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CICLO XXV

Three essays on fair division, colonialism and lobbying

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Ay, Antonio!,
los bichos que hay en el mar
no toman cañas ni con pincho,
y tú quieres montar un bar,
en el fondo del mar...
...¡cómo vas a montar un bar!

Contents

Introduction

This thesis is composed of three chapters on topics of theoretical economics and applied theory. The first chapter analyzes the existence and implementation of a land division rule, defined through two properties: efficiency and equal opportunity equivalence. It is a joint work with Antonio Nicolò and Andrés Perea, and was published in SERIEs (2011), in the special issue in honor of Salvador Barberà, see Nicolò et al. (2012). The second chapter presents a citizen-candidate voting model with lobbying on a multidimensional policy space, with salient issues. The third chapter investigates the strategic behavior of colonizers in state capacity investment in non settlement colonies, giving an explanation also to civil conflict outcomes after independence.

Going more in detail, in the first chapter we look for a normative solution to a land division problem that could be applied to different types of disputes when the arbitrator has a very limited information about the agents' preferences, and market mechanisms are not available. The solution must be fair and efficient under the constraint of the limited information available to the arbitrator. To this scope, we propose to use the concept of equal-opportunity equivalence defined by Thomson (1994). A land division is equal-opportunity equivalent if each agent receives a parcel of the land who makes her indifferent with respect to her best parcel of a given size μ,where the size of the reference set must be the same for both agents. Existence of the land division rule, uniqueness of utility levels are proved, along with a mechanism to implement it, in which the preferences of the agents do not need to be common knowledge. Moreover there is a unique μ for which the rule exists, therefore μ is not a discretionary choice of the arbitrator.

The second chapter is devoted to the analysis of a citizen-candidate model on a multidimensional policy space with lobbying, where citizens regard some issues more salient than others. In equilibrium special interest groups that lobby on less salient topics move the implemented policy closer to their preferred policy, compared to the ones that lobby on more salient issues. After introducing two types of citizens, who differ with respect to the salience assigned to issues, pooling equilibria are found, where voters are not able to offset the effect of lobbying on the implemented policy. This result is in sharp contrast with previous work on unidimensional citizen-candidate models that predict the irrelevance of lobbying on the implemented policy, see Besley and Coate (2001). In an extension of the model citizens are provided with the possibility of giving monetary contributions to lobbies in order to increase their power. With more than one lobby per dimension there are two findings. First, under some conditions only the most extreme lobbies receive contributions. Second, the effectiveness of a lobby is maximized when the salience of an issue is low in the population and high for a small group of citizens.

The third chapter investigates the determinants of investment in state capacity in non settlement colonies. The results of this analysis overcome the limitations of the framework provided by Acemoglu et al. (2001), whose theory predicts that extractive institutions were set in non settlement colonies, with no explanation for the wide heterogeneity of institutions in those colonies. Roughly half of the colonies that became independent after 1945 suffered costly civil conflicts thereafter. Empirical evidence suggests that the colonizer's investment in state capacity is one of the determinants of civil conflict in ex colonies. A good state capacity, in the form of an efficient bureaucracy, a working police force, an independent judiciary enforcing the rule of law, fiscal capacity, prevented state failure and civil conflict, once independence was achieved.

A theory is developed to study the strategic behavior of colonizers in choosing investment in state capacity in the colony. High state capacity creates a productive gain in the colonial economy, but as side effect it prevents civil conflict in case of independence, and therefore increases the incentive of the colony to fight for it. Colonizers decide to invest in state capacity comparing its productivity gain with the increased military cost of maintaining power when colonies aim at independence. The equilibrium investment in state capacity depends on the matching between the identity of colonizer (a colonizer with a larger colonial empire will have a lower average military cost) and the identity of the colony (the productivity gain depends on the presence of natural resources, distance from the sea).

If the colonizer is forced to leave the colony for exogenous events, the lack of state capacity, and the inefficiency of the decolonization process, determine the civil conflict outcome after independence.

Introduzione

Questa tesi è composta di tre capitoli su argomenti di economica teorica e teoria applicata. Il primo capitolo analizza l'esistenza e l'implementazione di una regola per la divisione di terra, definita attraverso due proprietà: efficienza e equivalenza di pari opportunità. E' un lavoro coautorato con Antonio Nicolò e Andrés Perea, ed è stato pubblicato in SERIEs (2011), in un numero speciale in onore di Salvador Barberà, vedi Nicolò et al. (2012). Il secondo capitolo presenta un modello di voto con citizen-candidate, con lobby su uno spazio politico multidimensionale, con argomenti salienti. Il terzo capitolo studia il comportamento strategico dei colonizzatori nell'investimento in state capacity nelle colonie di non insediamento, dando una spiegazione anche agli effetti sui risultati di conflitto civile dopo l'indipendenza.

Andando più in dettaglio, nel primo capitolo cerchiamo una soluzione normativa al problema di divisione di terra, che possa essere applicata a differenti tipi di dispute, quando il negoziatore ha a disposizione informazioni molto limitate sulle preference degli agenti, e meccanismi di mercato non sono disponibili. La soluzione deve essere equa ed efficiente, sotto il vincolo dell'informazione limitata disponibile al negoziatore. A questo scopo proponiamo il concetto di equivalenza di pari opportunità, definito da Thomson (1994). Una divisione di terra è equivalente in pari opportunità se ogni agente riceve un pezzo di terra che la rende indifferente rispetto al suo miglior pezzo di una data area μ, dove l'area del pezzo di riferimento deve essere lo stesso per entrambi gli agenti. L'esistenza di una regola per la divisione di terra, l'unicità dei livelli di utilità vengono dimostrate, insieme ad un meccanismo per implementarla, nel quale le preferenze degli agenti non sono informazione comune. Inoltre c'è un unico μ per quale la regola esiste, quindi μ non è una scelta discrezionaria del negoziatore.

Il secondo capitolo è dedicato all'analisi di un modello di citizen-candidate su uno spazio politico multidimensionale con lobby, nel quale i cittadini considerano alcuni argomenti più salienti di altri. In equilibrio i gruppi di interesse che fanno lobby sui temi meno salienti riescono a muovere la politica implementata più vicino alla loro politica preferita, rispetto a gruppi che fanno lobby su argomenti più salienti. Dopo aver introdotto due tipi di cittadini, che differiscono per quanto concerne la salienza assegnata agli argomenti, troviamo equilibri pooling, nei quali i votanti non sono in grado di annullare l'effetto dell'attività di lobby sulla politica implementata. Questo è risultato è in forte contrasto con i precedenti lavori su modelli di citizen-candidate unidimensionali che predicono l'irrilevanza dell'attività di lobby sulla politica implementata, vedi Besley and Coate (2001). In una estensione del modello, ai cittadini viene data la possibilità di finanziare le lobby con donazioni monetarie per incrementare il loro potere. Con più di una lobby per argomento ci sono due risultati. Primo, sotto alcune condizioni solo le lobby più estreme ricevono contributi. Secondo, l'effettività di una lobby è massimizzata quando la salienza di un argomento è bassa nella popolazione e alta per un piccolo gruppo di cittadini.

Il terzo capitolo si occupa dei determinanti dell'investimento in state capacity nelle colonie di non insediamento. I risultati di questa analisi superano i limiti del framework creato da Acemoglu et al. (2001), la cui teoria afferma solo che istituzioni estrattive sono state promosse nelle colonie di non insediamento, senza dare alcuna spiegazione alla grande eterogeneità di istituzioni in queste colonie.
Circa metà delle colonie che diventarono indipendenti dopo il 1945 hanno affrontato costosi conflitti civili successivamente. Evidenze empiriche suggeriscono che l'investimento del colonizzatore in state capacity sia uno dei determinanti del conflitto civile nelle ex colonie. Una buona state capacity, nelle forme di una burocrazia efficiente, una forza di polizia che funziona, un sistema giudiziario indipendente, capacità fiscale, hanno impedito il fallimento dello stato e il conflitto civile, una volta che l'indipendenza fu ottenuta. Una teoria è sviluppata per studiare il comportamento strategico dei colonizzatori nello scegliere l'investimento in state capacity nella colonia. Una buona state capacity crea un aumento di produttività nell'economia coloniale, ma come effetto collaterale previene il conflitto civile in caso di indipendenza, e quindi aumenta l'incentivo della colonia di combattere per essa. I colonizzatori quindi scelgono il livello di investimento in state capacity comparando l'aumento di produttività con il maggiore costo militare per mantenere il potere quando la colonia punta all'indipendenza. L'investimento in state capacity in equilibrio dipende dal matching tra l'identità del colonizzatore (un colonizzatore con un impero coloniale più vasto avrà un costo militare medio più basso) e l'identità della colonia (l'aumento di produttività dipende dalla presenza di risorse naturali, distanza dal mare).
Se il colonizzatore è forzato a lasciare la colonia a causa di eventi esogeni, la mancanza di state capacity, e l'inefficienza del processo di decolonizzazione, determinano la presenza o meno di conflitto civile dopo l'indipendenza.

Chapter 1

Equal Opportunity Equivalence in Land Division

1.1 Introduction

There are several situations where the solution of a land division problem cannot be found using instruments like prices or monetary compensations. This may be due to liquidity constraints; or to the psychological difficulty of bringing a dispute down to monetary evaluations; or the division of the land has to be in kind under the provisions of the law. According to the common law, co-owners of land (or of any other assets) in case of inharmonious association have the right to partition in kind (see Miceli and Sirmans (2000)). In case the partition of the land causes excessive fragmentation, a second remedy is the sale of the undivided parcel with division of the proceeds in proportion to each owner's share. However, this second remedy is considered an *extrema ratio* that courts should implement only in case there is a strong evidence that land division is inefficient[1]. In absence of scale economies, division in kind is *de facto* the only remedy according to the common law. Division in kind is not problematic if the land (or the asset) to be divided is homogeneous. However even if the land is homogeneous for the market value, it could be heterogeneous with respect to owners' preferences: owners' evaluation may depend, in fact, on sentimental considerations or on private information about the land (for instance, the presence of natural resources in some parcels). If according to owners' preferences the good is not homogeneous, a division in kind can be inefficient, and therefore courts have to

[1]"Physical division does not compel a person to sell his property against his will. which, it has been said, should not be done except in case of imperious necessity" Miceli and Sirmans (2000) p.794 quoting the court of the case of Trowbridge v. Donner (1950).

try to elicit private information from the parties.

The case of two countries disputing over their border has similar features. Often, the only feasible remedy is the division in kind. The territory object of the dispute is rarely homogeneous, since many characteristics are relevant to determine the preference of each country: the presence of ethnic groups, of natural resources, geographic characteristics, (access to the sea for instance), or strategic and military considerations, etc.. Also in this case a land division may be not efficient and, moreover, it is far from being obvious which normative properties can be called for.

The solution we are looking for and the mechanism to implement it, should hold for a large class of problems. The solution should be applied to solve disputes between co-owners in case of division of a land as also between countries. The solution must be fair and efficient under the constraint of the limited information available to any external party called to settle the dispute (the arbitrator). We assume, in fact, that the arbitrator has not much information about the litigants' preferences, while parties have complete information about each other. Namely the only information available to the arbitrator is that the value of the parcel an agent receives is positively affected by its size; that is, a larger parcel it is always preferred to a smaller one that is contained by it (set-inclusion property). This informational framework fits many real world situations. A judge who has to partition a piece of land between two co-owners, two heirs or a divorcing couple, hardly knows parties' preferences, while it is very likely that each party knows the preferences of the other party over the good to be divided. Similarly, an international organization, like United Nations, which tries to solve a dispute over a territory in the border of two countries cannot claim to know which are the preferences of each country, even if they are common information.

It is important to note that set-inclusion property does not mean that in general any parcel of larger size is preferred to a smaller parcel, since as we pointed out, the land to be divided is heterogenous. However, if preferences satisfy this property, then the following easily follows. For any size μ, consider the preferred parcel of that size by agent i, and call it a *best parcel of size* μ for agent i (which of course is not necessarily unique). For each agent, his best parcel of size μ is preferred to his best parcel of size μ' if and only if $\mu \geq \mu'$.

As regards the properties that the solution has to satisfy, both efficiency and fairness appear as necessary requirements. An inefficient solution can be renegotiated between the parties: any property of an inefficient solution is not necessarily preserved after renegotiation, and therefore to ask for normative properties without requiring efficiency turns to be a vacuous exercise.

In the fair division literature, there are two main ordinal concepts of distributive justice[2]. The first is the envy-free principle which states that each party should (weakly) prefers its share to anyone else's. This was proposed by Gamow and Stern (1958), but became known in the economics literature after Foley (1967). Efficient and envy-free allocations are ex post stable because no one desires to exchange what he received with anyone else's share. However,there may be many efficient envy-free allocations, and individuals may dispute on which one should be selected. The divide-and-choose mechanism under complete information, for instance, selects among all the efficient envy-free allocations the division that maximizes the payoff of the divider so conflict is likely to shift over how the divider is chosen.

An alternative normative concept is the egalitarian equivalent criterion which states that each party should be indifferent between getting her share and some reference bundle, identical for all agents. However, in this case the conflict is likely to shift on which reference bundle should be chosen, as different reference bundles lead to different shares. Pazner and Schmeidler (1978) suggest eluding the problem by focusing only on those reference bundles that are proportional to the total endowment (assuming efficiency, this leads to a unique selection.). It is not immediately obvious how to extend the "Pazner-Schmeidler" rule when the endowment is a single heterogeneous good. LiCalzi and Nicolò (2009) suggests a way of constructing a reference bundle for a heterogeneous infinitely divisible good. Each agent partitions the good in finitely, or countably many, parcels that she considers as homogeneous. The common refinement of all the agents' partitions the good in parcels that are homogeneous for each agent. Hence by choosing the reference bundle among those that are proportional to this common refinement, we end up with a reference bundle that is "proportional" to the total endowment as suggested by Pazner and Schmeidler (1978). However, if the heterogeneous good cannot be partitioned in finitely, or countably many, parcels, then the problem of how to choose the reference bundle still arises.

In this paper we propose to overcome the informational constraints and avoid an arbitrary choice of a reference bundle, using the concept of equal-opportunity equivalence defined by Thomson (1994). Thomson (1994) combines the ideas of equal opportunities and egalitarian-equivalence in the context of economies with private and public goods. In such environments, an allocation is said to be *equal-opportunity equivalent* relative to a family of choice sets if there exists some reference set of this family such that each agent is indifferent between the allocation and his best alternative in this

[2]See for instance Berliant et al. (1992) and Moulin (2004) for a complete overview of modern contributions to the problem of distributive justice in economics.

reference set. Since here the only commonly known characteristic is the set-monotonic inclusion property of the preference domain, and the size is the unique commonly observable (verifiable) characteristic of any set, we define the concept of *equal-opportunity equivalence with respect to a family of sets with the same size.* Our solution implies that each agent receives a parcel of the land who makes him indifferent with respect to his best parcel of a given size μ,where the size of the reference set must be the same for both agents. The last question to solve is which size μ should be considered. Efficiency requires to choose as reference set the largest size μ^* such that both agents are indifferent between the parcel they receive and their best parcel of that size μ^*.

In the rest of the paper we first prove the existence of an efficient and equal opportunity equivalent allocation for our problem and we propose a simple procedure to implement a rule that selects such allocation at each preference profile under the assumption that agents have complete information about their preferences. The mechanism is the same used in Nicolò and Perea (2005), that generalizes a mechanism suggested in Crawford (1979) and ameliorated in Demange (1984).

1.2 The Model

The problem we consider is how to divide a piece of land between two agents. Let $X \subseteq \mathbb{R}^n$, represent a piece of land which is bounded, connected and Lebesgue-measurable. The set X is the total piece of land to be divided among the two agents. Let $L(X)$ be the set of all Lebesgue-measurable subsets of X. By μ we denote the Lebesgue measure on $\mathbb{R}^n$. The utility function u_i of agent i, $i = 1, 2$, is assumed to be a measure on $L(X)$ that is absolutely continuous w.r.t. μ. That is, if $\mu(A) = 0$ for some $A \in L(X)$, then also $u_i(A) = 0$. The number $u_i(A)$ represents the utility that agent i assigns to the piece of land A. Since u_i is absolutely continuous w.r.t. μ we know by the Radon-Nykodim Theorem that there exists a non-negative function $v_i : X \to \mathbb{R}$ such that

$$u_i(A) = \int_A v_i \, d\mu$$

for all $A \in L(X)$.

Definition 1.1. *A land division problem is a tuple $P = (X, u_1, u_2)$ where X is a connected and Lebesgue measurable subset of $\mathbb{R}^n$, and u_1, u_2 are measures on $L(X)$ that are absolutely continuous w.r.t. the Lebesgue measure.*

For a given land division problem $P = (X, u_1, u_2)$, a *feasible land division* is a pair (A_1, A_2) of subsets such that $A_2 = X \backslash A_1$ and both A_1 and A_2 belong to $L(X)$.

Definition 1.2. *A land division rule is a function D that assigns to every land division problem P a feasible land division $D(P)$.*

We shall focus on land division rules satisfying two properties: *efficiency* and (a specific form of) *equal opportunity equivalence.* Efficiency is defined in the usual sense, that is, a feasible land division (A_1, A_2) for $P = (X, u_1, u_2)$ is efficient if there is no other feasible division (B_1, B_2) for which $u_i(B_i) > u_i(A_i)$ and $u_j(B_j) \geq u_j(A_j)$ for $i, j = 1, 2$ and $i \neq j$. Equal opportunity equivalence states that there should be some number $\lambda > 0$ such that both agents are indifferent between the part assigned to them and their most preferred piece of land of size λ.

Definition 1.3. *For a given land division problem $P = (X, u_1, u_2)$, a feasible land division (A_1, A_2) is equal opportunity equivalent if there is some $\lambda > 0$ such that*

$$\begin{aligned} u_1(A_1) &= \max\{u_1(A) \mid A \in L(X) \text{ and } \mu(A) = \lambda\} \text{ and} \\ u_2(A_2) &= \max\{u_2(A) \mid A \in L(X) \text{ and } \mu(A) = \lambda\}. \end{aligned}$$

A land division rule is said to be efficient (equal opportunity equivalent) if its assigns to every land division problem a feasible land division which is efficient (equal opportunity equivalent).

1.3 Efficient and Equal Opportunity Equivalent Rules

In this section we prove that there exist land division rules which are both efficient and equal opportunity equivalent. For the proof of the following theorem we need first the following lemmas:

Lemma 1.1. *For every $R \leq u_i(X)$, $r \in [0, R]$ and for every measurable $B \subset X$ such that $u_i(B) = R$ there exists a measurable subset $A \subset B$ such that $u_i(A) = r$, where $i = 1, 2$.*

Proof. Given the absolute continuity of u_i we can apply Theorem 1 in Dubins and Spanier (1961). The convexity of the range $u_i(C), C \subset B$, guarantees that exists $A \subset B$ such that $u_i(A) = r$.

