamma_A < 1$ and $\alpha_1 < \frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}} < 1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}} < \alpha_2$.

$V_A'(1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}})$ has the same sign as $1 - \beta_B(\sigma - 1) - \sigma \Gamma_B \beta_B^{\frac{\sigma-1}{\sigma-1}}$. Therefore if $\Gamma_B \geq \frac{1 - \beta_B(\sigma-1)}{\sigma \beta_B^{\frac{\sigma-2}{\sigma-1}}}$, A is sure to set $\alpha_A = \alpha_1$ in the two former cases, and to come back to the $\begin{cases} x_A^{**} = R_A \\ x_B^{**} = R_B \end{cases}$ equilibrium in the two latter. This condition provides a upper limit to the upper bound of the values of Γ_B for which A would not find it profitable to induce as much investment from B as possible under the constraint that he invests all his own asset. For Γ_B under a value lower than that limit, he is going to offer an intermediate sharing rule, implicitly defined by $\alpha = (\alpha_M, 1 - \alpha_M)$ such that $\Gamma_B(1 - \alpha_M)^{\sigma-2}(1 + \alpha_M(\sigma - 1)) = 1$.

If $\begin{cases} x_A^{**} = R_A \\ x_B^{**} = \eta_B R_A < R_B \end{cases}$, $\sigma > 2$ and $\Gamma_B > 1$, V_A can be defined by extension over $]1 - \frac{1}{\Gamma_B}^{\frac{1}{\sigma-1}}, 1]$. It decreases first, then increases. Consequently, I need only compare the value of V_A for the lower and upper bound the range of α which implement this equilibrium:

- $[1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}, \alpha_1]$ when $\Gamma_A < 1$ and $\frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}} < 1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}} < \alpha_1$,

- $[1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}, \alpha_1] \cup [\alpha_2, 1]$ when $\Gamma_A > 1$ and $\frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}} < 1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}} < \alpha_1$,

- $[1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}, 1]$ when $\frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}} < 1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}$ and α_1 and α_2, if they exist, are inferior to $\frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}}$,

- $[\alpha_2, 1]$ when $\alpha_1 < 1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}} < \frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}} < \alpha_2$.

$\frac{V_A(\alpha_1)}{V_A(1-\frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}})} = \frac{\frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}}}{1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}} \frac{\beta_A}{\Gamma_A \alpha_1^{\sigma-1}}$ is lower than 1 in the first range, where consequently A comes back to the $\begin{cases} x_A^{**} = R_A \\ x_B^{**} = R_B \end{cases}$ equilibrium. In the second range $\frac{V_A(1)}{V_A(1-\frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}})} = \frac{\beta_A^{\frac{\sigma}{\sigma-1}}}{1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}}$ is higher than 1 for high values of σ and β_A and for $\Gamma_B < \frac{1-\beta_A}{(1-\beta_A^{\frac{\sigma-1}{\sigma}})^{\sigma-1}}$: if investing B's asset is not profitable enough, A will not involve him in the common endeavor at all; if it is profitable enough, A comes back to the $\begin{cases} x_A^{**} = R_A \\ x_B^{**} = R_B \end{cases}$ equilibrium. In the third range, the same considerations remain mostly true. In the fourth range, $\frac{V_A(1)}{V_A(\alpha_2)} = \Gamma_A^{\frac{\sigma}{\sigma-1}} \alpha_2^{\sigma-1}$, an expression which decreases with Γ_A from 1 when $\Gamma_A = 1$. Therefore, in that range, A would prefer $\alpha_A = \alpha_2$. In that last range, A still needs to choose between α_2, which leads to $\begin{cases} x_A^{**} = R_A \\ x_B^{**} =< R_B \end{cases}$, and α_1, which leads to $\begin{cases} x_A^{**} < R_A \\ x_B^{**} = R_B \end{cases}$ The frontier between the two decisions can be implicitly given by:

$$\frac{\beta_A}{\beta_B}^{\frac{\sigma}{\sigma-1}} = \frac{\Gamma_A \alpha_2^{\sigma-1}}{\Gamma_B(1-\alpha_2)^{\sigma-1}} \left(\frac{\Gamma_A \alpha_1^{\sigma-1}}{\Gamma_B(1-\alpha_1)^{\sigma-1}} \right)^{\frac{1}{\sigma-1}}. \tag{B.4}$$