Lemma 1.2. *If* $u_j(\tilde{A} \backslash A) = 0$ *for every* $A \subset \tilde{A}$ *such that* $u_i(A) = r$ *we have* $u_j(\tilde{A}) = 0$*, where* $\tilde{A} \subset X$*,* $r < u_i(\tilde{A})$ *and* $i, j \in \{1, 2\}, i \neq j$*.*

Proof. Let us suppose by contradiction that $u_j(\tilde{A}) \neq 0$. That means that there is a set $A \subset \tilde{A}$ such that the Radon-Nikodym derivative f_j of u_j is larger than 0 almost everywhere on A. There are three possibilities: $u_i(\tilde{A} \backslash A)$ can be larger, equal or less than r. If it is equal to r then we have found a contradiction, because $u_j(A) > 0$. If $u_i(\tilde{A} \backslash A) > r$, using Lemma 1.1 we can find a set $\bar{A} \subset \tilde{A} \backslash A$ such that $u_i(\bar{A}) = r$ and $u_j(\tilde{A} \backslash \bar{A}) > 0$, contradicting the assumption. If $u_i(\tilde{A} \backslash A) < r$ for Lemma 1.1 we can find a set $B \subset A$ such that $u_i(B) = r - u_i(\tilde{A} \backslash A)$, then defining $C := B \cup (\tilde{A} \backslash A)$ we have that $u_i(C) = r$, and $u_j(A \backslash B) > 0$, which implies $u_j(\tilde{A} \backslash C) > 0$.

Lemma 1.3. *The function*

$$f(\lambda) := \max\{u_i(A) : \mu(A) = \lambda, A \in L(X)\} \tag{1.1}$$

exists for every $0 \leq \lambda \leq \mu(X)$*.*

Proof. The $\max\{u_i(A) : \mu(A) = \lambda, A \in L(X)\}$ can be transformed into $\max\{u_i(A) : \mu(A^C) = \mu(X) - \lambda, A \in L(X)\}$. From the compactness theorem of Dubins and Spanier (1961) we know that the range of the vector $(u_i(A), \mu(A^C))$ as A varies in $L(X)$ is compact. The vertical section of this range is compact as well so $f(\lambda)$ exists.

Theorem 1.1 (Existence)**.** *Let* $P = (X, u_1, u_2)$ *be a land division problem. Then, there exists a feasible land division* (A_1, A_2) *which is both efficient and equal opportunity equivalent.*

Proof. We first need some notation. Let $L_1^*(X)$ be the collection of those subsets $A \in L(X)$ such that $u_1(A) \geq u_1(B)$ for all $B \in L(X)$ with $\mu(B) = \mu(A)$. Let $R_1 := u_1(X)$ and $R_2 := u_2(X)$. We define functions $U_2, \hat{U}_2 : [0, R_1] \to [0, R_2]$ by

$$\begin{aligned} U_2(r_1) := \max\{u_2(A_2) \quad | \quad & A_2 \in L(X),\ \exists A_1 \in L(X) \text{ such that} \\ & u_1(A_1) = r_1 \text{ and } A_2 = X \backslash A_1\}, \end{aligned}$$

and

$$\begin{aligned} \hat{U}_2(r_1) := \max\{u_2(B_2) \quad | \quad & B_2 \in L(X),\ \exists B_1 \in L_1^*(X) \text{ such that} \\ & u_1(B_1) = r_1, \text{ and } \mu(B_2) = \mu(B_1)\}. \end{aligned}$$

In the same fashion we define $U_1(r_2)$ and $\hat{U}_1(r_2)$.

First we need prove that:

1. The functions $\hat{U}_1$ and $\hat{U}_2$, U_1 and U_2 exist,
2. $\hat{U}_2(0) \leq U_2(0) = R_2$,
3. $U_2(R_1) \leq \hat{U}_2(R_1) = R_2$,
4. U_2 and U_1 are weakly decreasing, $\hat{U}_2$ and $\hat{U}_1$ are weakly increasing (monotonicity property),
5. the functions U_2 and $\hat{U}_2$ are continuous in r_1,
6. U_1 is the inverse function of U_2, and $\hat{U}_1$ is the inverse function of $\hat{U}_2$, namely $U_2(r_1) = U_1^{-1}(r_1)$ and $\hat{U}_2(r_1) = \hat{U}_1^{-1}(r_1)$.

- (Existence) To prove the existence of $\hat{U}_2$ we need to prove that for every $r_1 \in [0, R_1]$ there exists a set $B \subset X$ such that $B \in L_1^*(X)$ and $u_1(B) = r_1$. This is equivalent to prove that the function $f : [0, \mu(X)] \to [0, u_1(X)]$, $f(\lambda) := \max\{u_1(B)|\mu(B) = \lambda\}$ is continuous. The existence of f is guaranteed by Lemma 1.3. $f(\lambda)$ is a weakly increasing function. Let us suppose by contradiction that in $\bar{\lambda}$ f is not continuous. Then there is an r_1 such that $\lim_{\lambda\to\bar{\lambda}^-} f(\lambda) < r_1 < \lim_{\lambda\to\bar{\lambda}^+} f(\lambda)$. For that r_1 consider the function $g(x) := \min\{\lambda|\mu(A) = \lambda, u_1(A) = x\}$. $g(r_1)$ cannot be smaller than $\bar{\lambda}$, because it would violate the maximum condition of $f(\lambda)$. Moreover it cannot be larger than $\bar{\lambda}$, because there would be a couple $(\lambda, f(\lambda))$ such that $\lambda < g(r_1)$ and $f(\lambda) > r_1$. If we call A_1 the set generated by $f(\lambda)$, for Lemma 1 there would be an $\tilde{A}_1 \subset A_1$ such that $u_1(\tilde{A}_1) = r_1$ and $\tilde{\lambda} = \mu(\tilde{A}_1) < g(r_1)$ which violates the definition of g. So $g(r_1) = \bar{\lambda}$, for every r_1 that respects the inequality. Then $g(x)$ would be constant on $[\lim_{\lambda\to\bar{\lambda}^-} f(\lambda), \lim_{\lambda\to\bar{\lambda}^+} f(\lambda)]$. This is not possible because $g(\lim_{\lambda\to\bar{\lambda}^+} f(\lambda))$ generates a set A that, for Lemma 1, strictly contains an $\hat{A}$ such that $u_1(\hat{A}) = \lim_{\lambda\to\bar{\lambda}^-} f(\lambda)$. So $\mu(\hat{A}) < \bar{\lambda}$, violating the definition of g. The existence of the maximum in $\hat{U}_2$ is given by Lemma 1.3. The existence of U_2 is guaranteed by the compactness theorem in Dubins and Spanier (1961), using the same reasoning of the proof of Lemma 1.3. The proof of existence of $\hat{U}_1$ and U_1 can be done in the same way.
- The second and the third points are straightforward.
- (Monotonicity) If U_2 were not decreasing there would be $\tilde{r}_1$ and $\hat{r}_1$ such that $\tilde{r}_1 < \hat{r}_1$ and $U_2(\tilde{r}_1) < U_2(\hat{r}_1)$. Defining $(\hat{A}_1, \hat{A}_2)$ the partition generated by $U_2(\hat{r}_1)$ and $(\tilde{A}_1, \tilde{A}_2)$ the partition generated by $U_2(\tilde{r}_1)$ for

Lemma 1 there must be an $A_1 \subset \hat{A}_1$ such that $u_1(A_1) = \tilde{r}_1$ and, using the set inclusion property, either $u_2(X \backslash A_1) > u_2(\hat{A}_2)$, so $u_2(\tilde{A}_2)$ cannot be a maximum or $u_2(X \backslash A_1) = u_2(\hat{A}_2)$. If there is no A_1 such that the strict inequality is satisfied then for Lemma 2 $u_2(\hat{A}_1) = 0$ and $U_2(\hat{r}_1) = R_2$ and it is constant in $[0, \hat{r}_1]$.
Similarly we can prove the monotonicity property of U_1 .
To prove that $\hat{U}_2$ is weakly increasing we take $\tilde{r}_1$ and $\hat{r}_1$ such that $\tilde{r}_1 < \hat{r}_1$. $\hat{U}_2(\tilde{r}_1)$ generates $(\tilde{B}_1, \tilde{B}_2)$ such that $u_1(\tilde{B}_1) = \tilde{r}_1$, $u_2(\tilde{B}_2) = \hat{U}_2(\tilde{r}_1)$ and $\mu(\tilde{B}_1) = \mu(\tilde{B}_2)$.Then for any set $B_1 \in L(X)$ such that $u_1(B_1) = \hat{r}_1$ we will have $\mu(B_1) \geq \mu(\tilde{B}_1)$, otherwise $\tilde{B}_1 \notin L_1^*(X)$. Then $\mu(B_1) \geq \mu(\tilde{B}_2)$ and any set B_2 such that $\tilde{B}_2 \subset B_2$ and $\mu(B_2) = \mu(B_1)$ will satisfy the following inequality: $u_2(B_2) \geq u_2(\tilde{B}_2)$, proving that $\hat{U}_2$ is weakly increasing. We can be more specific and state that $\hat{U}_2$ can be constant only if it is equal to R_2. In fact if $\hat{U}_2$ is constant on $[\bar{r}_1, \hat{r}_1]$ then calling $\hat{A}_1$ and $\bar{A}_1$ the maximal sets where $\hat{r}_1$ and $\bar{r}_1$ are assumed , it must be $\mu(\hat{A}_1) > \mu(\bar{A}_1)$. The same must hold for the maximal sets $\hat{A}_2$ and $\bar{A}_2$: $\mu(\hat{A}_1) = \mu(\hat{A}_2) > \mu(\bar{A}_2) = \mu(\bar{A}_1)$. Then if $u_2(\hat{A}_2) = u_2(\bar{A}_2)$ the Radon-Nikodym derivative f_2 must be zero almost everywhere on $X \backslash \bar{A}_2$ and $\hat{U}_2(\bar{r}_1) = R_2$.
In the same fashion we can prove that $\hat{U}_1$ is weakly increasing.

- (Continuity) To prove the continuity of U_2 let us do it by contradiction: suppose that in $\tilde{r}_1$ U_2 is not continuous. For the monotonicity property it must be a jump discontinuity and moreover $\lim_{\tilde{r}_1^-} U_2(r_1) > \lim_{\tilde{r}_1^+} U_2(r_1)$. Consider $U_1(\tilde{r}_2)$, where we take $\lim_{\tilde{r}_1^+} U_2(r_1) < \tilde{r}_2 < \lim_{\tilde{r}_1^-} U_2(r_1)$. Then $U_1(\tilde{r}_2)$ cannot be larger than $\tilde{r}_1$, otherwise $U_2(U_1(\tilde{r}_2)) < \tilde{r}_2$ and would not be a maximum. Moreover $U_1(\tilde{r}_2)$ cannot be smaller than $\tilde{r}_1$. Indeed for the monotonicity property there would be a couple $(r_1, U_2(r_1))$ such that $U_2(r_1) > \tilde{r}_2$ and $r_1 > U_1(\tilde{r}_2)$. This is not possible because, calling $(\bar{A}_1, \bar{A}_2)$ the partition generated by $U_2(r_1)$, for Lemma 1 there would be an $A_2 \subset \bar{A}_2$ such that $u_2(A_2) = \tilde{r}_2$ and $u_1(X \backslash A_2) \geq r_1$, and $U_1(\tilde{r}_2)$ would not be a maximum. So $U_1(\tilde{r}_2) = \tilde{r}_1$. Being $\tilde{r}_1$ any real number between $\lim_{\tilde{r}_1^+} U_2(r_1)$ and $\lim_{\tilde{r}_1^-} U_2(r_1)$ U_1 must be constant in $\left[\lim_{\tilde{r}_1^+} U_2(r_1), \lim_{\tilde{r}_1^-} U_2(r_1)\right]$. This is not possible because U_1 and U_2 can be constant only when they are respectively equal to R_1 and R_2, where there would be no matter of discontinuity. Indeed let's call $(\hat{A}_1, \hat{A}_2)$ the partition generated by $U_1\left(\lim_{\tilde{r}_1^-} U_2(r_1)\right)$. Then for all the feasible sets $A_2 \subset \hat{A}_2$ such that $u_2(A_2) = \lim_{\tilde{r}_1^+} U_2(r_1)$

it must be that $u_1(\hat{A}_2 \backslash A_2) = 0$. Then for Lemma 2 $u_1(\hat{A}_2) = 0$, which implies $u_1(\hat{A}_1) = R_1$ and $U_1\left(\lim_{\tilde{r}_1^-} U_2(r_1)\right) = R_1$. Then it must be $\lim_{\tilde{r}_1^-} U_2(r_1) = \lim_{\tilde{r}_1^+} U_2(r_1)$ so U_2 must be continuous. We can prove in the same fashion the continuity of $U_1, \hat{U}_2, \hat{U}_1$.

- (Inverse functions) Let us suppose by contradiction that in r_1 $U_2(r_1) < U_1^{-1}(r_1)$. This is not possible because $U_2(r_1)$ should be the maximum of $u_2(A_2)$ such that $u_1(X \backslash A_2) = r_1$ but $U_1^{-1}(r_1)$ would generate a partition $\left(\tilde{A}_1, \tilde{A}_2\right)$ such that $u_1(\tilde{A}_1) = r_1$ and $u_2(\tilde{A}_2) > u_2(A_2)$. Instead if $U_2(r_1) > U_1^{-1}(r_1)$ for the monotonicity property we would have that $r_1 < U_2^{-1}\left(U_1^{-1}(r_1)\right) = r_1^*$, but that would mean that there is partition $\left(\tilde{A}_1, \tilde{A}_2\right)$ generated by $U_2(r_1^*)$ such that $u_2(\tilde{A}_2) = U_1^{-1}(r_1)$ but $u_1\left(\tilde{A}_1\right) > r_1$. This is a violation of the maximum condition of U_1.
  So $U_2(r_1) = U_1^{-1}(r_1)$. The proof that $\hat{U}_2(r_1) = \hat{U}_1^{-1}(r_1)$ comes from the definition of the two functions.

By these properties, applying the Bolzano Theorem to the function $(U_2 - \hat{U}_2)(r_1)$, there must be some r_1^* such that $U_2(r_1^*) = \hat{U}_2(r_1^*)$. Let $r_2^* := U_2(r_1^*) = \hat{U}_2(r_1^*)$. By definition of U_2, there are subsets $A_1, A_2 \in L(X)$ such that

1. $u_1(A_1) = r_1^*$ and $u_2(A_2) = r_2^*$,
2. $A_2 = X \backslash A_1$, and
3. given that $U_2(r_1) = U_1^{-1}(r_1)$ and $\hat{U}_2(r_1) = \hat{U}_1^{-1}(r_1)$ there is no feasible land division (A_1', A_2') with $u_1(A_1') \geq r_1^*$ and $u_2(A_2') \geq r_2^*$ such that $(u_1(A_1'), u_2(A_2')) \neq (r_1^*, r_2^*)$.

Since the function U_2 is weakly decreasing and $\hat{U}_2$ is weakly increasing it follows from (1), (2) and (3) that (A_1, A_2) is a feasible and efficient land division with $u_1(A_1) = r_1^*$ and $u_2(A_2) = r_2^*$.

On the other hand, by definition of $\hat{U}_2$ there are subsets $B_1, B_2 \in L(X)$ and a number $\lambda > 0$ such that
(4) $u_1(B_1) = r_1^*$ and $u_2(B_2) = r_2^*$,
(5) $\mu(B_1) = \mu(B_2) = \lambda$,
(6) $u_1(B_1) = \max\{u_1(B) \mid B \in L(X) \text{ and } \mu(B) = \lambda\}$, and
(7) $u_2(B_2) = \max\{u_2(B) \mid B \in L(X) \text{ and } \mu(B) = \lambda\}$.

Here, (6) follows from the assumption that $B_1 \in L_1^*(X)$. By (4) - (7), and our previous insight that (A_1, A_2) is a feasible and efficient land division with $u_1(A_1) = r_1^*$ and $u_2(A_2) = r_2^*$, it follows that the feasible land division (A_1, A_2) is efficient and equal opportunity equivalent. This completes the proof.

□

Theorem 1.2 (Uniqueness)**.** *All the efficient and equal opportunity equivalent land divisions* (A_1, A_2) *yield a unique utility pair* $(u_1(A_1), u_2(A_2))$ *if the Radon-Nikodym derivatives* f_1 *and* f_2 *respectively of* u_1 *and* u_2 *are different from zero almost everywhere on* X*.*

Proof. If the Radon-Nikodym derivatives f_1 and f_2 are different from zero a.e. on X the function U_2 is strictly decreasing and the function $\hat{U}_2$ is strictly increasing on on $[0, R_1]$. Then they cross just in one point (r_1, r_2) which is the unique utility pair that can be obtained by any efficient and equal opportunity equivalent land division.

□

1.4 The mechanism

In this section we present a simple mechanism to implement an efficient and equal opportunity equivalent allocation when agents have complete information.

Round 1. Agent 1 announces $\lambda \in [0, \mu(X)]$. Agent 2 can take any portion B_2 such that $\mu(B_2) \leq \lambda$ or propose a land division $(A_1, A_2) \in L(X) \times L(X)$. If agent 2 takes B_2, agent 1 gets $X \backslash B_2$. If agent 2 proposes a land division $(A_1, A_2) \in L(X) \times L(X)$, then round 2 is played

Round 2. Agent 1 can accept agent 2's proposal and in this case the proposal is implemented, or reject it and take any portion B_1 with $\mu(B_1) \leq \lambda$. In case of rejection agent 2 gets the portion $X \backslash B_1$.

For any $\lambda \in [0, \mu(X)]$ and for any $i = 1, 2$ let $B_i^\lambda = \{\, B \in L(X) | \arg\max \ u_i(B)$ s.t. $\mu(B) \leq \lambda\}$.

The equilibrium concept used is subgame perfection; for short, we simply speak of "equilibrium".

Theorem 1.3. *The mechanism described above has unique equilibrium payoffs, with final allocations that are efficient and equal opportunity equivalent. In every equilibrium allocation, each agent* i *is indifferent between the parcel* *he receives and getting $u_i(B_i^{\lambda^*})$, where $\lambda^* = \max\{\lambda :$ there exists $(A_1, A_2) \in L(X) \times L(X)$ with $u_i(A_i) \geq u_i(B_i^{\lambda})$ for each $i\}$*

Proof. We proceed by stating and proving some easy lemmas.

Lemma 1.4. *Suppose that agent 1 has announced λ at round 1 and agent 2 has made a proposal (A_1, A_2) at round 2. Agent 1 accepts agent 2's proposal if and only if $u_1(A_1) \geq u_1(B_1^{\lambda})$, otherwise he takes B_1^{λ}.*

The proof of lemma 1.4 is straightforward.

Lemma 1.5. *Suppose that agent 1 has announced λ at round 1. Agent 2 proposes the allocation*

$$(A_1^{\lambda}, A_2^{\lambda}) \in \{(A_1, A_2) \in L(X) \times L(X) | \arg\max u_2(\cdot) s.t. u_1(A_1) = u_1(B_1^{\lambda})\} \tag{1.2}$$

if and only if $u_2(A_2^{\lambda}) \geq u_2(B_2^{\lambda})$; if $u_2(A_2^{\lambda}) < u_2(B_2^{\lambda})$ then he takes the portion B_2^{λ}.