If $\begin{cases} x_A^{**} = R_A \\ x_B^{**} = \eta_B R_A < R_B \end{cases}$, $\sigma > 2$ and $\Gamma_B < 1$, V_A is defined over $\alpha_A \in [\max[1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}, \alpha_2], 1]$. If $\Gamma_B \leq \frac{(\sigma-1)^{2\sigma-3}}{\sigma^{\sigma-1}(\sigma-2)^{\sigma-2}}$, then V_A increases over $[0,1]$, and if Γ_B is under another threshold (higher than the previous one), then V_A increases until it reaches a local maximum, decreases until it reaches a local minimum, then increases again until it reaches its absolute maximum in 1: in both cases A sets $\alpha_A = 1$. Over the latter threshold, V_A increases until it reaches its absolute maximum, decreases until it reaches a local minimum, and increases again. At the lower bound of the interval, it is decreasing: A has again to choose between α_2 and 1, or between $1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}$ and 1. In each case, the frontier is at the same level.

The previous analysis uniquely determines all A's program, and the resulting useful utilities are (I do not present α_M):

$$\left. \begin{array}{l} \alpha_A = \alpha_{1/2} \\ x_A^{**} = R_A \\ x_B^{**} < R_B \end{array} \right\} \longleftrightarrow \left\{ \begin{array}{l} V_A = \frac{\gamma_A R_A}{\Gamma_A \alpha_{1/2}^{\sigma-1}} \\ V_B = \gamma_B R_B + \gamma_A R_A \frac{1-\alpha_{1/2}}{\alpha_{1/2}} \end{array} \right. \tag{B.5}$$

$$\left. \begin{array}{l} \alpha_A = 1 \\ x_A^{**} = R_A \\ x_B^{**} < R_B \end{array} \right\} \longleftrightarrow \left\{ \begin{array}{l} V_A = \gamma \mu_A^{\frac{\sigma}{\sigma-1}} R_A \\ V_B = \gamma_B R_B \end{array} \right. \tag{B.6}$$

C First-best asset allocation (proof of Prop. n°3)

Two properties of the production function are useful: $Y - \sum_k \gamma_k R_k$ is homogeneous of degree 1 and concave (P1), and if $x_i \neq 0$, $\lim_{x_j \to 0} \partial_{j \neq i} f = +\infty$ (P2). If the social planner invests anything, I know that she invests fully at least one asset (P1). Suppose B's asset is fully invested, then A's is at least partly invested (P2), and possibly fully invested. I have four situations to consider: no investment, full investment, full investment of B's asset and partial investment of A's and conversely.

Let me first determine a condition for the social planner to implement no investment. I turn to polar coordinates: I define (ρ, θ) such that $x_A = \rho \cos \theta$ and $x_B = \rho \sin \theta$, and I consider the slope of Y along a ray indexed by θ: $\frac{dY}{d\rho}(\theta) = \gamma(\mu_A \cos(\theta)^{\frac{\sigma-1}{\sigma}} + \mu_B \sin(\theta)^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma}{\sigma-1}} - \gamma_A \cos(\theta) - \gamma_B \sin(\theta)$. Since Y is concave (strictly since $\sigma > 0$), and since $Y'(0) = +\infty$ and $Y'(\frac{\pi}{2}) = -\infty$, $\frac{dY}{d\rho}(\theta)$ reaches its maximum in $]0, \frac{\pi}{2}[$. The social planner would not invest in the common endeavor iff this maximum slope along a ray is negative. I only need to determine a condition for this maximum slope to be equal to 0. That condition is that there exists a θ for which $\frac{dY}{d\rho}(\theta) = 0$ and $\frac{d^2 Y}{d\rho d\theta}(\theta) = 0$. I obtain that such a θ verifies $\tan(\theta) = (\frac{\gamma_A}{\gamma_B} \frac{\mu_B}{\mu_A})^{\sigma}$. Finally, the social planner invests no asset in the common endeavor iff $\Gamma_A + \Gamma_B < 1$.