Proof. By lemma 1.4 agent 1 accepts a proposal if and only $u_1(A_1) \geq u_1(B_1^{\lambda})$. Since agent 2 can chop off a morsel of agent 1's portion and give it to himself, then if he makes a proposal (A_1, A_2) it must be that $u_1(A_1) \leq u_1(B_1^{\lambda})$. Hence agent 2's best proposal satisfies the constraint $u_1(A_1) = u_1(B_1^{\lambda})$. Finally agent 2 makes a proposal only if there exists a proposal which guarantees to him a payoff higher than the payoff he gets by taking the portion B_2^{λ} (note that any agent 2's proposal that is rejected by agent 1 is payoff equivalent to the (acceptable) proposal $(A_1, A_2) = (B_1^{\lambda}, X \backslash B_1^{\lambda})$)

Let $\mathbf{A} = \{(A_1^{\lambda}, A_2^{\lambda})$ for some $\lambda \in [0, \mu(X)]$ and $u_2(A_2^{\lambda}) \geq u_2(B_2^{\lambda})\}$ and $A^{\lambda^*} = (A_1^{\lambda^*}, A_2^{\lambda^*}) \in \mathbf{A}$ be such that for all $A^{\lambda} \in \mathbf{A}$, $\lambda \leq \lambda^*$.

Lemma 1.6. *At round 1, agent 1 proposes λ^*.*

Proof. Suppose agent 1 proposes λ^* at round 1. By lemma 1.5 at round 2 agent 2 proposes the allocation $(A_1^{\lambda^*}, A_2^{\lambda^*})$ and agent 1 accepts. Hence agent 1 by proposing λ^* at round 1, gets $u_1(A_1^{\lambda^*}) = u_1(B_1^{\lambda^*})$. Suppose agent 1 proposes $\lambda < \lambda^*$. For all $\lambda < \lambda^*$ $(A_1^{\lambda}, A_2^{\lambda}) \in \mathbf{A}$. By Lemmas 1.4 and 1.5 by proposing λ agent 1 obtains $u_1(B_1^{\lambda}) < u_1(B_1^{\lambda^*})$. Suppose now agent 1 proposes $\lambda > \lambda^*$.By definition of $\lambda^*, (A_1^{\lambda}, A_2^{\lambda}) \notin \mathbf{A}$ and $u_2(A_2^{\lambda}) < u_2(B_2^{\lambda})$. By lemma 1.5, agent 2 at round 2 takes B_2^{λ} and agent 1 gets $X \backslash B_2^{\lambda}$. Since $\lambda > \lambda^*$, it follows that $u_2(B_2^{\lambda}) > u_2(B_2^{\lambda^*})$. Since by construction $(A_1^{\lambda^*}, A_2^{\lambda^*})$ is an efficient allocation, it follows that $u_1(X \backslash B_2^{\lambda}) < u_1(A_1^{\lambda^*}) = u_1(B_1^{\lambda^*})$.

□

Chapter 2

Lobbying in a multidimensional policy space with salient issues

2.1 Introduction

In 2012 in the US 3.30 billion dollars were spent on lobbying the Congress and federal agencies. In 2012 there were 12411 unique, registered lobbying firms in the US[1]. The amount of resources devoted to this activity and the number of firms involved shows the relevance of lobbying in the policy making process. In the political economy literature with a fixed number of candidates, the equilibrium policy, resulting from the interaction of the voting and lobbying processes, is determined by the maximization of a weighted sum of the utility function of lobbies and some aggregate welfare function of voters, see Grossman and Helpman (1996). Lobbying therefore, in these models, has always an effect on the implemented policy.

A recent literature, initiated by Besley and Coate (2001) and Osborne and Slivinski (1996), has endogenized the number of candidates, allowing politicians to be selected, by majority voting, among those citizens who choose to enter the electoral campaign. The citizen-candidate framework was meant to provide useful insights on the endogenous positions of candidates and their number. Nonetheless the citizen-candidate model with lobbying, introduced by Besley and Coate (2001) on a unidimensional policy space, predicts that lobbies do not have an effect on the equilibrium policy. Indeed voters can always support candidates with offsetting policy preferences, thus lobbying changes the identity of the elected politician, but not the implemented policy. Considering that the possibility of finding offsetting candidates is inherent of citizen-candidate models, it seems that they are not fit for understanding

[1]http://www.opensecrets.org/lobby/index.php

lobbying.

In this paper we overcome this limitation, investigating a citizen-candidate model with lobbying on a multidimensional policy space. A multidimensional policy space is a very realistic environment for studying the interaction between voters and candidates, because citizens truly have preferences on many different issues, from taxation to environmental topics and moral values. All these matters are subject to the action of elected politicians.

Multidimensionality innovates Besley and Coate (2001) because, with many topics in the policy space, it is natural to differentiate them based on their salience. Indeed in every national and local political race voters consider some issues more important than others. For example in the United States in the 2012 the state of the economy was important for 92% voters[2]. Issues like gay marriage and abortion was instead important for 38 % voters. In the model presented here we introduce two types of citizens, differentiated by their ranking of issues. For example, one type gives more importance to state of the economy, while the other type considers the moral issue the most relevant. The type is private information of the citizen. Still for each type citizens have heterogenous preferences for policies in each dimension, e.g. for the type that considers the state of the economy the most relevant, there are citizens who believe in state intervention, and others who think there should be more market and less state. Given that candidates are citizens, they also have types. To keep the analysis more intuitive we introduce a single unidimensional lobby per issue. When faced with contributions from lobbies after elections, an elected politician of a type that considers the economy more relevant, will please more the lobby on the moral issue, because the policy preferences of the politician are weaker on that topic. Therefore, different types of politicians implement different policies. Going back to the voting stage, we prove that there are pooling equilibria, in which citizens are not able to identify the type of the candidates, and vote on expected policies. Hence they will offset lobbying either too much or too little, and as anticipated, in equilibrium lobbying will have an effect on the implemented policy.

There are other results that flow naturally from the setting of the game. One of them is that if, for all types of citizens, the salience of an issue is lowered, then the lobby that works on that topic increases its influence on the implemented policy. Thus the most effective lobbies are the ones that work on the topics that people care less about. This result provides an explanation of why politicians are more sensitive to lobbying, and therefore less sensitive to voters'preferences, on some issues. For example, in January 2003, 63 % of

[2]http://www.gallup.com/poll/153029/economy-paramount-issue-voters.aspx

Americans were against the US government's decision of invading Iraq[3]. In 2005, 64% of Italian voters, 55% among rightwing ones, were in favour of civil unions, but the parliament rejected the law proposal[4]. Still in Italy, in 2010, the parliament voted laws for building new nuclear plants and privatizing the public water system. Nevertheless, a citizen initiative in 2011 brought 54 % of the italian voting population to vote on these issues, and 96% of citizens who showed up voted for the rejection of these laws.

Another finding that emerges from the equilibrium analysis is that some citizens, with the same most preferred policy but with a different ranking of issues, vote for different candidates. An example referred to the American Presidential elections of 2012 would be two citizens, both wishing more income redistribution and against legal abortion, who voted for different candidates, because one thought the economy was more important than moral issues and supported Obama, while the other citizen felt the opposite and voted for Romney.

An extension of the model partially endogenizes the power of lobbies. We provide citizens with the possibility of giving monetary contributions to lobbies in order to increase their ability to move the implemented policy closer to their bliss point. With more than one lobby per issue we find that, under some conditions, only the more extreme lobbies in every dimension receive contributions. When studying the effect of the salience of an issue on citizens' contributions to lobbying, we find that the effectiveness of a lobby is maximized when the salience of a topic is low for most of citizens and high for a small group. This small group is indeed the special interest group the finances the lobby.

All the results mentioned above are derived from the three main ingredients of the model. The main contribution of this paper is thus to bring together in a citizen candidate model lobbying, multidimensionality of the policy space and salience of issues.

The paper is organized as follows: section 2.2 makes a literature review on voting and lobbying. Section 2.3 introduces the model. Section 2.4 presents the results, section 2.5 endogenizes lobbying, while section 2.6 concludes.

2.2 Literature Review

An extended literature exists on voting and lobbying, in most of it lobbying is modeled through menu auctions: the politician receives contributions contingent on the implemented policy. See Bernheim and Whinston (1986),

[3]http://www.cbsnews.com/stories/2003/01/23/opinion/polls/main537739.shtml

[4]http://www.repubblica.it/2005/i/sezioni/politica/prodipacs/itafavo/itafavo.html?ref=search

Grossman and Helpman (1996) and Besley and Coate (2001). The citizen candidate model has been developed separately by Osborne and Slivinski (1996) and Besley and Coate (1997). Osborne and Slivinski (1996) study the model on a single dimension and assumes sincere voting, while Besley and Coate (1997) prove their results on a multidimensional setting with strategic voters. Besley and Coate (2001) take the one dimensional citizen candidate model and add lobbies. In this paper in equilibrium lobbying is always offset by the voters, who foresee the subsequent lobbying and strategically delegate undoing the work of lobbies. Even though lobbies pay their contributions and there is an effect of interest groups on the choice of candidates, there is no effect on the implemented policy. We will study the citizen candidate model on a multidimensional policy space, with salient issues, with strategic voting and lobbies. Moreover coherently with the idea that information about the general salience of issues is incomplete, during the electoral campaign we assume that there are different types of voters, each of them identified with a different ranking of issues. It is not known which type is a voter by the other citizens. In this way we also address the strategic delegation, showing that in some cases there is a visible of effect of lobbying on the implemented policy. Felli and Merlo (2006) study the interaction between voting and lobbying on a unidimensional setting where the elected politician can choose which lobbies to receive contributions from. They show an effect of lobbying on policies. Glaeser et al. (2005) argue that Republicans and Democrats have become increasingly extremist on the religious issue, to induce their core constituencies to show up and vote, and that is caused by a growing religious sentiment in the US. Reading this fact through the lenses of our model we should see an effect of lobbying on non moral related issues in these last years. It is indeed true that for example the Buffet rule was supported by the 72 % of Americans, 53 % among Republicans [5]. Still it was not approved by the Congress. Krasa and Polborn (2010) created a multidimensional binary model with salient issues. They argue that policy spaces, formed by finite and especially binary choices on each issue, are common in electoral campaigns and deliver more realistic results. In their setting candidates start with some fixed positions on some dimensions and fight for swing voters on others, where they are flexible. Besley and Coate (2008) analyze the positive role of citizens' initiatives or referenda, in order to bring implemented policies closer to the will of the majority. The reasons why, even if a Condorcet winner policy in all dimensions exists, it could not be implemented, are that in all elections issues are bundled together. They

[5] http://politicalticker.blogs.cnn.com/2012/04/16/cnn-poll-7-out-of-10-support-buffett-rule/

identify three main channels: a divergence between the elite of a party and the popular opinion on non salient issues, a group of voters who vote as a single issue voter on a minority view, and when a minority view is supported by an interest group on a non salient issue. The third case is the one we focus on in this paper. Two papers that consider the salience of issues are Roemer (1998) and Lee and Roemer (2006). Roemer (1998) investigates with a theoretical model why a redistributive political party could be forced to propose a low tax rate, in a world with two issues (tax policy and religion), if the religious dimension becomes very salient. Lee and Roemer (2006) study empirically how racism among voters contributed to reduce the income tax rate in the US in the period 1976-1992. While the reasoning behind Roemer (1998) relies on a specific distribution of voters in the policy space, in particular on the presence of a large poor racist part of the population, the results of our model explain the same phenomenon analyzed by Roemer (1998) and are valid for any distribution of citizens in the policy space.

Finally there is an important part of the political economy literature dedicated to the empirical study of the dimensions of the political space and the bliss points of MPs. Poole and Rosenthal (1985) use data on the roll call voting on the US House and Senate to test the program NOMINATE on the positions of MPs in a unidimensional model. Poole and Rosenthal (1997) and Poole and Rosenthal (2001) integrate this initial work with a dynamic program, testing for the number of dimensions of the political space of MPs. They find that the multidimensionality of the policy space can be reduced to 2. Hix et al. (2006) test the same statistical model on the European Parliament. The concept of policy space in our model is different from the political space of Poole and Rosenthanl. They collapse the policy space in a 2-dimensional political space because most of the times MPs vote following their party direction on the conservative-liberal axis, while on other votes their behavior can be regrouped following the North-South US axis. The number of dimensions is thus related to the number of opposite parliamentary blocks that appear in different votes. Instead the dimensions of the policy space in our model refer to different issues that affect voters. We do not model parliamentary voting and assume a single politician implements a multidimensional policy when she is elected.

2.3 The Model

The $K-$dimensional policy space is denoted by $D = [0,1]^K$. The set of citizens is denoted by $N = \{1, ..., M\}$. Citizen $i \in N$ has the following utility function:

$$U(q,i) = \sum_{k=1}^{K} \lambda_k^i u(q_k, q_k^i) + \rho y^i, \tag{2.1}$$

where q_k is the kth element of the vector policy $q \in D$. $u(q_k, q_k^i)$ is strictly concave in q_k, single-peaked and symmetric around q_k^i. q^i is citizen i's bliss point. ρ measures the intensity of citizen's preferences over money with respect to policy. $\lambda_k^i \geq 0$ is the weight given by citizen i to dimension or issue k. We normalize $\lambda_1^i = 1$, so all other weights are relative to the first one.
We assume that M is large enough such that the density function f on the space $D = [0,1]^K$ and "cumulative" induced measure F, such that $F(A) = \int_A f d\mu, A \subset D$, can be assumed to be continuous[6].
Lobbies have a similar utility function. For simplicity we assume that there is just one lobby for each dimension:

$$V(q,k) = \mu_k u(q_k, q_k^L) + y_k^L, \tag{2.2}$$

where μ_k is an idiosyncratic parameter for every lobby. μ_k is the relative intensity of lobby's preferences for policy with respect to money. For the same utility gain a lobby with higher μ_k is willing to pay more. We normalize transfers to be zero $\int_S y^i di + \sum_{k=1}^{K} y_k^L = 0$.

2.3.1 Uncertainty about voters' preferences

Some parts of our analysis will be restricted to $K = 2$. In this setting we will assume that there are only two types of citizens: type 1 is characterized by weights $(1, \lambda_2^1)$, type 2 by $(1, \lambda_2^2)$, where $\lambda_2^1 < \lambda_2^2$, meaning that type 1 citizens weight more dimension 1 with respect to type 2 citizens. The types set is denoted by $T = \{1, 2\}$. Citizens of type 1 and 2 have the same distribution f on the policy space. The type of each citizen is not known at the beginning, there is a common prior: each citizen has probability p of being of type 1 and probability $1 - p$ of being of type 2. We parameterize $\lambda_2^1 = \theta\eta$ and $\lambda_2^2 = (2 - \theta)\eta$, $\theta < 1$, where $\eta = 1/2(\lambda_2^1 + \lambda_2^2)$ is the arithmetic average of the two parameters. Uncertainty about types of voters makes this game Bayesian.

[6]This assumption was made also in Felli and Merlo (2006). Having an infinite and continuous amount of strategic voters poses theoretical questions about the definition of the equilibria and the consistency of the game. In a later version of the paper we prove that the equilibria presented in this chapter exist also with a finite number of citizens. Moreover they are the only equilibria that exist for a large, but finite, number of citizens.

2.3.2 Entry of candidates

Each citizen can enter as a candidate paying a small cost c. We denote by $\sigma(i,t) : S \times T \to \{0,1\}$ the decision of type t citizen i, $\sigma(i,t) = 1$ indicates (i,t)'s decision to enter as a candidate, while if $\sigma(i,t) = 0$ (i,t) will stay out. We define $C(\sigma) = \{i \in S : \exists t \text{ such that } \sigma(i,t) = 1\}$ the set of candidates for every entry function σ. If no one runs for office we assume that a default policy $q^{sq} \in [0,1]^K$ is implemented.

2.3.3 Voting

Every citizen has one vote to cast for one of the candidates in $C(\sigma)$. Given $C(\sigma)$ each citizen simultaneously decides to cast a vote for a candidate or abstain. Let $\gamma(i)$ citizen i's choice, if $\gamma(i) = e$ citizen i casts a vote for candidate $e \in C(\sigma)$, if $\gamma(i) = 0$ she abstains. Each citizen makes her decision maximizing her expected utility, given the choice of other voters. Voters are strategic. The candidate that gets more votes is elected. If two or more candidates tie the winner is selected with equal probability among all the tying candidates. The voting subgame is also Bayesian, because the voters' types are private information.

2.3.4 Lobbying

Lobbies offer the winning candidate binding contracts contingent to the future implemented policy. The contribution, or willingness to pay, offered by lobby k to politician P for a policy q is defined as follows:

$$w(q_k, k) = \mu_k[u(q_k, q_k^L) - u(q_k^P, q_k^L)], \tag{2.3}$$

which is the utility gain lobby k gets if policy q is implemented instead of policy q^P. The elected politician receives contributions from all the lobbies and chooses q^* maximizing her utility after lobbying:

$$q^* = \arg\max_{q \in D} \sum_{k=1}^{K} \lambda_k^P u(q_k, q_k^P) + \rho \sum_{k=1}^{K} \mu_k[u(q_k, q_k^L) - u(q_k^P, q_k^L)]. \tag{2.4}$$

Summarizing the timing of the game is the following:

1. citizens simultaneously decide to enter as candidates,

2. voters simultaneously vote for a candidate or abstain,

3. lobbies offer contributions to the winning candidate,
4. the elected politician implements a policy.

In order to have closed form solutions we assume the concave function $u(x, y)$ takes the following form:

$$u(x, y) = -(x - y)^2$$

We will make use also of the matrix notation:

$$q^i = \begin{pmatrix} q_1^i \\ \vdots \\ q_K^i \end{pmatrix},$$

$$\Lambda^i = \begin{pmatrix} \lambda_1^i & 0 & \cdots & 0 \\ 0 & \lambda_2^i & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \lambda_K^i \end{pmatrix},$$

$$M = \begin{pmatrix} \mu_1 & 0 & \cdots & 0 \\ 0 & \mu_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \mu_K \end{pmatrix}.$$

2.4 Results

We proceed backwards to solve for the perfect Bayesian equilibrium of the multistage game. We start from the last stage: lobbying and the implementation of a policy by the elected politician. We keep K unspecified in this subgame, and restrict to $K = 2$ in the voting subgame.

2.4.1 Equilibria in the lobbying subgame

After elections are over one candidate P becomes the politician and, aware of the lobbying contributions, decides which policy q^* to implement.

Lemma 2.1. *The elected politician P implements the following policy:*

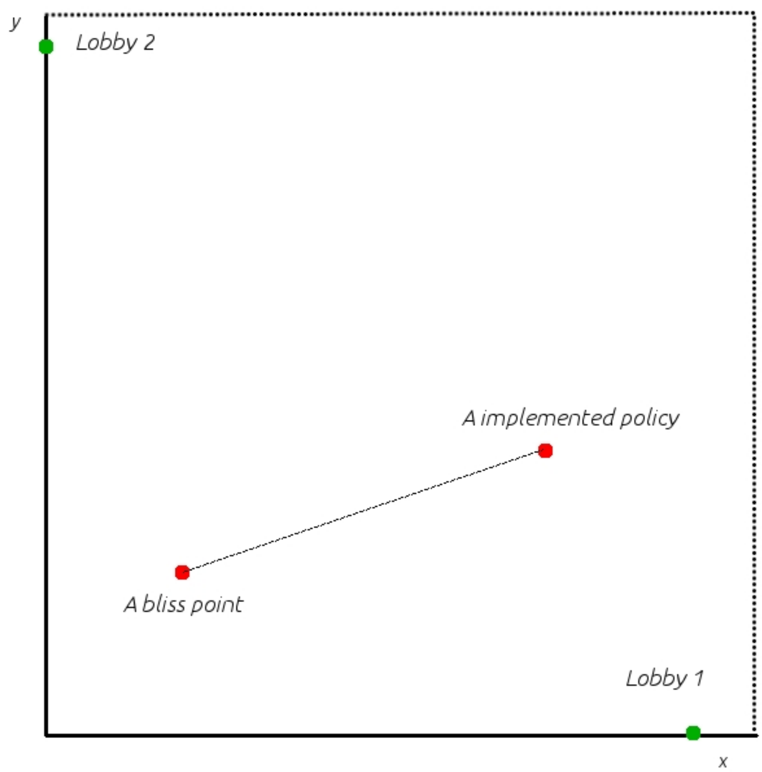
$$q^{*P} = \left(\Lambda^P + \rho M\right)^{-1} \left(\Lambda^P q^P + \rho M q^L\right). \tag{2.5}$$

The equilibrium policy is unique, given the entry function σ, and voting decision γ.
If $\Lambda^P = \Lambda$ is common for all citizens the implemented policy is:

$$q^{*P} = (\Lambda + \rho M)^{-1} \left(\Lambda q^P + \rho M q^L\right). \tag{2.6}$$

The proof is presented in the appendix.
The politician implements a policy which is a convex combination of her most preferred policy and the most preferred policy of the lobbies, in each dimension. If the ranking Λ is the same for every citizen then in dimension j the weights are $\frac{\lambda_j}{\lambda_j+\rho\mu_j}$ and $\frac{\rho\mu_j}{\lambda_j+\rho\mu_j}$.

Figure 2.1: Divergence between A bliss point and A impl policy. $\lambda_2^A >> \lambda_1^A$



The salience of each dimension λ_j interacts with ρ and μ_j to determine the implemented policy. In the following sections the superscript P is dropped from q^*, when there is no confusion about the identity of the politician. We now perform some comparative statics.

If there is a common ranking Λ we define $q^*(\lambda_j)$, where we underline the dependence of the equilibrium policy q^* on the common salience of issue j. $q^*(\lambda_j^o)$ and $q^*(\lambda_j^l)$ are then two equilibrium policies that arise with the same set of parameters $\lambda_{i \neq j}, M, \rho, c, q^i$, apart from λ_j. It is important to notice that $q^*(\lambda_j)$ could not be an equilibrium for some $\lambda_j > 0$.

Proposition 2.1. *Given a politician with bliss point q^P, and $\lambda_j^i, \lambda_j^l > 0$, if $q^*(\lambda_j^i)$ and $q^*(\lambda_j^l)$ are both equilibria, then:*

$$\lambda_j^i < \lambda_j^l \Longrightarrow |q_j^*(\lambda_j^i) - q_j^L| < |q_j^*(\lambda_j^l) - q_j^L|. \tag{2.7}$$

The proof is presented in the appendix.
If an issue is less salient it is easier for the lobby in that dimension to move the implemented policy closer to its bliss point.

With abuse of notation we define $q^*(\mu_j)$, where the equilibrium implemented policy now depends on μ_j, the preference for policy with respect to money of lobby j. The other parameters are fixed.

Proposition 2.2. *Given $\mu_j^i, \mu_j^l > 0$, if $q^*(\mu_j^i)$ and $q^*(\mu_j^l)$ are both equilibria, then:*

$$\mu_j^i < \mu_j^l \Longrightarrow |q_j^*(\mu_j^i) - q_j^L| > |q_j^*(\mu_j^l) - q_j^L|. \tag{2.8}$$

The proof is presented in the appendix.
If a lobby has stronger preferences for policy with respect to money in a dimension, the implemented policy is closer to the lobby's bliss point.

Now we restrict to $K = 2$ and we use the parametrization of λ_2^1 and λ_2^2. We define $q^*(\eta)$ as before. We state the following:

Proposition 2.3. *Given $\eta^i, \eta^l > 0$, if $q^*(\eta^i)$ and $q^*(\eta^l)$ are both equilibria, then:*

$$\eta^i < \eta^l \Longrightarrow |q_2^{*P}(\eta^i) - q_2^L| < |q_2^{*P}(\eta^l) - q_2^L|, \tag{2.9}$$

for a politician P of type 1 or 2.

The proof is presented in the appendix.

If a dimension is less salient for all types of voters in the population the lobby obtains a higher utility gain from the policy implemented by the elected candidate. Proposition 2.1 and 2.3 say that a lobby can "move" the policy maker closer to its bliss point if the issue on which the interest group is lobbying is less salient for all citizens. These comparative statics confirm our prediction: in this model the elected politician in the most salient dimensions implements a policy closer to her own bliss point, in less salient issues she pleases lobbies.

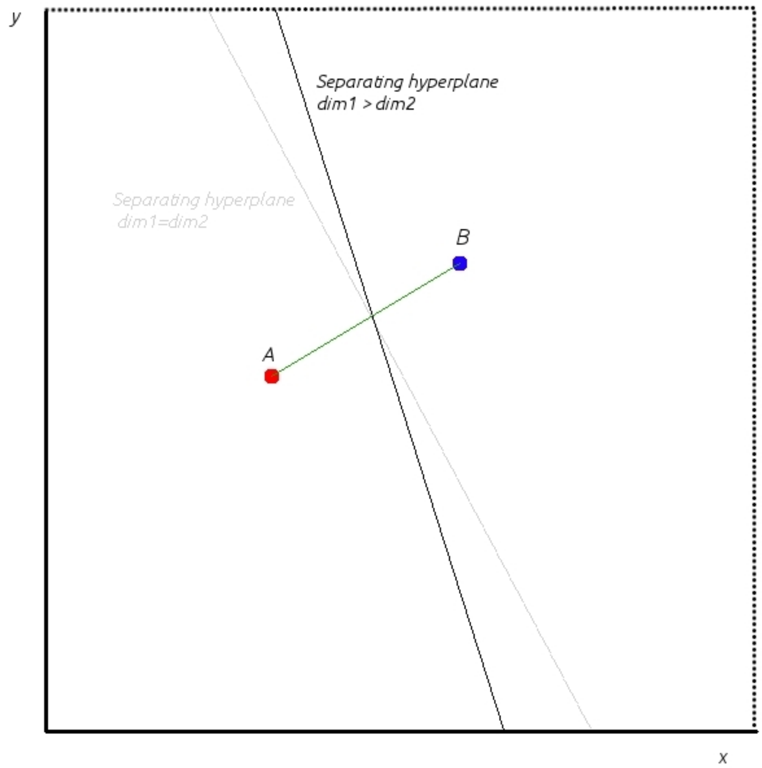
2.4.2 Voting Equilibrium

In the voting equilibrium we rule out weakly dominated strategies, as in Besley and Coate (1997). We concentrate our attention on two-candidate equilibria. If in the entry stage equilibrium the two types of the same citizen i take different actions, for example type A of citizen i enters as a candidate and type 2 does not, voters correctly predict that they are facing type A of candidate i and they behave accordingly. If the two types of citizen i take the same action, voters use the prior on the types to compute the expected implemented policy. Consequently in this section we identify the candidates with the policies voters think they will implement, anticipating also the effect of lobbying. We call them candidates' expected policies.

If there is just one type of voters and two candidates, $C(\sigma) = \{A, B\}$, given that in this situation strategic voting implies sincere voting, to compute the voting equilibrium we partition the policy space, computing for each candidate $c \in C(\sigma)$ the subset $N(c) = \left\{q^v \in D | v \in N, c = \arg\max_{P \in C(\sigma)} u(q^{*P}, v)\right\}$, where q^{*P} is candidate P's expected policy. The winning candidate is $P = \arg\max_{c \in C(\sigma)} F(N(c))$.

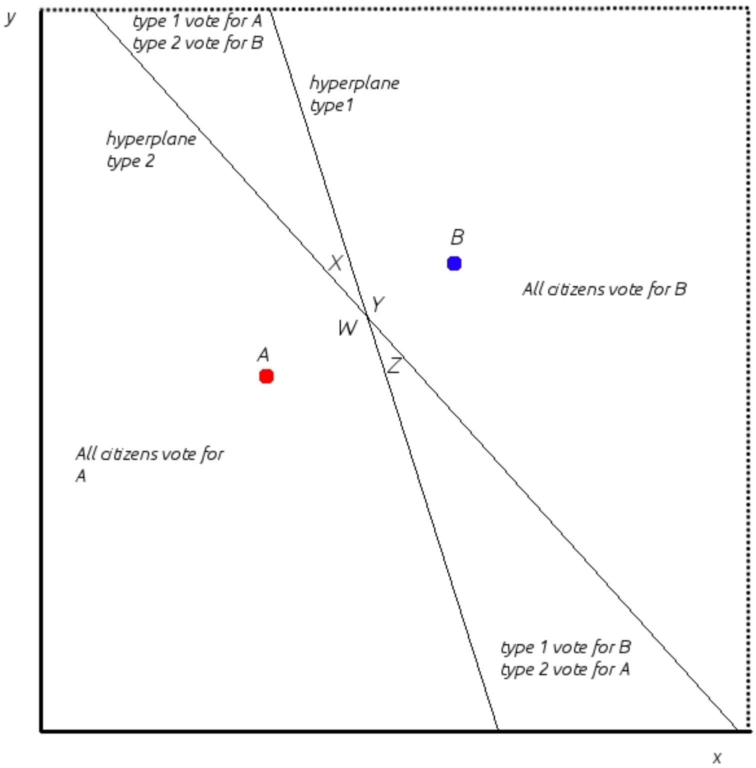
With just one type of voters the partition of the policy space D is carried through separating hyperplanes: if $\lambda_1 = \lambda_2$ the hyperplane is orthogonal to the segment connecting the expected policies of the two candidates and cuts it in half. If $\lambda_1 \neq \lambda_2$ the hyperplane cuts in half the segment connecting the two candidates' policies and "leans" towards the more important dimension. Indeed if the expected policies of candidates A and B are respectively (x_A, y_A) and (x_B, y_B) the derivative of the separating hyperplane is $\frac{\lambda_1(x_B - x_A)}{\lambda_2(y_A - y_B)}$. We define such hyperplane $h_{\lambda_1 \lambda_2}$. It is worth noticing that the angle between the orthogonal hyperplane and the "leaning" one depends not only on the relative weights but also on the positions of the two candidates. Indeed if the two candidates have the same positions on one of the two issues, that is either $x_A = x_B$ or $y_A = y_B$ the orthogonal and the "leaning" hyperplanes coincide.

Figure 2.2: A separating hyperplane "leaning" towards dimension 1



With two types of voters there is uncertainty about the number of citizens who vote for a candidate, because depending on their type, they could vote for one or another candidate. The Law of Large Numbers helps us in having easy results, indeed the probability distribution of voters for a candidate is degenerate, when the number of voters is infinite. Let us make an example with $K = 2$ and two types of voters: if the entry stage delivered two candidates, we will have the following partition of the policy space:

Figure 2.3: Partition of the policy space with 2 types of voters



The dots A and B represent candidates A and B's expected policies. The hyperplanes $h_{1\lambda_2^1}$ and $h_{1\lambda_2^2}$ partition the policy space in 4 areas. As we can see there are two areas, W and Y, where the two types of same citizen vote for the same candidate. There are other two areas, X and Z, where the two types vote for different candidates. In area X every citizen votes with probability p for A and with probability $1-p$ for B. In area Y the converse is true. In area X we are interested to know the probability density function $g(y)$ of the proportion y of citizens voting for A, which is equivalent to compute the density of the variable $\sum_{i=1}^{n} \frac{X_i}{n}$ for $n \to \infty$, where X_i is the Bernoullian variable taking value 1 if citizen i with bliss point $q^i \in X$ is of type 1. For the law of Large Numbers we know that the limit converges almost surely to the expected value $\mathbb{E}(X_1) = \mathbb{E}(X_2) = ... = p$. We then know that the event "of all citizens with bliss point in X p of them vote for A" has probability 1. Candidate A receives the following votes:

$$\int_W f(x)dx + p\int_X f(x)dx + (1-p)\int_Z f(x)dx,$$

while candidate B receives:

$$\int_Y f(x)dx + p\int_Z f(x)dx + (1-p)\int_X f(x)dx.$$

It is necessary for the characterization of the equilibria to understand under which conditions 2 candidates will split in half the constituency.

Lemma 2.2. *A necessary condition for a two-candidate equilibrium with tying candidates, $C(\sigma) = \{A, B\}$, is the following:*

$$\int_W f(x)dx+p\int_X f(x)dx+(1-p)\int_Z f(x)dx = \int_Y f(x)dx+p\int_Z f(x)dx+(1-p)\int_X f(x)dx, \tag{2.10}$$

where (W, X, Y, Z) result from the partition of the space by two separating hyperplanes, h_{1,λ_2^1} and h_{1,λ_2^2}. In W citizens of both type vote for A, in Y citizens of both types vote for B, in X type 1 citizens vote for A and type 2 citizens vote for B and the converse in Y. If the candidates' expected policies q^{*A} and q^{*B} are such that $q_i^{*A} = q_i^{*B}$ for i either $\in \{1,2\}$ h_{1,λ_2^1} and h_{1,λ_2^2} coincide and equation 2.10 becomes:

$$\int_W f(x)dx = \int_Y f(x)dx. \tag{2.11}$$

The next lemma gives states conditions about the entry of a third candidate.

Lemma 2.3. *There is a subgame voting equilibrium, where voters face 3 candidates and 2 candidates' expected implemented policies satisfy condition 2.10, such that the candidate, whose expected implemented policy does not satisfy 2.10, loses with certainty.*

2.4.3 Entry Equilibrium

To characterize a two-candidate equilibrium we need to study the Bayesian nature of the entry stage. We know that a necessary condition for a two tying candidate equilibrium is given by equation 2.10. In equation 2.10 the four areas are defined by the hyperplanes, which are based on the candidates' expected policies. Let us define σ^* the equilibrium entry function. If for all $i \in C(\sigma^*)$ $\sigma^*(i,1) = \sigma^*(i,2)$ the entry equilibrium is defined totally pooling. If for all $i \in C(\sigma^*)$ $\sigma^*(i,1) \neq \sigma^*(i,2)$ the entry equilibrium is defined totally separating. If the entry equilibrium is totally separating, the expected policies are the implemented policies, if the entry equilibrium is totally pooling,

the expected policies are the expected implemented policies. In this section with abuse of notation we refer to q^{*i_t} as the policy implemented by type t candidate i if she were elected, and to P_t if nature has drawn type t for candidate P. We refer also to the Euclidean distance in $\mathbb{R}^2$ between x and y as $|x-y|$. We denote $-t$ as the non t type. When there are only two candidates we denote $-P$ as the non P candidate. We define $\bar{q}^P := pq^{*P_1} + (1-p)q^{*P_2}$ the expected implemented policy of candidate P.
There is an infinite amount of entry equilibria given by the positions of the candidates. In a game without uncertainty about the types of candidates, and without uncertainty about the voting behavior, a necessary condition for a 2 candidates equilibrium is that the 2 candidates tie. Otherwise one candidate would lose for sure and would rather not enter and save c. Moreover when the population of strategic voters is large Besley and Coate (1997) prove that there cannot be equilibria with more than 2 candidates. In our game the uncertainty about voting behavior is solved with the law of large number. For what concerns uncertainty about the types of candidates, if we have a pooling equilibrium we know that in the voting stage citizens will face 2 candidates, even though they do not know their identity. In this case the expected implemented policies of the candidates must split the electorate evenly. Instead, if we have a separating equilibrium, it could be that the type that is supposed to enter of a certain candidate is not drawn by Nature. Therefore citizens in the voting stage would face only one candidate. This changes the incentives to enter as a candidate, because a candidate that would lose against its opponent could find convenient to enter, indeed with some probability the other candidate is not drawn and she wins with certainty. Consequently there will be separating equilibria with 2 tying candidates, and with 2 non tying candidates. The same reasoning opens the way to separating equilibria with more than 2 candidates. 2 candidates equilibria with non tying candidates and equilibria with more than 2 candidates are not analyzed in this chapter.

In the next theorems we state the conditions such that 2 candidates find convenient to enter.

Condition 2.1 (strong non proximity)**.** *A two-candidate equilibrium,* $C(\sigma^*) =$

$\{A, B\}$, satisfies strong non proximity if the following conditions are satisfied:

$$\begin{aligned}
\frac{1}{2}\left[U(q^{*A_t}, A_t) - U(\bar{q}^B, A_t)\right] &> c, \qquad (2.12)\\
\frac{1}{2}\left[U(q^{*B_s}, B_s) - U(\bar{q}^A, B_s)\right] &> c,\\
\frac{1}{2}\left[U(q^{*A_{-t}}, A_{-t}) - U(\bar{q}^B, A_{-t})\right] &> c,\\
\frac{1}{2}\left[U(q^{*B_{-s}}, B_{-s}) - U(\bar{q}^A, B_{-s})\right] &> c,
\end{aligned}$$

where $U(q^{*i}, i)$ includes the lobbies' contribution.

Condition 2.2 (non proximity)**.** *A two-candidate equilibrium, $C(\sigma^*) = \{A_t, B_s\}$, satisfies non proximity if the following conditions are satisfied:*

$$\begin{aligned}
\left(1 - \frac{p_s}{2}\right) U(q^{*A_t}, A_t) - \frac{p_s}{2} U(q^{*B_s}, A_t) &> c + (1 - p_s) U(q^{sq}, A_t), \qquad (2.13)\\
\left(1 - \frac{p_t}{2}\right) U(q^{*B_s}, B_s) - \frac{p_s}{2} U(q^{*A_t}, B_s) &> c + (1 - p_t) U(q^{sq}, B_s),\\
\left(1 - \frac{p_s}{2}\right) U(q^{*A_{-t}}, A_{-t}) - \frac{p_s}{2} U(q^{*B_s}, A_{-t}) &< c + (1 - p_s) U(q^{sq}, A_{-t}),\\
\left(1 - \frac{p_t}{2}\right) U(q^{*B_{-s}}, B_{-s}) - \frac{p_s}{2} U(q^{*A_t}, B_{-s}) &< c + (1 - p_t) U(q^{sq}, B_{-s}),
\end{aligned}$$

and for all citizens $r \in N$, that would win with certainty pairwise against either A_t or B_s, the following condition is satisfied:

$$(1 - p_t p_s)\, U(q^{*r}, r) < c + p_t(1-p_s) U(q^{*A_t}, r) + p_s(1-p_t) U(q^{*B_s}, r) + (1-p_s)(1-p_t) U(q^{sq}, r), \qquad (2.14)$$

for all citizens $r \in N$, that would lose with certainty pairwise against both A_t or B_s, the following condition is satisfied:

$$(1 - p_s)(1 - p_t) U(q^{*r}, r) < c + (1 - p_s)(1 - p_t) U(q^{sq}, r), \qquad (2.15)$$

for all citizens $r \in N$, that would lose with certainty against A_t and win against B_s, the following condition is satisfied:

$$(1 - p_t) U(q^{*r}, r) < c + (1 - p_t) p_s U(q^{*B_s}, r) + (1 - p_s)(1 - p_t) U(q^{sq}, r), \qquad (2.16)$$

for all citizens $r \in N$, that would win with certainty against A_t and lose against B_s, the following condition is satisfied:

$$(1 - p_s) U(q^{*r}, r) < c + (1 - p_s) p_t U(q^{*A_t}, r) + (1 - p_s)(1 - p_t) U(q^{sq}, r), \qquad (2.17)$$

where p_t and p_s are the prior probabilities respectively of types t and s, and $U(q^{*i}, i)$ includes the lobbies' contribution.