Notice that for the social planner to invest any asset, she must have found that $\max_k \frac{\Gamma_k}{\beta_k} \geq 1$. Suppose $\Gamma_i \geq \beta_i$ but $\Gamma_j < \beta_j$, and suppose i's asset is invested only partially. (P1) ensures that j's must be fully invested, which is not possible. Therefore if asset i is such that $\Gamma_i \geq \beta_i$, it must be fully invested. The social planner fully invests both assets iff $\min_k \frac{\Gamma_k}{\beta_k} \geq 1$. Lastly, consider

a situation where i's asset is fully invested and j's only partially. The social planner maximizes $Y(x_j)$ and thus invests $x_j^{FB} = \left(\frac{\mu_i}{\mu_j} \frac{\Gamma_j}{1 - \Gamma_j} \right)^{\frac{\sigma}{\sigma-1}} R_i$.

D Second-best (proof of Prop. n°4)

The social planner is able to reach the first best solution only for $\sum_k \Gamma_k < 1$ (she is in fact not at liberty of doing otherwise) and for $\sum_k \frac{\beta_k}{\Gamma_k}^{\frac{1}{\sigma-1}} \leq 1$, in which range $\begin{cases} x_A^{**} = R_A \\ x_B^{**} = R_B \end{cases}$ is feasible and is her desired outcome (in that case, she may have a range of α leading to it: she has no preference between different sharing rules).

When she is not, two cases may arise. First, if only one non-(0,0) situation is feasible, the social planner chooses α so as to maximize the investment of the partially invested asset under the condition that the other asset remains invested ($\eta_A \eta_B \geq 1$). The condition is binding. If $\sigma > 2$, $\eta_A \eta_B = 1$ can only have exactly one solution. Depending on $\sigma \lessgtr 2$ and A/B's partial investment, that solution is unambiguously $\alpha_{1/2}$.

Second, $\begin{cases} x_A^{**} = R_A \\ x_B^{**} < R_B \end{cases}$ and $\begin{cases} x_A^{**} < R_A \\ x_B^{**} = R_B \end{cases}$ may be simultaneously feasible while $\begin{cases} x_A^{**} = R_A \\ x_B^{**} = R_B \end{cases}$ is not. This can only happen when $\sigma > 2, \forall k, \Gamma_k \geq 1$, and $g(\alpha) = 1$ has two solutions. The regulator would induce full investment by B by choosing $\alpha \leq \alpha_1$, and by A by choosing $\alpha \geq \alpha_2$. If she chooses the former, following the same reasoning as before, she would set $\alpha = \alpha_1$, and the latter, $\alpha = \alpha_2$. Among those two possibilities, she chooses according to which maximizes Y. Equality between the alternative productions provides an implicit equation of the frontier between the two ranges of implementation:

$$\frac{\beta_A}{\beta_B}^{\frac{\sigma}{\sigma-1}} = \left(\frac{\Gamma_A \alpha_2^{\sigma-1}}{\Gamma_B (1 - \alpha_1)^{\sigma-1}} \right)^{\frac{\sigma}{\sigma-1}} \frac{1 - \sum_k \Gamma_k \alpha_1^{\sigma}}{1 - \sum_k \Gamma_k \alpha_2^{\sigma}}. \tag{D.1}$$

E Complementarity and the stakes of political competition (proof of Prop. n°6)

Superimposing B's program over A's in the (Γ_A, Γ_B)-plane, there are as many as eleven possible couples of sharing rules which we need to consider (not counting O_{AB}, the no-investment range, in which nobody cares about setting the sharing rule). The problem can be considerably simplified, however, by eliminating situations when they are symmetric to another when we exchange A and B's roles. We are left with six possible situations:

1. $\begin{cases} \alpha^A = (1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}, \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}) \\ \alpha^B = (\frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}}, 1 - \frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}}) \end{cases}$

2. $\begin{cases} \alpha^A = (\alpha_1, 1 - \alpha_1) \\ \alpha^B = (\alpha_1, 1 - \alpha_1) \end{cases}$

3. $\sigma > 1 :$ $\begin{cases} \alpha^A = (\alpha_M, 1 - \alpha_M) \\ \alpha^B = (\alpha_1, 1 - \alpha_1) \end{cases}$

4. $\sigma > 2 :$ $\begin{cases} \alpha^A = (1, 0) \\ \alpha^B = (\alpha_1, 1 - \alpha_1) \end{cases}$