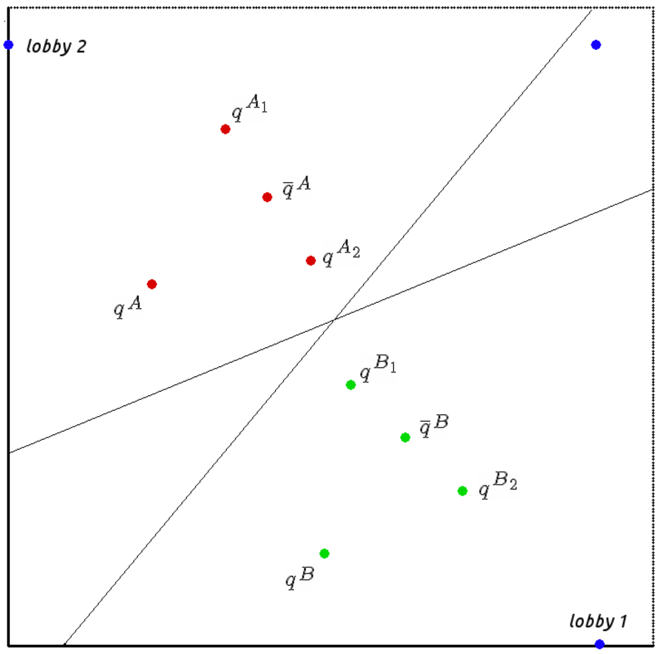
Theorem 2.1 (totally pooling)**.** *A two-candidate equilibrium, $C(\sigma^*) = \{A, B\}$, exists and is totally pooling if and only if condition 2.1 is satisfied and the two expected implemented policies $\bar{q}^A = pq^{*A_1} + (1-p)q^{*A_2}$ and $\bar{q}^B = pq^{*B_1} + (1-p)q^{*B_2}$ generate hyperplanes h_{1,λ_2^1} and h_{1,λ_2^2} that satisfy equation 2.10.*

Theorem 2.1 says that a sufficient condition for a two-candidate totally pooling equilibrium is that the expected implemented policies split in half the electorate. All types of candidates A and B find profitable to enter because they have 1/2 probability to win and for condition 2.1 they are better off than letting the other candidate win.

Theorem 2.2 (totally separating)**.** *A two tying candidate equilibrium, $C(\sigma^*) = \{A_t, B_s\}$, exists and is totally separating if condition 2.2 is satisfied and the two policies q^{*A_t} and q^{*B_s} generate hyperplanes h_{1,λ_2^1} and h_{1,λ_2^2} that satisfy equation 2.10.*

Theorem 2.2 says that a sufficient condition for a two-candidate totally separating equilibrium is that nature selects types whose implemented policies split in half the constituency. Moreover for condition 2.2 only one type per candidate must find convenient to enter. Still for condition 2.2 a third candidate would not find convenient to enter.

Figure 2.4: Positions of a 2 candidates totally pooling equilibrium



With abuse of notation we define the implemented policy $q^*(\rho)$ in equilibrium as depending on the parameter ρ, the preference for money of citizens, while keeping all other parameters constant.

Proposition 2.4. *In totally pooling equilibria the interest groups' lobbying has an effect on the implemented policy, that is*

$$q^*(\rho) \neq q^*(0),$$

for every $\rho > 0$.

The entry equilibrium analysis delivers several results: first of all, differently from Besley and Coate (1997) we have an effect of lobbying on implemented policies if the equilibrium is totally pooling. Indeed in a totally pooling entry equilibrium both types of the same candidate enter, voters do no know which type they face so they vote on expected policies. Depending on the type of candidate realized, they will have offset either too much or too little. Therefore lobbying can matter for implemented policies, and in our model the channel is the incomplete information about general salient issues in the electoral campaign. The difference between a totally pooling and a totally separating equilibrium is that in the latter the candidates entering are signalling their type, not only with their action of entering, but also with the opponent's action.

2.5 Endogenizing lobbying

We present here an extension of the model where citizens can interact directly with lobbies, giving them monetary contributions in order to increase their power and thus obtain a more favorable implemented policy.
We assume that preference intensity for policy with respect to money and the salience of issues are idiosyncratic, i.e. ρ^i and λ^i_j for citizen i. We assume also that there can be more than one lobby for every political dimension. Contribution to lobbies is implemented after elections are over. To simplify the analysis we also assume that after elections and before contribution takes place the type of each citizen is revealed. If a subset $R \subset N$ of citizens contributes to lobby k her relative intensity for policy with respect to money becomes:

$$\mu^L_k := b^L_k + \sqrt{y_k}, \tag{2.18}$$

where $y_k := \sum_{i \in R} y^i_k$, y^i_k is the monetary contribution of citizen i to lobby k, and b^L_k is a positive constant [7]. We also define $y^{-i}_k := \sum_{j \in R, j \neq i} y^j_k$.

[7] We assume that citizens' monetary contribution affects μ^L_k and thus the willingness to pay w with a decreasing margin, the same results would be obtained if we assume that the

If citizen i contributes $y^i = \sum_{k=1}^{K} y_k^i \geq 0$ to lobbying her utility becomes:

$$U(q,i) = \sum_{k=1}^{K} \lambda_k^i u(q_k, q_k^i) - \rho^i y^i,$$

Citizens contribute after elections are over and before lobbies offer their contribution schedules to the elected politician.
If a citizen contributes y_k^i to lobby k the interest group increases its preferences for the policy, this has a positive effect on the contribution schedule offered to the politician and thus on q^{*P}, moving it closer to the bliss point of the lobby.
Let us define

$$y_k^M(\rho, q_k, \lambda_k) := \left[\frac{\rho^P \lambda_k^P \lambda_k (q_k - q_k^*)(q_k^L - q_k^P)}{\rho(\lambda_k^P + \rho^P \mu_k^L)^2}\right]^2.$$

Proposition 2.5. *In equilibrium only a subset $R_k \subset N$ donates to lobby k. Citizen i belongs to R_k if and only if $(q_k^i - q_k^*)(q_k^L - q_k^P) \geq 0$ and $(\rho^i, q_k^i, \lambda_k^i) \in \arg\max y_k^M$. The equilibrium contribution to lobby k is $y_k = \max_{\rho, q_k, \lambda_k} y_k^M$* [8].

The reason why only a subset of all citizens donate to lobbying is that moderate citizens free ride on the more extreme. The equilibrium contributions are not unique, e.g. every vector of positive individual contributions y_k^i such that $\sum_{i \in R_k} y_k^i = y_k$ is an equilibrium.
Next we perform brief comparative statics on the equilibrium total contribution y_k to lobby k, that take into account that y_k is not in a closed form solution, because also q_k^* and μ_k^L depend on y_k. First of all condition $(q_k^i - q_k^*)(q_k^L - q_k^P) \geq 0$ implies that citizens and lobbies are "on the same side" with respect to the implemented policy, otherwise the contribution from citizen i to lobby k is zero. Let us assume that $(q_k^i - q_k^*) > 0$ and $(q_k^L - q_k^P) > 0$. Interestingly the contribution y_k depends positively, under some conditions, on the distance $(q_k^L - q_k^P)$. Indeed moving q_k^L further from q_k^P increases the contribution y_k if $(q_k^i - q_k^*)$ remains positive and $q_k^i - q_k^* - \rho^P \mu_k^L / (\lambda_k^P + \rho^P \mu_k^L)(q_k^L - q_k^P) > 0$, which is always satisfied if $\rho^P \mu_k^L$ is relatively small. Under this condition the more extreme is a lobby the more

contribution increases linearly w and the citizen's monetary cost is convex. The drawback of this last and more natural formulation is that for internal coherence also the lobby's monetary cost would need to be convex, w would then be concave in the lobby's utility and the implemented policy q^* would need to be recomputed.

[8] A similar result would be obtained defining $\mu_k^L := b_k^L + \phi(y_k)$, where $\phi(\cdot)$ is a concave function. The equilibrium contribution would be $y_k = (\phi')^{-1}\left(\frac{\rho^i(\lambda_k^P + \rho^P \mu_k^L)^2}{2\rho^P \lambda_k^P \lambda_k^i (q_k^i - q_k^*)(q_k^L - q_k^P)}\right)$. The comparative statics bring the same results as with $\phi(\cdot) = \sqrt{\cdot}$.

contributions it will receive. Also the term $(q_k^i - q_k^*)$ tells us that the further is the citizen's bliss point from the implemented policy the more she contributes to lobbying. y_k depends also positively on λ_k^i and negatively on ρ^i as expected. Thus if λ_k^i is low for many citizens there will be a counteracting effect with respect to the one we focused in proposition 2.1, indeed the lobby can move the policy closer to her bliss point because citizens do not care a lot about that topic, but they will also contribute less to lobbying, giving her less power. If instead the salience of an issue is high for the whole population the lobby will receive contributions but the politician will not move too much the implemented policy in the direction of the lobby because citizens care about it. Therefore the capability of a lobby to move the implemented policy close to her position depends on the existence of a small group of individuals that consider an issue very salient, while the majority of citizens does not.

If we have n lobbies in dimension k where each lobby is denoted by j^k the implemented policy in equilibrium is:

$$q_k^{*P} = \frac{\lambda_k^P q_k^P + \rho^P \sum_{j=1}^n \mu_k^j q_k^j}{\lambda_k^P + \rho^P \sum_{j=1}^n \mu_k^j}, \tag{2.19}$$

so in each dimension the implemented policy is a convex combination of the bliss point of the politician and that of lobbies that operate on that issue.
The next condition applies only to individuals who donate in equilibrium. The equilibrium contribution y_{jk}^i of citizen i to lobby j^k satisfies:

$$\sqrt{y_{jk}} = \frac{\lambda_k^i (q_k^i - q_k^*) \rho^P [\lambda_k^P (q_k^{Lj} - q_k^P) + \rho^P \sum_{s=1}^n \mu_k^s (q_k^{Lj} - q_k^{Ls})]}{\rho^i (\lambda_k^P + \rho^P \sum_{s=1}^n \mu_k^s)^2} \tag{2.20}$$

if the numerator is positive.
The same reasoning that was applied to the equilibrium contributions with one lobby per issue tells us that only individuals for which the RHS of equation 2.20 is the highest donate. The same comparative statics results with one lobby apply with more than one. Interestingly with more than one lobby citizens contribute mostly and under some conditions ONLY to the most extreme lobby. Indeed let us consider the case of just two lobbies 1 and 2, where $q_k^P < q_k^1 < q_k^2$. If contributing only to lobby 2 implies $q_k^1 < q_k^* < q_k^i$, then in equilibrium citizen i does not contribute to lobby 1. These results about extremism are given by the fact that the lobby contribution schedule is a function increasing in the distance between the politician bliss point and the lobby one. The result does not always hold, indeed if the stated condition is not valid citizen i could find profitable to contribute to lobby 1, because

the contribution function $\sqrt{\cdot}$ is concave, with a decreasing marginal return. The previous comparative statics take into account that y^i_{jk} is not in a closed form solution.

2.6 Conclusion

We have analyzed a voting model where citizens candidates have a ranking over issues. After elections unidimensional lobbies intervene in order to influence the politician. They offer contributions contingent to the implemented policy. We find that interest groups that lobby on dimensions that are less salient are able to move the implemented policy further from the bliss point of the politician and closer to their own with respect to interest groups that intervene in more salient issues.

When studying the entry and voting equilibria of the model, we reduce the political dimensions to two and add a source of information incompleteness. Voters are of two different types: type 1 gives less importance to the second issue with respect to type 2. Depending on the position of candidates, we can have 2-candidates pooling or separating equilibria. Pooling equilibria are particularly interesting, because differently from Besley and Coate (2001), we have an effect of lobbying on the implemented policy. Indeed, citizens in pooling equilibria do not know the candidate's type and vote based on the expected value of the implemented policy. In this way they will offset too much or too little the work of lobbies. Moreover, in equilibrium there are citizens with the same most preferred policy that vote for different candidates if they are of different types. This result captures the real paradox of voters that have the same political views, but end up supporting different candidates, because they have dissimilar opinions on what is the most important political issue.

An extension of the model provides citizens with the possibility of giving monetary contributions to interest groups, partly endogenizing lobbying. Contributions increase the power of the lobby and its ability to move the implemented policy towards its bliss point. With more than one lobby per issue, we find that, under some conditions, only the most extreme lobbies receive contributions, because the willingness to pay of the lobby increases with the distance between the politician's bliss point and the lobby's one. Moreover the effectiveness of a lobby is maximized when the salience of an issue is low for the general population and high for a small group of citizens.

Further research can be done on the same topic. Instead of taking as exogenous the citizens' ranking of issues, it would be interesting to consider a politician or a lobby that can manipulate salience through advertising.

A politician would like to receive contributions from lobbies with a higher willingness to pay, thus she could try to lower the salience of issues on which these lobbies operate. Thus the interaction of lobbying after elections and the manipulation before could show that in equilibrium interest groups can be more successful in the political dimensions that were ex ante more relevant for citizens.

2.7 Appendix

Proof of Lemma 2.1: the elected politician P maximizes the utility function in 2.4, the FOC is: $-2\lambda_k^P(x_k - x_k^P) - 2\rho\mu_k(q_k - q_k^L) = 0$ which put in a matrix form brings the result in lemma 2.1. The 2nd order conditions are guaranteed by the concavity of the quadratic function u.

Proof of Proposition 2.1: we assume that there is a continuum of set of parameters $\wp_{\lambda_j^s}$ such that for each $\lambda_i \geq 0$ $q^{*P}_{\lambda_j^i}$ is an equilibrium. $q^{*P}_{\lambda_j}$ is a continuous and differentiable function of λ_j, with both properties guaranteed by lemma 2.1. Then we can compute the derivative $\frac{\partial}{\partial \lambda_j}|q^{*P}_{\lambda_j,j} - q_j^L| = \frac{\rho\mu_j|q_j^P - q_j^L|}{(\lambda_j+\rho\mu_j)^2} > 0$. The sign of the derivative proves proposition 2.1 for all λ_j^i, λ_j^l such that $q^{*P}_{\lambda_j^i}, q^{*P}_{\lambda_j^l}$ are equilibria.

Proof of Proposition 2.2: we assume that for all $\mu_j \in [0,1]$ $q^{*P}_{\mu_j}$ is an equilibrium. $q^{*P}_{\mu_j}$ is a continuous and differentiable function of μ_j, with both properties guaranteed by lemma 2.1. Then we can compute the derivative $\frac{\partial}{\partial \mu_j}|q^{*P}_{\mu_j,j} - q_j^L| = -\frac{\lambda_j^P\rho|q_j^P - q_j^L|}{(\lambda_j+\rho\mu_j)^2} < 0$. The sign of the derivative proves proposition 2.2 for all μ_j^i, μ_j^l such that $q^{*P}_{\mu_j^i}, q^{*P}_{\mu_j^l}$ are equilibria.

Proof of Proposition 2.3: we assume that for all $\eta \geq 0$ q^{*P}_{η} is an equilibrium. q^{*P}_{η} is a continuous and differentiable function of η, with both properties guaranteed by lemma 2.1. We take P of type 1. Then we can compute the derivative $\frac{\partial}{\partial \eta}|q^{*}_{\eta,2} - q_2^L| = \frac{\partial}{\partial \eta}\frac{\theta\eta|q_2^P - q_2^L|}{\theta\eta+\rho\mu_2} = \frac{\theta\rho\mu_2|q_2^P - q_2^L|}{(\theta\eta+\rho\mu_2)^2} > 0$. The sign of the derivative proves proposition 2.3 for all η^i, η^l such that $q^{*P}_{\eta^i}, q^{*P}_{\eta^l}$ are equilibria. The same result applies with P of type 2.

Proof of Lemma 2.3: We now provide equilibrium strategies in the voting subgame for 2 and 3 candidates such that a third candidate never finds convenient to enter. We do not specify what are the beliefs of voters on the candidates' implemented policies, because the proof is valid for every array

of beliefs that are common to all voters. If $C(\gamma) = \{A, B\}$ all non indifferent citizens vote for their favorite candidate and indifferent citizens do not vote. This vector of strategies is a subgame Nash equilibrium and does not include weakly dominated strategies. If $C(\gamma) = \{A, B, C\}$, where A and B's expected implemented policies satisfy condition 2.10, and voters face three candidates[9], equilibrium strategies are built as follows: all voters, including C, that are non indifferent between A and B vote for their favorite candidate among $\{A, B\}$. Voters that are indifferent between A and B but strictly prefer C to either A or B vote for C. Voters that are indifferent between A and B but prefer either A or B to C split: half of them vote for A and half of them vote for B. This vector of strategies is a subgame Nash equilibrium and does not include weakly dominated strategies. Voters that are not indifferent between A and B do not change their vote because they would make the other candidate win. Voters that are indifferent between A and B and strictly prefer C get the same utility in equilibrium voting for A, B, C or not voting. But voting for C is the only non weakly dominated strategy they have. Indeed voting for C makes this kind of citizen strictly better off than voting for A, B or not voting, when there are enough citizens who vote for C such that she is pivotal. Citizens that are indifferent between A and B and prefer either A, B to C get the same utility in equilibrium voting for A, B, C or not voting. Let us assume they vote for A. Voting for A is not weakly dominated by voting for B, but weakly dominates not voting and voting for C. If there are enough citizens who vote for C such that this kind of citizen is pivotal she prefers voting for A (or B) than voting for C or not voting. The voting equilibrium strategies in the 3 candidates' subgame are built such that if A and B were tying when C was not running, they are still tying with C running, because citizens that are indifferent between A, B either vote for C or they split equally among A and B. Given these voting equilibrium strategies, when voters face all 3 candidates, C loses with certainty.
Proof of Theorem 2.1: the voting equilibrium is guaranteed by lemma 2.2, where expected policies are $\bar{q}^A, \bar{q}^B$. Now we check if any type of A and B has an incentive to deviate not entering as a candidate. Condition 2.1 controls for that, indeed type t of candidate P does not deviate if $\frac{1}{2}\left[U(q^{*P_t}, P_t) + U(\bar{q}^{-P}, P_t)\right] - c > U(\bar{q}^{-P}, P_t)$.

Proof of Theorem 2.2: the voting equilibrium is guaranteed by lemma 2.2, where policies are q^{A_t}, q^{B_s}. Type t of candidate P runs because $\frac{p_s}{2}[U(q^{*P_t}, P_t) + U(q^{-P_s}, P_t)] + (1-p_s)U(q^{*P_t}, P_t) - c > p_s U(q^{-P_s}, P_t) + (1-p_s)U(q^{sq}, P_t)$. Type $-t$ of candidate P does not run because $\frac{p_s}{2}[U(q^{*P_{-t}}, P_{-t}) + U(q^{-P_s}, P_{-t})] +$

[9]This specification is needed, because not all candidates could be drawn by Nature.

$(1-p_s)U(q^{*P_{-t}}, P_{-t}) - c < p_s U(q^{-P_s}, P_{-t}) + (1-p_s)U(q^{sq}, P_{-t})$. A third candidate, that wins against either A_t or B_s does not find convenient to enter because $\frac{p_s p_t}{2}[U(q^{*A_t}, r) + U(q^{*B_s}, r)] + (1-p_t p_s)\, U(q^{*r}, r) < \frac{p_s p_t}{2}[U(q^{*A_t}, r) + U(q^{*B_s}, r)] + c + p_t(1-p_s)U(q^{*A_t}, r) + p_s(1-p_t)U(q^{*B_s}, r) + (1-p_s)(1-p_t)U(q^{sq}, r)$. By 2.3 when facing both candidates r loses for sure. The same reasoning applies to deviations from third candidates who are winning just against one candidate between A_t and B_s, or sure losers.

Proof of Proposition 2.5 The total contribution y_k to lobby k that maximizes citizen i's utility is:

$$y_k = y_k^M(\rho^i, q_k^i, \lambda_k^i) = \left[\frac{\rho^P \lambda_k^P \lambda_k^i (q_k^i - q_k^*)(q_k^L - q_k^P)}{\rho^i(\lambda_k^P + \rho^P \mu_k^L)^2}\right]^2, \qquad (2.21)$$

where condition 2.21 is derived from the FOC of citizen i's utility. If the sum y_k^{-i} of other citizens' contributions is already larger than the optimal $y_k^M(\rho^i, q_k^i, \lambda_k^i)$, citizen i does not contribute. The equilibrium contribution to lobby k is $\max_{\rho, q_k, \lambda_k} y_k^M$, that represents the optimal contribution of citizens whose idiosyncratic parameters ρ, q_k, λ_k are the $\arg\max$ of y_k^M. All other citizens do not contribute, because their optimal total contribution is lower than $\max_{\rho, q_k, \lambda_k} y_k^M$.

Chapter 3

Don't teach them how to fish: explaining the heterogeneity in state capacity in non settlement colonies

3.1 Introduction

Since Acemoglu et al. (2001) the long lasting effect, in terms ef economic growth, of colonial institutions on ex colonies is well established. The empirics in Acemoglu et al. (2001) were sustained by the idea that colonizers put good, growth enhancing institutions, in colonies where they had the possibility to settle, while extractive institutions were created where no settlement was possibile, therefore exploitation was the optimal choice. Still in the subset of non settlement colonies, most of the African and Asian ones, there is a wide heterogeneity in the quality of colonial institutions. This heterogeneity needs a finer explanation.
This paper develops a theoretical investigation on the strategic behavior of coloniers in setting up colonial institutions in non settlement colonies. First the histories of two non settlement colonies, Belgian Congo and Senegal, are described to show that there is heterogeneity in colonial institutions, even in non settlement colonies. Moreover, the civil conflict outcome of these two colonies agrees with an empirical literatures that consistently finds a negative correlation between high state capacity and civil war. Secondly a theoretical model is presented, in order to study the equilibrium strategies of colonizers in choosing investment in state capacity. Indeed, while having high state capacity can create a productive gain in the colonial economy, it is also

an efficient machine for avoding civil conflict and chaos, once the colonized take power. Thus creating a modern colonial state makes independence an attractive outcome for the local groups.

Roughly half of the colonies that got independent after 1945 experienced episodes of civil conflict. In some of these countries the metropole left such an institutional setting that civil conflict could not be avoided. Striking in this direction is the example of Belgian Congo, that became independent in 1960. Five days after independence a mass-scale civil war was triggered, leading to 100 000 deaths in five years. The Belgian authorities, since domination was established in 1885, did not make any attempt to build a modern and efficient state, that could have given Belgian Congo a chance for self-government. There was no indigenous council, bureaucracy was managed by Belgian personnel, there was no Congolese military officer in the Congolose army, and at the time of independence only 30 Congoleses held a university degree. A few years before independence, when all other colonies were starting to become independent, Belgium proposed a decolonization process in order to create institutions that Congo needed to survive after independence, but Congolese leaders refused. When independence came two regions seceded, the military mutinied, leaders of different parties plotted against each other. A complete state failure was avoided only because a self-declared general named Mobutu won the civil war and began ruling with an iron fist, erasing the democratic constitution of 1960. An opposite colonial history is the one of Senegal. Senegal was the first French colony in Africa, in 1848 its inhabitants gained the possibility of electing a deputy to the French parliament, the Assemblée nationale. In the first half of the XXth century Senegal elected many African deputies. There was an African elite that was educated in French universities, high schools were created in Senegal, the indigenous population was part of the bureaucracy and of the political decision making process in the colony. When independence came in the 1960 the president Senghor, a politician and intellectual, was elected. He relinquished power to Diouf in the 1981, who ruled until 2000. The ex colony after independence experienced low levels of political violence and no civil conflict.

The institutional setting left by the colonizer was clearly different in the two colonies, and had a strong effect on the civil conflict outcome when the countries became independent. There is also an empirical literature that correlates different aspects of state capacity with civil conflict, see Hendrix (2010). Military personnel per capita, measures of bureaucratic capacity, rule of law, private property enforcement, fiscal capacity all correlate negatively with civil conflict onset and the rebel probability of victory, once conflict has begun.

Given that the quality of state capacity at the time of independence was determined by choices taken by the colonizer well before, understanding the determinants of these choices can be helpful to figure out the determinants of civil conflict in ex colonies.

Taking into account these considerations, a dynamic game is presented, where the colonizer strategically chooses to invest in state capacity, in order to create a productive gain in the colonial economy. This investment reduces the probability of civil conflict after independence in the colony, thus it increases the incentive of local groups to become independent, choice otherwise costly because of the subsequent civil war. The colonizer, aware of these dynamics, can also choose investment in a colonial military to crush independence attempts. In equilibrium the colonizer keeps the local groups indifferent between fighting for independence and accepting colonial rule. Equilibrium choices about investment in state capacity and in the military depend on the magnitude of the productive gain and the cost of the military. Hence the main message of this theory is that the equilibrium investment in high state capacity depend on the matching between two identities, the one of the colonizer and the one of the colony. Indeed the cost of the colonial military depends on the size of the colonial empire, e.g. France and UK had a lower average cost of the military, considering scale effects, compared to Belgium and the Netherlands. At the same time the magnitude of the productive gain of state capacity investment depends on inherent features of the colony, for example the presence of natural resources or the distance to the sea. Moreover when in equilibrium there is investment in state capacity there is always investment in the military. There are also equilibria where the metropole does not invest in state capacity, to lower to incentives for the local groups to become independent and save the cost of military. Indeed if the colony becomes independent, there would be civil conflict, caused by the lack of a working state machine, therefore local groups are willing to accept in equilibrium a large exploitation by the metropole.

The equilibria of this game adapt to the colonial history till 1945. Colonies were steadily under control of metropoles, that were extracting resources. There was quite heterogeneity in the colonial institutions set by metropoles in different colonies. After 1945 many events give rise to the independence wave of colonies: the end of WWII showed the weakness of the old European colonizers. US and URSS were becoming global powers willing to extend their areas of influence in Africa and Asia. The UN was created, article 73 of the UN charter explicitly stated that colonial powers had to start demobilizing their empires. In 1960, the so called year of Africa 17 colonies became independent, and in the 30 years after 1945 the colonial empires had completely vanished. Thus an unexpected exogenous shock is added to the previous model. After choices about military and state capacity have already been taken, the shock forces the metropole to leave the colony at the end of the period. If the colony has an efficient state machine, the colonial power can only extract the maximal rent in that period and leave, and the ex colony does not experience civil conflict thereafter. If instead the colony does not have the institutions to avoid chaos, the metropole proposes a process of decolonization, in order to invest in state capacity and prevent civil war after independence. The metropole takes advantage of the process of decolonization to devise institutional loopholes that give her a perpetual rent, even after the colony becomes independent. For example political institutions are designed such that politicians can be bribed by foreign companies to get favorable terms for public tenders. Therefore the process of decolonization is costly for the colony and inefficient. In equilibrium, if the inefficiency of decolonization is too large, local groups rather become independent immediately, facing the unavoidable civil conflict. This equilibrium matches the failed decolonization of Belgian Congo. Thus civil war appears in equilibrium when there had not been investment in state capacity before and inefficiency of decolonization is too large. The effect of natural resources on civil conflict is investigated in the game. The channel goes through the metropole's incentive to create state capacity. If the presence of natural resources lowers this incentive, then a colony with a large natural resources sector is more likely to experience civil war after independence.

A large economic literature has been developed in these years on colonial institutions. Acemoglu et al. (2001) focus on settlement and non settlement colonies, where in the first ones inclusive economic institutions were created, while non settlement colonies had extractive institutions. The effect of this choice is still visible today in the different economic growths of ex colonies. The focus of this paper is instead only on non settlement colonies, where all institutions were set for extractive purposes. Still the heterogeneity of colonial institutions in different colonies, and their effect on civil conflict, makes it interesting to study the strategic behavior of colonizers in this matter. The paper of Acemoglu et al. (2001) is also part of a rich debate on the causal effects of inclusive institutions on economic growth, see also Glaeser et al. (2004) and Acemoglu et al. (2005). There is been also an increasing attention in the past years on the strategies that a ruling extractive party can implement to remain in office. Acemoglu et al. (2004), Miquel (2007), De Luca et al. (2011) analyze how weak rulers, that do not have strong military, use the ethnic and social divisions of a society to withold power. This paper contributes to this literature analyzing the incentives that an extractive party has into not investing in state capacity, in order to destroy the chances of a stable peace in the colony after independence. The literature on the determinants of civil conflict is too wide to be summarized here. Ethnic,

linguistic and religious fractionalization, the presence of natural resources, lack of political representation, wealth inequality are still under study as possible causes of civil conflict, see Elbadawi and Sambanis (2000), Sambanis (2001), Ross (2006), Reynal-Querol (2002), Buhaug and Rød (2006) and Humphreys (2005). Thyne (2006) finds that primary and secondary education lowers the probability of civil war in a sample of 160 countries from 1980 to 1999. Wantchekon and García-Ponce (2011) test with an IV estimation the idea that the type of insurgency against colonial rule determined the level of democracy of ex colonies. The instrument is terrain ruggedness. Specifically rural insurgencies are empirically associated with autocratic regimes, while urban insurgencies with democracies. The authors also find that rural insurgencies are also a strong predictor of civil conflict after independence. The quality of state capacity, in its many facets, is consistently correlated with civil conflict onset, see Hendrix (2010). There will be a focus on the literature on state capacity and conflict in the next section.
Berman et al. (2011) focus on the effectiveness of reconstruction and service provision spending in Iraq in reducing the violence against Coalition forces, finding a weak negative relation between aid and violence. Berman et al. (2011) paper raises the question of what are proper tactics that an occupying force has to implement to prevent civil conflict when occupation is over. The analysis presented here suggests that looking at colonial institutions and their effect on failed decolonizations and civil conflicts after independece can be useful to determine some policy implications.

The paper is organized as follows. In the next section the colonial histories of Belgian Congo and Senegal are presented, along with a review of the literature on state capacity and civil conflict. Section 3.3 discusses a model of colonial rule and its equilibria. Section 3.4 studies the effect of an exogenous shock in the same framework. The results match the independence wave after 1945. Section 3.5 concludes.

3.2 Stylized facts

Here follows the description of the colonial histories of Belgian Congo and Senegal. These countries received very different institutional treatments from their colonizers, and faced opposite civil conflict outcomes after independence.

3.2.1 Belgian Congo

In the 1885 Léopold II, king of Belgium, conquered Congo with a mercenary army, taking over all the kingdoms that were present in the area. The Congo Free State was created, a de facto private property of Léopold II. Soon the Belgian king discovered that Congo was rich in minerals and natural resources, going from copper, diamonds, gold, cobalt to rubber and ivory. In the 1908 after an international civil rights campaign unraveled the dramatic conditions of African workers in the mines and plantations of Congo, the Belgian government took over and Congo became an official colony. Forced labor was formally forbidden, but the extraction of the riches of Congo continued.

The Belgian administration became more concerned with the material conditions of the African population. Hospitals and primary schools were instituted. The Belgian approach was paternalistic: while the basic needs of the Congolese were satisfied, there was no willingness to develop self-government, high education or in any institution that would have given Congo the appearance of a modern state. Till independence in Congo there was no indigenous parliament, no Congolese officer in the military (Force Publique), and very few university graduates (in 1960 only 30 Congolese had a degree).

After the Second World War Belgium joined the UN. There was strong pressure from the international organization on Belgium to start a process of decolonization. In the 1950 the first Congolese political party was created: ABAKO, founded by Kasa-vubu and aiming to represent the interests of the Bakongo ethnicity. In the 1955 a Belgian professor, Antoine Van Bilsen, published a "Thirty Year Plan for the Political Emancipation of Belgian Africa", Van Bilsen (1956). The proposal started from the realization that Congo could not become independent right away because there were no institutions supporting a peaceful transition. In thirty years the Belgian administration would have taken the responsibility of establishing these institutions and at the time of independence a sort of Belgian-Congolese commonwealth would have been created. A public debate on Congolese newspaper started about this proposal. While a small number of évolués seemed to appreciate the plan, ABAKO strongly opposed it asking for immediate independence. In the 1956 another party was created, MNC, the Congolese National Movement, whose leader was Patrice Lumumba. In 1959 violent riots against whites exploded in Leopoldville, fueled by ABAKO and MNC leaders. The Belgian government hoped to buy more time and king Badouin declared that Belgium would lead Congo to independence, "without undesirable procrastination but also without undue haste". A five year decolonization plan was proposed by the colonial government to the Congolese leaders. While the Belgians underlined the probability of a Congolese failed state in case of immediate independence, Gondola (2003) claims that that the plan was proposed "in order to devise a constitutional structure that would guarantee a peaceful transfer of power without depriving Belgium of most of its economic interests in Congo."

In 1960 a round table conference was organized in Brussels between the Congolese leaders and the Belgian government to discuss the terms of decolonization. Unexpectedly the Congolese leaders united in refusing any decolonization plan and asking for immediate independence. The Belgian government accepted and on 30 June 1960 Congo became independent. General elections delivered a parliament divided in two between ABAKO and MNC. Lumumba became prime minister and Kasa-vubu President. Five days after independence the army mutinied against its Belgian officers, who had no intention of leaving their post in the short term. In the meanwhile Katanga, the richest region in terms of minerals, asked for secession, Lumumba decided to send the army there but no one answered his request in the mutinied military. The UN was forced to intervene, unsuccessfully. Also South Kasai seceded, Kasa-vubu declared Lumumba deposed of his office but the parliament voted against this decision. A self-declared general named Mobutu, ordered by Kasa-vubu took Lumumba as a prisoner. Lumumba was tortured and then killed. The conflict escalated and in five years took around 100000 lives. Mobutu became President in 1965, erasing all democratic institutions set in the 1960. Today Congo is still being flagellated by civil conflicts. Congo scores 51 in the Ibrahim Index of African Governance.

The colonial and postcolonial history of Belgian Congo shows that colonial institutions mattered for civil conflict after independence. The lack of the monopoly of violence, caused by the desegregation of the local police force, the mistrust between the different leaders, and the possibility to extract political rents, were all factors determining conflict.

Moreover there is a puzzle concerning the decision of the Congolese to refuse the process of decolonization. The debate on the African newspapers before 1960 shows that Belgian and Congolese leaders were aware that Congo was in a risky situation once independence was reached. Diverging interests of the local groups that belonged to the colony suggested that conflict was unavoidable. Then it is a priori unclear why decolonization, that was proposed in different forms, was refused.

3.2.2 Senegal

The four Senegalese cities of Saint-Louis, Dakar, Gorée, and Rufisque, also called "Le quatre communes", were the oldest colonial towns in French Africa. In 1848 their inhabitants received, first in Africa, the full citizenship making them formally equal to French citizens, even though technical barriers made this equality only theoretical. On 27 April 1848 the French National Assembly voted a law that enabled the four quarters to elect a deputy to the parliament. In 1916 Blaise Degne, the first full-blooded African was elected to the National Assembly, and from that time on the Senegal deputies were always African.

France had an economic interest in Senegal because it was a slave trade port until 1848. In 1895 Senegal was included in the West French Africa (AOF), which was a federation of eight colonies: Mauritania, Senegal, French Sudan (now Mali), French Guinea, Côte d'Ivoire (Ivory Coast), Upper Volta (now Burkina Faso), Dahomey (now Benin) and Niger. The capital of the federation was Dakar in Senegal. Senegalese Africans had a special status in the confederation. Senegalese deputies were always at the forefront of the decolonization struggle. After the WWII France started a transfer of power to the colonies of AOF. Between the 1958 and the 1960 all African colonies of the AOF through referenda approved by the metropole decided to become independent. The institutional situation in Senegal at the time of independence was better than the other colonies in AOF and much better than Congo: Senegal Africans could access higher education in France. High schools were spread in the colony. There was a number of associations and parties that were involved in the policy making process in Senegal in the previous 30 years, see Chafer (2002).

Elections in the 1960 delivered the presidency to Léopold Sedar Senghor, an intellectual and ex African deputy at the French parliament. Power was retained by Senghor until he handed it over to his picked successor, Abdou Diouf, in 1981. Even though political activity was restricted and Senghor's party, the Senegalese Progressive Union (now the Socialist Party of Senegal), was the only legally permitted party until 1973, Senghor was considerably more tolerant of opposition than most African regimes became in the 1960s. Today Senegal is a peaceful and relatively democratic country, scoring 16 in the Ibrahim Index of African Governance.

3.2.3 State capacity and civil conflict

State capacity is a general concept that has been conceptualized in different ways, in the international relations literature and the economic literature. The broader definition of state capacity is "the ability of a government to administer its territory effectively", Walder (1995). The three key dimensions of state capacity are coercive capacity, extractive capacity, and administrative capacity. Coercive or military capacity is the ability of state to repel challenges to its authority with force. Military capacity, usually measured as military personnel per capita, is associated with lower likelihood of civil con-

flict onset and rebel defeat, see Mason and Fett (1996), Mason et al. (1999), Hegre and Sambanis (2006), De Rouen and Sobek (2004). Indeed a state with a stronger military will be more likely to deter insurgencies attempts, either to take over the central government, or to secede.
Extractive capacity represents the ability of a state to tax its population. Extractive capacity is the main focus of the economic literature on state capacity, see North and Thomas (1976), Besley and Persson (2007). Relative political capacity, defined as the ratio of actual tax revenue to expected tax revenue, is shown to be negatively correlated with civil conflict onset at the geographical core of the state, see Buhaug (2010).
Administrative capacity includes two different interrelated aspects of state capacity: the quality of state bureaucracy and the quality of the rule of law. These two indicators of state capacity show to be negatively correlated with civil conflict onset, see De Rouen and Sobek (2004) and Fearon (2005). Bureaucratic capacity gives to the government the possibility to monitor the population, to gain information about the identity of possible rebels. The quality of the rule of law, that is the ability of the state to make credible commitments to private investors, acts on the incentives of individuals to invest productively, instead of challenging state authority.