5. $\sigma > 1 :$ $\begin{cases} \alpha^A = (\alpha_M, 1 - \alpha_M) \\ \alpha^B = (\frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}}, 1 - \frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}}) \end{cases}$

6. $\sigma > 2 :$ $\begin{cases} \alpha^A = (1, 0) \\ \alpha^B = (\frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}}, 1 - \frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}}) \end{cases}$

Situation n°2 does not generate any conflict, as both individuals would in fact implement the same sharing rule if they were in power. This situation with no need for a state or any form of political power may arise mostly in the case of a moderately attractive common endeavor, and not too asymmetric outside options (also, they only arise because of mostly corner solutions; a more realistic model, which would be intractable, would not provide such a range). Also notice that situations n°5 and 6 cannot coexist with their respective symmetric situations on the (Γ_A, Γ_B)-plane, as they cannot exist except if the endowments are strongly asymmetric. When $\sigma < 1$, the only situations possible are n°1 and 2; when $\sigma \in]1, 2[$, the possible situations are n°1, 2 and 3. The remaining situations arise for higher levels of σ and asymmetric endowments. We focus on the simpler computations.

As a preliminary, let me examine the evolution of $\alpha_{1,2}$ with respect to σ. Using the definition of $\alpha_{1/2}$ and the implicit function theorem, I derive that:

$$\frac{d\alpha_{1/2}}{d\sigma} = -\frac{\sum_k \epsilon_k \ln \frac{\epsilon_k}{\mu_k}}{(\sigma - 1)g'(\alpha_{1/2})}$$

with $\epsilon_A = \Gamma_A \alpha_{1/2}^{\sigma-1}$ and $\epsilon_B = \Gamma_B (1 - \alpha_{1/2})^{\sigma-1}$ $(\epsilon_A + \epsilon_B = 1)$. The numerator is always positive, while the denominator is positive either for α_1 when $\sigma < 2$ or for α_2 when $\sigma > 2$, and negative conversely. The solutions of $g(\alpha) = 1$ are such that:

- when $\sigma > 2$, $\frac{d\alpha_1}{d\sigma} > 0$ and $\frac{d\alpha_2}{d\sigma} < 0$,

- when $\sigma < 2$, $\frac{d\alpha_1}{d\sigma} < 0$ and $\frac{d\alpha_2}{d\sigma} > 0$.

In situation n°1

$$v_A = v_B = \gamma \left(\sum_k \mu_k R_k^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \left(1 - \sum_k \frac{\beta_i}{\Gamma_i}^{\frac{1}{\sigma-1}} \right) \qquad (\text{E.1})$$

$$\frac{dv_A}{d\sigma} = \frac{\gamma \left(\sum_k \mu_k R_k^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}}{(\sigma - 1)^2} \left[\sum_k \beta_K \ln \frac{\beta_k}{\mu_k} \right.$$
$$\left. + \frac{\sigma - 1}{\sigma} \ln \frac{\mu_B \beta_A}{\mu_A \beta_B} \left(\beta_B \frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}} - \beta_A \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}} \right) \right].$$

The first factor of the latter expression is always positive. The first term of the second factor is always nonnegative. The second term is ambiguous. It is always positive for $\sigma < 1$. It is nonnegative for $\sigma \in]1, 2[$ for symmetric individuals, and may become slightly negative for symmetric endowments but asymmetric outside options (γ_k). It is slightly negative for $\sigma > 2$, especially when endowments are very asymmetric. The variation of v_A and v_B is actually composed of two effects: production is nonincresing in σ, which should not be interpreted as more than an artifact of the CES function; and the stakes in terms of the share of the common production, which always increases with σ. The fact that the derivative can be positive may thus be neglected, and a numerical analysis confirms that indeed when negative the value of the derivative is very small relative to $(\sigma - 1)^2$, and relative to the ranges where it is positive.

Overall, v_A and v_B are therefore nondecreasing functions of σ *even though* the total production of the common productive endeavor is decreasing with σ and the stakes are a fraction of this production.