All the dimensions of state capacity are empirically negatively correlated with civil conflict onset. In the following model, by assumption, when there has not been investment in state capacity, and the colony for some reasons becomes independent, civil conflict between the local groups cannot be avoided. This rule of the game is common knowledge of colonizers and colonized. This assumption is justified by the idea that, even though colonizers and local groups could not be aware of the empirical literature on the topic, they knew that having a more efficient state machine meant less probability of chaos and state failure. This awareness was evident in the debate about decolonization in the Belgian Congo, where the decolonization process was needed to avoid state failure after independence.

3.3 The model

There are $n+1$ players in the game: n local groups, $i \in N = \{1, ..., n\}$, and a colonial power/metropole: m. The game is played on an infinite horizon in a discrete time. $0 \leq t < \infty$ denotes period t. In every period t local group i produces $\bar{y}_i$ inelastically with respect to taxation and constant in time, $y := \sum_{i \in N} \bar{y}_i$. In every period there is a rent coming from natural resources r. Production and extraction of natural resources take place before any action is taken by the players. This 2-sector economy depends on the level of state capacity $h \in \{0, 1\}$. $Y(h) = (1 + x(h))y + (1 - bx(h))r$ is the output as a function of the level of state capacity, with $x(1) = x, x(0) = 0$. $x > 0$ is the productivity gain and b is a parameter that determines the effect of state capacity investment on the natural resources sector. If $b > 0$ there is a negative effect on the natural resources sector, that can depend on the relocation of workers from the natural resources to the modern sector, due to change in their education level, that is included in the investment in state capacity. If $b < 0$ also the natural resources sector gains from state capacity investment. If $b = 0$ the natural resources sector is untouched by state capacity investment. In any case b has a lower bound: $b > -1$, so the productivity gain is always stronger for the modern sector with respect to the natural resources one. When the state machine is working efficiently, there is a side effect: in the event of independence no chaos arises and no civil conflict is triggered. If the level of state capacity is low when independence comes, the outcome is civil war[1]. m is in power in the colony. In period 0 m chooses to invest in state capacity, $h \in \{0, 1\}$. There is no direct cost of state capacity investment[2]. At the same time m also chooses if investing (i) or not (ni) in a stable army. This choice is denoted by $\phi \in \{i, ni\}$. The army has a per period cost p. In period $t > 0$ m chooses a redistribution to perform between the $n + 1$ players, through taxation and transfers. There is no inefficiency or cost of taxation. Thus m determines a vector $(y_1^t, ..., y_n^t, y_m^t)$ where y_i^t is the post tax aggregate income accruing to group $i \in \{1, ..., n\}$, y_m^t is the rent extracted by the metropole, and $\sum_{i=1}^n y_i^t + y_m = Y(h)$. No group i can receive less than a subsistence level: $y_i \geq \underline{y}_i$. Thus, there is an upperbound on the rent y_m^t extracted by the colonial power: $y_m \leq Y(h) - \underline{y}$, where $\underline{y} := \sum_{i=1}^n \underline{y}_i$. In period 0 redistribution is performed after (h, ϕ) have been determined. In period $t \geq 0$, after taxation and redistribution are implemented, the local groups can pick one action among the following:

- accept the colonial rule (a);
- rebel (w) against the metropole m.

[1]Thus the probability of civil conflict after independence is 0 with high state capacity, and 1 without it. It could instead be assumed that the probability X_E of civil conflict after independence, with a high level of state capacity, is lower than the same probability X_{NE}, with a low level: $X_{NE} > X_E$. The equilibrium outcomes would not change with this assumption.

[2]Adding a positive cost would not change the results, because if there is investment in state capacity, there must be always investment in the military to avoid a costless independence for the local groups. Therefore in the game only the cost of the military is considered, to save on the number of parameters.

This choice is denoted by $\nu_i^t \in \{a, w\}$. If at least one local group chooses $\nu_i^t = w$ war is triggered, all local groups form a coalition against the metropole. The game enters the political state W, war of independence. W depends on the couple (h, ϕ) and on redistribution $(y_1^t, ..., y_n^t, y_m^t)$:

- if $h = 1, \phi = ni$, the metropole has no military and cannot stop an insurgency. The colony becomes independent without the cost of insurgency. A high level of state capacity guarantees no civil conflict and a fair redistribution among the social groups. Specifically the redistribution is a result of a Nash bargaining, where the status quo is the vector of payoffs that make all local groups indifferent between a and w, in this case $(y_1^t, ..., y_n^t)$. Income after tax of local groups in period t is redistributed too.

- If $h = 0, \phi = ni$ the metropole has no military. The colony becomes independent without the cost of insurgency, and the metropole leaves the colony with y_m. There is a low level of state capacity, thus chaos arises and local groups can only trigger conflict with each other. Each group wins with the same probability $1/n$. There is a cost of civil conflict $c\sum_{1=1}^n y_i^t$. The higher is the output left in the colony $\sum_{1=1}^n y_i^t$, the higher is the cost of conflict. The winning group enjoys the total output from period t on, minus the part extracted by the metropole and the cost of civil conflict.

- If $h = 0, \phi = i$ the metropole reacts with the military to the insurgency. With probability 1/2 the metropole represses the rebellion, with the same probability the local groups win and the metropole has to leave the colony, guaranteeing independence[3]. The cost of insurgency for group i is $sy_i^t > 0$, $0 < s < 1$. If independence is achieved, with a low level of state capacity, local groups trigger a civil conflict with the same features described in the previous point, where the cost of civil conflict is $c(1-s)\sum_{1=1}^n y_i^t$.

- If $h = 1, \phi = i$ the metropole starts a war with local groups, with the same features described previously. If independence is achieved the presence of a working state machine prevents civil conflict. Redistribution is performed through a Nash bargaining, where the status quo is the vector of payoffs that make all local groups indifferent between a and w.

[3]Adding a parameter for the probability of repression, instead of considering it fixed to 1/2, does not deliver any interesting insight on the results.

If all local groups choose $\nu_i^t = a$, or if the colonial power represses the insurgency, next period starts with the metropole still ruling.

The timing in period t can be summarized as follows:

1. (only in period 0) the metropole m decides about investment in state capacity (h) and in the military (ϕ);
2. production $(1+x(h))y$ and extraction of natural resources $(1-bx(h))r$ are performed;
3. m implements the redistribution $(y_1^t, ..., y_n^t, y_m^t)$;
4. each local group $i \in N$ chooses between accepting the colonial rule a and rebel w.

If all local groups choose a period $t+1$ starts with the metropole m still in power. Otherwise the outcome of the political state war of independence W is determined by $h, \phi, (y_1^t, ..., y_n^t, y_m^t)$, as previously described.

3.3.1 Results

The characterization of equilibria focuses on pure strategy Markov perfect equilibria (MPE) of the game, which are a mapping from the current state of the game to strategies, where the last ones form a subgame perfect equilibrium. The investigation of MPE is performed through backward induction. In this section time subscripts are dropped.

Local groups: accept colonial rule or rebel?

After the metropole has decided about the investment in state capacity h, in the military ϕ and redistribution $(y_1, ..., y_n, y_m)$, each local group has to decide if accepting colonial domination and move to the next period, or rebel. Thus the subgames are defined by choices $h, \phi, (y_1, ..., y_n, y_m)$ of the metropole in the upper part of the game. Next follows the analysis of the strategic decision of local groups about rebellion or acceptance of colonial rule.

If $h = 1, \phi = ni$ there has been investment in state capacity, thus there is a larger output $Y(1)$, and no civil conflict in case of independence. The colonial power has not created a military, so local groups can get independent without paying the cost of insurgency. Given that there is no cost in becoming independent,and since under colonial rule the metropole takes a positive rent y_m, independence can ensure to each local group an income per period that is higher than the one under colonial rule. Thus every local group always prefers to rebel. Formally group i accepts colonial rule, $\nu_i = a$, if the present value of receiving y_i in every period is larger than the share of the present value of output in this period and in the future, minus the rent y_m extracted by the metropole:

$$\frac{1}{1-\beta} y_i \geq k_i \left[\frac{1}{1-\beta} Y(1) - y_m \right],$$

where k_i is defined by the Nash bargaining. The inequalities for $i = 1, ..., n$ are all satisfied if the surplus from bargaining is less or equal to 0, that is $y_m = 0$, considering that there is no cost in becoming independent.

Proposition 3.1 ($h = 1, \phi = ni$)**.** *In the subgame where the metropole has invested in state capacity ($h = 1$) but it has not created a military ($\phi = ni$) all local groups accept the colonial rule ($\nu^i = a$, $i = 1, ..., n$) if and only if $y_m = 0$ in every period. If $y_m > 0$ all local groups choose $\nu_i = w$, independence is achieved and no civil conflict arises. The surplus from independence is $\beta/(1-\beta) y_m$.*

If $h = 0, \phi = ni$ the level of state capacity is low and there is no military. Thus if local group i chooses $\nu_i = w$ the colony becomes independent without the cost of insurgency. In the neo-independent country chaos arises, so local groups are bound to trigger conflict with each other. In this case local groups face two costly choices: remain under colonial rule losing the extracted rent y_m in every period, or rebel and embark in a civil war that destroys part of the output of the colony. A large y_m, extracted by the metropole, can thus induce local groups to become independent and pay the cost of civil conflict thereafter. For the same reason, if the cost of civil conflict is too high, local groups are willing to accept colonial rule even though the exploitation on the side of the metropole is substantial. Therefore for the metropole in the upper part of the game it is important to know what is the maximum y_m that can be extracted, without making any local group choose to rebel. It is useful to notice that m cannot advantage only one group in the redistribution, because civil war needs only one group to trigger it, thus every local groups must prefer colonial rule to rebellion. Formally local group i chooses a if

$$\frac{1}{1-\beta} y_i \geq \frac{1}{n} \left[\frac{1}{1-\beta} Y(0) - y_m - c \sum_{i=1}^{n} y_i \right],$$

On the RHS $1/n$ is the probability of winning the civil war, y_m is subtracted only in the present period because in the following periods the metropole will have left. Independence is achieved if at least one group chooses w, thus all the inequalities, for $i = 1, ..., n$, must be satisfied. The RHS of the inequality does not depend on i, thus the sum of the RHS of every inequality, for $i = 1, ..., n$, divided by $1/(1-\beta)$, and by n, gives the condition for y_i.

Proposition 3.2 ($h = 0, \phi = ni$). *In the subgame where the metropole has not invested in state capacity ($h = 0$) and it has not created a military ($\phi = ni$) all local groups accept the colonial rule ($\nu^i = a$, $i = 1, ..., n$) if and only if*

$$y_i \geq \frac{\beta Y(0)}{n[(1-\beta)c+\beta]}, \qquad i = 1, ...n, \tag{3.1}$$

that implies $y_m \leq (1-\beta)cY(0)/[(1-\beta)c+\beta]$. If inequality 3.1 is not satisfied for at least one group i, that group chooses $\nu_i = w$, independence is achieved and a civil conflict starts. The winner is selected with probability $1/n$ and enjoys all the output from the present period, minus the rent y_m extracted by the colonial power, minus the cost of conflict.

It is convenient for the analysis that follows to give the following definition: $A(c, \beta) := (1-\beta)c/[(1-\beta)c+\beta]$. $A(c, \beta)$ is the maximum proportion of output $Y(0)$ that can be extracted in every period by the metropole, under the condition of inducing every local group to accept colonial rule. A depends positively on c, because the higher the cost of conflict is for the local groups, the lower is their incentive to get independent, and the larger is the rent that can be expropriated by the colonial power.

If $h = 1, \phi = i$ there are both investment in a military and in state capacity. Thus if local groups want independence they have to mount an insurgency against the metropole. Insurgency is costly and does not guarantee that independence is achieved. If the colony becomes independent a high level of state capacity ensures that civil conflict is not triggered. Also in this subgame local groups face two costly choices: either to lose in every period the rent y_m that the metropole extracts, or to mount a costly and uncertain insurgency against the colonial power. Local groups only save the cost of civil war after independence. The colonial power cannot favor one group or a small set of local groups in the redistribution, because insurgency needs just one local group to be triggered. Group i chooses a when

$$\frac{1}{1-\beta}y_i \geq \frac{1}{2}k_i\left[\frac{1}{1-\beta}Y(1) - y_m - s\sum_{i=1}^{n} y_i\right] + \frac{1}{2}\left[\frac{\beta}{1-\beta}y_i + (1-s)y_i\right],$$

where on the RHS with probability $1/2$ the insurgency is successful and the present value of the output in every period is split among local groups fairly, minus the rent y_m extracted by the metropole, minus the cost of insurgency for all the groups. With probability 1/2 the insurgency is defeated and local group i can enjoy only $(1-s)y_i$ and the present value of future redistribution from the metropole. The one shot deviation property is applied. k_i is defined by the Nash bargaining.

Proposition 3.3 $(h = 1, \phi = i)$**.** *In the subgame where the metropole has invested in state capacity ($h = 1$) and a military ($\phi = i$), all local groups accept the colonial rule ($\nu^i = a$, $i = 1, ..., n$) if and only if*

$$y_i \geq \frac{\beta Y(1)}{n[(1-\beta)2s+\beta]}, \qquad i = 1, ...n, \tag{3.2}$$

that implies $y_m \leq (1-\beta)2sY(1)/[(1-\beta)2s+\beta]$. If condition 3.2 is not satisfied for at least an i, all groups choose $\nu_i = w$, the insurgency starts. With probability 1/2 the insurgents win, the colony becomes independent, output is redistributed fairly and no civil conflict arises. With probability 1/2 the metropole wins and the next period starts with the colony still under foreign rule.

It is convenient for the analysis that follows to give the following definition: $B(s, \beta) := (1-\beta)2s/[(1-\beta)2s+\beta]$, where $B(s, \beta)$ is the maximum proportion of output $Y(1)$ that the metropole can extract in every period, under the condition of inducing local groups to accept colonial rule. B depends positively on s, because a higher cost of insurgency lowers the incentive of the local groups to rebel, highering the rent that the colonial power can extract in every period.

If $h = 0, \phi = i$ the level of state capacity is low, but the metropole creates a military. Choosing w bears two costs for the local groups: the cost of insurgency and the cost of civil war if independence is achieved. Thus local groups face a very high cost in choosing rebellion. Local group i chooses a if:

$$\frac{1}{1-\beta}y_i \geq \frac{1}{2n}\left[\frac{1}{1-\beta}Y(0) - y_m - [s + c(1-s)]\sum_{i=1}^{n} y_i\right] + \frac{1}{2}\left[\frac{\beta}{1-\beta}y_i + (1-s)y_i\right].$$

The coefficient $[s + c(1-s)]$ takes into account that in case the insurgency is successful and group i wins also the subsequent civil conflict, the total cost for the winner includes the cost of insurgency and the cost of civil conflict.

Proposition 3.4 ($h = 0, \phi = i$)**.** *In the subgame where the metropole has not invested in state capacity ($h = 0$) but it has created a military ($\phi = i$), all local groups accept colonial rule ($\nu^i = a$, $i = 1, ..., n$) if and only if*

$$y_i \geq \frac{\beta Y(0)}{n[(1-\beta)(2s + (1-s)c) + \beta]}, \tag{3.3}$$

that implies $y_m \leq (1-\beta)(2s + (1-s)c)Y(0)/[(1-\beta)(2s + (1-s)c) + \beta]$. If condition 3.3 is not satisfied for at least a group i, insurgency is triggered, if the local groups win the colony becomes independent but a civil war starts. With probability $1/n$ one group wins, it enjoys the present value of output, minus the rent y_m extracted by the colonial power, minus the cost of insurgency and civil war.

It is convenient for the following analysis to define $C(c, s, \beta) := (1-\beta)(2s + (1-s)c)/[(1-\beta)(2s + (1-s)c) + \beta]$. $C(c, s, \beta)$ is the maximum proportion of output $Y(0)$ that the metropole can extract in every period, under $h = 0, \phi = i$. C depends both on the cost of insurgency s and the cost of civil war after independence c, and is increasing in both. Moreover C is always larger or equal than B and A, so the metropole always appropriates a larger proportion when choosing $h = 0, \phi = ni$, because two conflicts are always costlier than one. This ensures that the maximum rent y_m extracted by m is larger if $h = 0, \phi = i$, than the same rent under $h = 0, \phi = ni$, because $CY(0) \geq AY(0)$. $C \geq B$ does not guarantee that the maximum rent y_m under $h = 0, \phi = i$ is larger than the rent under $h = 1, \phi = i$, because $CY(0)$ is compared to $BY(1)$, where $Y(1) > Y(0)$.

The metropole: investment in state capacity and/or military?

Next follows the investigation of the strategic decision of the metropole, about investment in state capacity h, military ϕ and redistribution $(y_1, ..., y_n, y_m)$. As underlined in the characterization of the subgame equilibria the colonial power can extract different maximal y_m, based on h and ϕ. Indeed if $h = 1$, $\phi = ni$ the maximum rent extracted is $y_m = 0$, if $h = 0$, $\phi = ni$ the highest y_m is $A(c, \beta)Y(0)$, if $h = 1$, $\phi = i$ the upperbound for the rent is $y_m = B(s, \beta)Y(1)$, and finally if $h = 0$, $\phi = i$ at most the metropole can take in every period $y_m = C(c, s, \beta)Y(0)$. When $\phi = i$ the colonial power includes in her payoff the per period cost p for the military.
To avoid considering the case of a metropole that in equilibrium leaves the colony in period 0, because the other choices are costlier than the outside option $y_m = Y(\cdot) - \underline{y}$, some assumptions are added on the parameters.

Assumption 3.1.

$$Y(0) - \underline{y} < \frac{1}{1-\beta} A(c,\beta) Y(0) < \frac{1}{1-\beta}(Y(0) - \underline{y}), \tag{3.4}$$

$$Y(1) - \underline{y} < \frac{1}{1-\beta} B(s,\beta) Y(1) - \frac{p}{1-\beta} < \frac{1}{1-\beta}(Y(1) - \underline{y}), \tag{3.5}$$

$$Y(0) - \underline{y} < \frac{1}{1-\beta} C(c,s,\beta) Y(0) - \frac{p}{1-\beta} < \frac{1}{1-\beta}(Y(0) - \underline{y}). \tag{3.6}$$

The first inequality in 3.4 implies that not investing in state capacity, nor in the military, is better for the metropole than taking the maximum rent in one period and induce local groups to rebel. The second inequality in 3.4 implies that, with a low level of state capacity and no military, and if local groups are left with their subsistence levels of income, at least one local group chooses w. The rationale behind this second inequality is that $y_m = AY(0)$ is the maximum rent that makes local groups indifferent between accepting colonial rule and rebel. If this rent y_m is larger than $Y(0) - \underline{y}$, the metropole can take all the extractable output in the colony without inducing local groups into rebellion. Conditions 3.5 and 3.6 control for the same choice respectively under $h = 1, \phi = i$ and $h = 0, \phi = i$.

After stating assumption 3.1, the characterization of MP equilibria of the game is done comparing the metropole's payoffs under different choices of h and ϕ. First of all, in equilibrium, the metropole never chooses to invest in state capacity ($h = 1$) but not in the military ($\phi = ni$), because it gives the colonial power in every period a rent $y_m = 0$, which is always lower than the outside option: $y_m = Y(0) - \underline{y}$. For this reason in assumption 3.1 actions $h = 1, \phi = ni$ were not considered.