In situation n°4

$$
\begin{cases}
v_A = \gamma_A R_A (\Gamma_A^{\frac{1}{\sigma - 1}} - \frac{1}{\Gamma_A \alpha_1^{\sigma - 1}}) \\
v_B = \gamma_A R_A \frac{\alpha_1}{1 - \alpha_1}.
\end{cases}
\tag{E.2}
$$

$$
\frac{dv_A}{d\sigma} = \gamma_A R_A \left(-\frac{\ln(\mu_A)\Gamma_A^{\frac{1}{\sigma - 1}}}{(\sigma - 1)^2} - \frac{\sum_k \epsilon_k \ln \frac{\epsilon_k}{\mu_k}}{(\sigma - 1)\epsilon_A g'(\alpha_1)} + \frac{\ln \frac{\epsilon_A}{\mu_A}}{(\sigma - 1)\epsilon_A} \right),
$$

where $\Gamma_A \alpha_1^{\sigma - 2} - 1 = (1 - \alpha_1) \frac{dg(\alpha_1)}{d\alpha_A} < 0$: when $\epsilon_A \geq \mu_A$ this derivative is the sum of three positive terms, and thus positive itself. The sum of the two last terms has the same sign as $\epsilon_B \ln \frac{\epsilon_B}{\mu_B} + (\frac{\epsilon_A}{\alpha_1} - 1 + \epsilon_A) \ln \frac{\epsilon_A}{\mu_A}$. Since $\frac{\epsilon_A}{\alpha_1} - 1 + \epsilon_A \geq 2\epsilon_A - 1$, this expression is positive when $\epsilon_A \leq \mu_A$. In all cases, the derivative is positive. The study of v_B is easier, as it is a decreasing function of α_2, itself a decreasing function of σ.

In situation n°6

$$
\begin{cases}
v_A = \gamma \left(\sum_k \mu_k R_k^{\frac{\sigma - 1}{\sigma}} \right)^{\frac{\sigma}{\sigma - 1}} \left(\beta_A^{\frac{\sigma}{\sigma - 1}} - \frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma - 1}} \right) \\
v_B = \gamma \left(\sum_k \mu_k R_k^{\frac{\sigma - 1}{\sigma}} \right)^{\frac{\sigma}{\sigma - 1}} \left(1 - \frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma - 1}} \right) - \gamma_B R_B
\end{cases}
\tag{E.3}
$$

$$
\begin{cases}
\frac{dv_A}{d\sigma} \propto \left[\sum_k \beta_k \ln \frac{\beta_k}{\mu_k} \left(\beta_A - \frac{1 + \beta_A}{\Gamma_A^{\frac{1}{\sigma - 1}}} \right) + \frac{\sigma - 1}{\sigma} \ln \frac{\beta_A}{\mu_A} + \frac{1}{\sigma} \ln \frac{\beta_B}{\mu_B} - \frac{\beta_a \beta_B \ln \mu_A}{\Gamma_A^{\frac{1}{\sigma - 1}}} \right] \\
\frac{dv_B}{d\sigma} = \gamma \left(\sum_k \mu_k R_k^{\frac{\sigma - 1}{\sigma}} \right)^{\frac{\sigma}{\sigma - 1}} \sum_k \beta_k \ln \frac{\beta_k}{\mu_k} - \frac{\beta_A}{\Gamma_A}^{\frac{\sigma}{\sigma - 1}} \ln \frac{\mu_A}{\Gamma_A}
\end{cases}
$$

Both expressions are the sum of positive terms on the relevant range of parameters, and are thus positive themselves. The other three situations would require a bit more work, but the intuition remains the same.

F Inequalities and the stakes of political competition (proof of Prop. n°8)

In F_{AB}, $\alpha_A^A - \alpha_A^B = 1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}} - \frac{\beta_A}{\Gamma_A}^{\frac{1}{\sigma-1}}$. Holding Γ_A and Γ_B, as well as σ, fixed,

$$\frac{d(\alpha_A^A - \alpha_A^B)}{d\beta_A} = -\frac{1}{\sigma-1}\left(\frac{\beta_B^{2-\sigma}}{\Gamma_B}^{\frac{1}{\sigma-1}} - \frac{\beta_A^{2-\sigma}}{\Gamma_A}^{\frac{1}{\sigma-1}}\right).$$

For $\sigma < 2$, $-\frac{1}{\sigma-1}\frac{x^{2-\sigma}}{y}^{\frac{1}{\sigma-1}}$ decreases with x and increases with y. As a consequence, $\frac{d(\alpha_A^A - \alpha_A^B)}{d\beta_A}$ is positive for β_A high enough (and thus β_B low enough) and Γ_B high enough relative to Γ_A. For $\Gamma_A = \Gamma_B$, $\frac{d(\alpha_A^A - \alpha_A^B)}{d\beta_A} > 0 \iff \beta_A > \beta_B$. Since production is kept constant, this concludes the proof of Prop. n°8.

G Commitment and complementarity (proof of Prop. n°11)

W_A increases in p over $]0, \alpha_A^A]$ and over $[\bar{p}, 1]$. Both V_A^r and C decrease in p over $[\alpha_A^A(\sigma), \bar{p}(\sigma)]$. Therefore $p_A^* \in [\alpha_A^A, \bar{p}] \cup \{1\}$, as indicated in the main text. The proof is identical in σ and γ.

There are four possibilities for any given σ or γ. Consider p_A^* as a function of the relevant variable: first, that it has a neighborhood in which $p_A^* = \alpha_A^A(\sigma)$ (the maximum remains locally stuck at the lower bound); second, that it has a neighborhood in which $p_A^* = 1$ (the maximum remains locally stuck at 1); third, that A is indifferent between setting $p_A^* = 1$ and another value in $[\alpha_A^A(\sigma), \bar{p}(\sigma)]$; and fourth is the interior situation.

In the first possibility, A finds that the gains from commitment outweigh the cost up to his optimal offer of sharing rule. Prop. n°11 is locally equivalent to his optimal offer increasing with complementarity, in other words, to $\frac{d\alpha_A^A}{d\sigma} \geq 0$ and $\frac{d\alpha_A^A}{d\gamma} \geq 0$. From Prop. n°2, α_A^A can take four nontrivial values: $1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}$, α_M and $\alpha_{1/2}$. Previous comments about the variation of $\alpha_{1/2}$ and simple computations show that these values increase with σ and γ in the corresponding range of parameters.

In the second possibility, Prop. n°11 is locally trivial.

I cover the two latter possibilities by making an argument in the line of Topkis's theorem. To finish proving Prop. n°11, I need only show that in the noncorner case and to its right, W_A is submodular, or equivalently, that $\forall p \geq \alpha_A^A$, $\frac{d^2 W_A(p,\sigma)}{dpd\sigma} = \frac{d^2 V_A^r(p,\sigma)}{dpd\sigma} \leq 0$ and $\frac{d^2 V_A^r(p,\sigma)}{dpd\sigma} \leq 0$. The noncorner case can never implement $\begin{cases} x_A^{**} < R_A \\ x_B^{**} = R_B \end{cases}$ or $\begin{cases} x_A^{**} = R_A \\ x_B^{**} = R_B \end{cases}$, since when these situations are feasible, I have shown in the proof of Prop. n°1 that should A implement either, he would always choose α_A^A at the upper bound of the implementability range. Therefore p's constraint can implement a noncorner $\begin{cases} x_A^{**} = R_A \\ x_B^{**} < R_B \end{cases}$

from which A derives utility $\dfrac{p\gamma R_A \mu_A^{\frac{\sigma}{\sigma-1}}}{\left(1-\frac{\gamma(1-p)}{\gamma_B}^{\sigma-1}\mu_B^\sigma\right)^{\frac{\sigma}{\sigma-1}}}$. Writing $x = \frac{\gamma(1-p)}{\gamma_B}^{\sigma-1}\mu_B^\sigma$, its cross-derivative in p and σ has the same sign as $\left(1-\frac{\sigma px}{(1-p)(1-x)}\right)\ln\frac{1-x}{\mu_A} + \frac{\sigma x}{1-x}\left(1-\frac{\sigma px+(\sigma-1)p}{(1-p)(1-x)}\right)\ln\frac{x}{\mu_B} - \frac{\sigma(\sigma-1)^2 px}{(1-p)(1-x)}$, while that in p and γ has the same sign as $(1-x)(1+(\sigma-1)x) - \frac{xp\sigma^2}{1-p}$. Both are negative when $p \geq \alpha_A^A \geq 1 - \frac{\beta_B}{\Gamma_B}^{\frac{1}{\sigma-1}}$.

Therefore, in all four possibilities, when σ or γ increases, p_A^* is either continuously nondecreasing or it "jumps" to an greater value. This concludes the proof of Prop. n°11.