While the full characterization of equilibria is left to the following theorem, it can be useful to provide the rationale behind the conditions for the equilibrium, where the metropole chooses $h = 1$ and $\phi = i$. The colonial power chooses to invest in state capacity ($h = 1$) and to create a military ($\phi = i$), if the largest rent y_m that can be appropriated under the condition of preventing the local groups from rebelling, minus the cost of military, gives a higher utility than all other options. For example the metropole prefers $h = 1, \phi = i$ to $h = 0, \phi = i$ if

$$\frac{1}{1-\beta} B(s,\beta) Y(1) - \frac{p}{1-\beta} > \frac{1}{1-\beta} C(c,s,\beta) Y(0) - \frac{1}{1-\beta} p.$$

where on the RHS the metropole considers the largest y_m taken under $h = 0, \phi = i$, minus the cost of military. What matters in comparing these two choices is not the cost of military, because it is the same for both, but the proportions of output that can be appropriated ($B < C$) and the magnitude of the output ($Y(1) > Y(0)$), that depends on the productive gain x. The metropole prefers $h = 1, \phi = i$ to $h = 0, \phi = 0$ if

$$\frac{1}{1-\beta} B(s,\beta) Y(1) - \frac{p}{1-\beta} > \frac{1}{1-\beta} A(c,\beta) Y(0).$$

The colonial power prefers investing in state capacity and in the military, with respect to not investing in neither of them, when the increase in output determined by efficient institutions is large enough compared to the cost of military. Indeed this inequality depends on p and x. The two previous conditions together define the set of parameters such that $h = 1, \phi = i$ is an equilibrium. The choice of $h = 1, \phi = i$ is not compared to $h = 1, \phi = ni$ because the latter is never an equilibrium, while assumption 3.1 ensures that investment in state capacity and a military is better than extracting $Y(1) - \underline{y}$ and leave the colony.

The following theorem states the conditions on the parameters for the different equilibria. To keep the theorem concise only the metropole's rent y_m is expressed in equilibrium. There are many redistributions $(y_1, ..., y_n)$ with the same y_m that correspond to an equilibrium under different actions (h, ϕ), e.g. $y_i = [Y(\cdot) - y_m]/n$, $i = 1, ..., n$.

Theorem 3.1. *The metropole's actions $h = 0, \phi = ni$, metropole's stable rent $y_m = A(c,\beta)(y + r)$, and local groups' actions $\nu^i = a$, $i = 1, ..., n$, is a MPE of the game if :*

$$p > B(s,\beta)[y + r + x(y - br)] - A(c,\beta)(y + r) \tag{3.7}$$

$$p > [C(c,s,\beta) - A(c,\beta)](y + r). \tag{3.8}$$

The metropole's actions $h = 1, \phi = i$, metropole's stable rent $y_m = B(s,\beta)[y + r + x(y - br)]$, and local groups' actions $\nu^i = a$, $i = 1, ..., n$, is a MPE of the game if:

$$C(c,s,\beta)(y + r) < B(s,\beta)[y + r + x(y - br)] \tag{3.9}$$

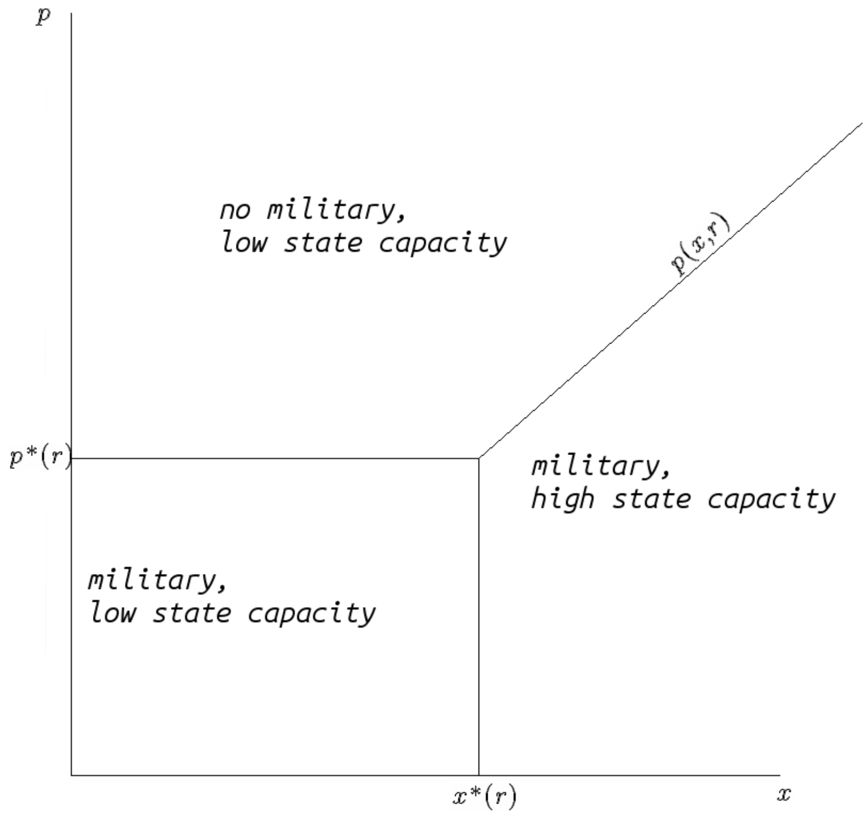
$$p < B(s,\beta)[y + r + x(y - br)] - A(c,\beta)(y + r). \tag{3.10}$$

The metropole's actions $h = 0, \phi = i$, metropole's stable rent $y_m = C(s,\beta)(y + r)$, and local groups' actions $\nu^i = a$, $i = 1, ..., n$, is a MPE of the game if conditions 3.7-3.10 are not satisfied. The couple of actions $h = 1, \phi = ni$ is never part of an equilibrium.

The following corollary gives a characterization of the previous theorem, focusing on the parameters (x, p, r). Dependencies on c, s, β are dropped from A, B, C. $p^*(r)$ is defined as follows: $p^*(r) = [C - A](y + r)$. $x^*(r)$ and $p(x, r)$ are defined as follows: $x^*(r) = [C - B](y + r)/[B(y - br)]$, $p(x, r) = B(y - br)x + [B - A](y + r)$. $p^*(r)$ solves with equality condition 3.8, $x^*(r)$ solves condition 3.9. $p(x, r)$ solves with equality condition 3.7.

Corollary 3.1. *The metropole in equilibrium invests in state capacity, and in the military, if $p < p(x, r)$ and $x > x^*(r)$. The metropole in equilibrium does not invest in state capacity, nor in the military, when $p > p(x, r)$ and $p > p^*(r)$. If $x < x^*(r)$, $p < p^*(r)$ the colonial power does not invest in state capacity, but it does invest in the military. The metropole, in equilibrium, never chooses to invest in state capacity but not in the military. In all equilibria local groups are kept indifferent between accepting colonial rule and rebel.*

Figure 3.1: The Markov Perfect equilibria of the game in the (x, p) space



There are some points that can be useful to underline, in light of the characterization of the equilibria.

First of all the equilibrium choice of investing in state capacity, that is the main concern of this paper, depends on two parameters: the productivity gain from state capacity investment, and the cost of the military. The former parameter can be attributed to features of the colony, for example the distance from the sea, or as endogenized in the model, the presence of natural resources. The magnitude of the latter parameter depends on the identity of the colonizer. Indeed a colonizer with a larger empire, considering scale effects in military technology and the possibility to move troops around the colonies, will have a lower average cost of the military. Therefore the heterogeneity in institutional quality in non settlement colonies depends on the matching between two identities, the one of colony and the one of the colonizer.

Secondly, when there is investment in state capacity there is always, also, investment in a military to suppress insurgencies, otherwise the local groups can get independent at no cost, choice that they would always take.

Thirdly, if the military cost is high enough compared to the productivity gain from state capacity investment ($p > p(x, r)$), and p is above a threshold p^*, the metropole does not invest in state capacity, nor in the military. The colonial power is ready to sacrifice a productivity gain, in order to save the cost of military. The metropole acts in this way because not modernizing the state burns the chances of a stable peace in the colony after independence, making independence excessively costly for the local groups. This dynamics are similar to the reasoning that brings a military commander to burn the fields and destroy all the supplies in order to slow down the enemy. The metropole prefers to lose the productivity gain in order to lower the opportunity cost of accepting foreign rule. Mimicking the name given to this military strategy, this equilibrium action can be defined as "scorched earth" strategy. Moreover this equilibrium shows that it is possible for an extractive party to control a country without the use of organized violence.

Furthermore, as anticipated in first point, brief comparative statics show that increasing the rent from natural resources r can reduce the set of parameters in which $h = 1$, if b, the effect of investment in state capacity on the natural resources sector, is positive. If $b > 0$ both $x^*(r)$ and $p(x, r)$ change with r, tightening the set of parameters in which the equilibrium action is $h = 1$. If $b = 0$ only $x^*(r)$ suffers the tightening effect. If b is large and negative both $x^*(r)$ and $p(x, r)$ change with r, enlarging the set of parameters in which the equilibrium action is $h = 1$. Hence if the effect of state capacity investment on natural resources is negative, having a larger natural resources sector makes it less likely to invest in state capacity in equilibrium. This result will bring more consequences when analyzing the equilibria after the shock.

3.4 An exogenous shock

An extension of the model is presented here, to take into account the independence wave after the 1945, in which metropoles were almost at once forced the demobilize their colonial empires. At time $v > 0$ an exogenous and unpredicted shock forces the metropole to leave the colony[4]. The shock is revealed at the beginning of the period. $Y(h)$ is produced, m redistributes $(y_1^v, ..., y_n^v, y_m^v)$. If at the beginning of period v, h is equal to 1, local groups get immediately independent and redistribution is performed as previously described. If $h = 0$, the metropole proposes a decolonization process, knowing that it has to leave at the end of the period. Decolonization implies the creation of a working state machine, $h = 1$, by the colonizer, in exchange for an institutional setting for the new independent country, such that the ex metropole can get involved in economic activities with the ex colony. These economic activities give m a rent $\underline{z}$ in every period and subtract $\bar{z}$ to the colonial output available to the local groups. φ is defined as follows: $\varphi = \bar{z} - \underline{z}$. If $\varphi > 0$ decolonization is inefficient. Each local group can either:

- accept the decolonization process (d);
- get immediately independent (f).

This choice is denoted by $\eta \in \{f, d\}$. If all local groups choose d the decolonization process D starts. From the next period on $\underline{z}$ is subtracted to the total output of the ex colony. After the metropole leaves in period v, redistribution is performed according to a Nash bargaining, where the status quo is the vector of payoffs that make local groups indifferent between d and f. The redistribution involves also the post tax income of local groups in period v.

$\bar{z}$ and $\underline{z}$ are assumed to be fixed, which means that local groups and the metropole cannot bargain over the terms of decolonization. The reason of this modeling choice lies in the idea that the colonial power in the process of decolonization is involved in the design of political and economic institutions of the future independent country. In order to receive a perpetual rent after independence there must be a loophole in these new institutions, such that the metropole can take advantage of it. For example political institutions are designed such that politicians can be bribed by foreign companies to get favorable terms for public tenders. But once these institutions are in

[4]While some colonies, as Indochina, India and Algeria, anticipated the wave and actively fought against the colonizer, the high number of colonies that became independent in the 1960 suggests that, for most of the colonies, the push for independence was not generated endogenously, but came as a shock.

place the ex colonial power has always an incentive to extract the maximal possible rent, because there is no third party enforcing any previous contract. φ captures the magnitude of all the inefficiencies of this process.

3.4.1 Results

If an exogenous and unpredictable shock at time v forces the metropole to leave the colony at the end of the period, different equilibria arise, based on the value of h, capturing the level of state capacity in period 0. If $h = 1$ the output of the colony is $Y(1) > Y(0)$, but more importantly civil conflict between the local groups is avoided after independence. Thus, if the level of state capacity is already high, the metropole can only extract a rent y_m and leave the country. In equilibrium the rent extracted will be the maximum: $y_m = Y(1) - \underline{y}$. Independence is achieved and the present value of the output minus the metropole's rent, $1/(1-\beta)Y(1) - y_m$, is redistributed fairly.

If $h = 0$ the metropole redistributes $(y_1, ..., y_n, y_m)$ and proposes a process of decolonization to the local groups. Both decolonization on one side, and immediate independence and civil conflict on the other, are costly for the local groups, the first implies a perpetual loss $\bar{z}$ for the economy of the ex colony, while the second destroys part of the present output of the colony. Formally local group i accepts the decolonization process, $\eta_i = d$, if the share of the present value of future output $Y(1)$ and present output $Y(0)$, minus the cost of decolonization $\bar{z}$, minus the metropole's rent y_m, is larger than the expected value of conflict:

$$k_i \left[\frac{\beta}{1-\beta} (Y(1) - \bar{z}) + Y(0) - y_m \right] \geq \frac{1}{n} \left[\frac{1}{1-\beta} Y(0) - y_m - c \sum_{i=1}^{n} y_i \right]. \tag{3.11}$$

Summing condition 3.11 for all groups $i = 1, ..., n$ determines the maximum y_m the metropole can extract in period v:

$$y_m \leq \bar{y}^m := \frac{\beta(Y(1) - Y(0) - \bar{z}) + (1-\beta)cY(0)}{(1-\beta)c}. \tag{3.12}$$

Another assumption is made, to make sure that the rent $\bar{y}^m$ that makes local groups indifferent between accepting decolonization and refusing it, is lower than the total extractable rent $Y(0) - \underline{y}$. Otherwise local groups accept decolonization for every feasible y_m.

Assumption 3.2.

$$\bar{y}^m < Y(0) - \underline{y}. \tag{3.13}$$

Considering condition 3.12 the metropole can either choose to take the maximum y_m that induces local groups to accept decolonization, or take the outside option $Y(0) - \underline{y}$, aware of the fact that local groups, for assumption 3.2, will refuse decolonization. Thus decolonization is successful if

$$\bar{y}^m + \frac{\beta \underline{z}}{1-\beta} \geq Y(0) - \underline{y}.$$

The equilibrium condition for successful decolonization depends on the inefficiency from decolonization $\varphi = \bar{z} - \underline{z}$:

Theorem 3.2. *If $h = 1$ the metropole in equilibrium extracts $y_m = Y(1) - \underline{y}$, the country becomes independent and a fair redistribution is performed. No civil conflict arises. If $h = 0$ the metropole's rent $y_m = \bar{y}^m$ and local groups' actions $\eta_i = d$, $i = 1, ..., n$, is a MPE of the game after the shock if*

$$\varphi \leq x(y - br) + \frac{1-\beta}{\beta} \underline{y} - (1-c)\underline{z}. \tag{3.14}$$

Under condition 3.14 the decolonization is successful and no civil conflict arises after independence, but the colony remains trapped in a neocolonialistic domination. If condition 3.14 is not satisfied the decolonization process fails, the metropole leaves extracting the maximum rent $y_m = Y(0) - \underline{y}$, the colony becomes independent and a civil conflict is triggered between the local groups.

Theorem 3.2 highlights that civil conflict after independence in equilibrium depends on two main factors: the investment in state capacity h previous to the shock, and the inefficiency of decolonization φ. If the colonial power decides to invest in state capacity, there will be no civil conflict in equilibrium after independence. Hence the conditions under which investment in state capacity takes place in theorem 3.1 are sufficient to determine a peaceful cohabitation after independence.

Instead for the set of parameters such that in theorem 3.1 in equilibrium there was no investment in state capacity, the inefficiency of decolonization φ determines if there is civil conflict after independence. In particular, if $\varphi > \varphi^*(r) := x(y - br) + \frac{1-\beta}{\beta} \underline{y} - (1-c)\underline{z}$, the decolonization process is not successful, the level of state capacity stays low, and civil conflict is triggered after independence.

Thus the exogenous shock can also determine civil conflict in equilibrium. This result can be interesting, because this shock mimics the decolonization and independence wave after 1945, in particular in the so called "year of Africa", the 1960. The United Nations were particularly engaged in pressuring the colonial powers to give up their colonies. Many of these colonies experienced civil conflict after independence, in some cases only after few days. Therefore the pressure of the UN, instead of being helpful in increasing the welfare of the subjected populations through independence, sometimes in a heterogony of ends has determined an unwanted and costly outcome for the ex colonies.

Even the possibility of a decolonization process to build the institutions the ex colony will need to be peaceful, can be useless if there is no third party providing a commitment device for the metropole and the local groups. Indeed the metropole cannot guarantee that she will not take advantage of the decolonization process to devise institutional loopholes that will provide her with a perpetual rent. If the inefficiency brought by this process is too high then local groups can prefer to become immediately independent and face a costly civil conflict. Indeed Belgian Congo followed this equilibrium path.

Additionally the identity of the colonizer influences the transition to independence: colonies dominated by metropoles with a lower cost of the military are more likely to receive a working state machine, thus they do not end up in a civil war.

Another interesting point is connected to the comparative statics on the natural resources sector size r in the previous section. In inequality 3.14 an increase in r, if $b > 0$, tightens the constraints on φ, reducing the set of parameters such that there is no civil conflict in equilibrium. The reason is that, if investment in state capacity has a negative effect ($b > 0$) on the natural resources sector, then for a colony rich in natural resources the productivity gain, consequent to decolonization, is low and local groups could prefer independence with low state capacity. This effect adds to the ones in the previous section, where it was showed that an increase in r, if $b > 0$, reduced the set of parameters such that $h = 1$, that in the post shock game translates into no civil conflict after independence.

Finally theorem 3.2 predicts path divergence in equilibrium: colonies that received a high level of state capacity, had also a productivity gain (higher growth), and no conflict, so no waste of human and physical resources. The ones where the colonizer did not invest in state capacity, did not receive the productivity gain (lower growth) and also suffered a costly civil conflict after independence. Next corollary summarizes the results of this section:

Corollary 3.2. *Civil conflict after independence is triggered in equilibrium if:*

$$p > p(x, r), \;\; x < x^*(r), \;\; \varphi > \varphi^*(r),$$

where p is the cost of military, x is the productivity gain from state capacity investment, φ is the inefficiency from decolonization, and r is the size of

the natural resources sector. In this case colonies become independent with a low state capacity investment. In particular local groups rationally choose to induce civil conflict in the neo-independent country because decolonization is too costly for them. Increasing natural resources r, if the effect of state capacity investment on the natural resources sector is negative, higher the probability of civil conflict in the ex colony. Thus natural resources influence civil conflict indirectly.
There is no civil conflict after independence in equilibrium if either there was investment in state capacity before the shock, or if decolonization is not too inefficient.
Colonies take divergent growth paths, based on the features of their economies (x) and the identity of the metropole (p): the ones that received a high state capacity in equilibrium, have a productivity gain and higher growth and no civil conflict after independence, the ones that did not receive state capacity investment face lower growth and costly civil conflict.

3.5 Conclusion

Starting from the colonial histories of Belgian Congo and Senegal, and from an empirical literature about the correlation between the level of state capacity and civil conflict, a model about the strategic behavior of metropoles in setting colonial institutions is developed. In equilibrium the colonizer's decision about the investment in state capacity is based on the cost of the colonial military and on the productive gain of state capacity investment in the colonial economy. The matching between the identity of the colonizer, which embeds a particular cost of the military, and the identity of the colony, defining a particular productivity gain, determines the equilibrium investment in state capacity.

One interesting equilibrium arises, if the productive gain is low compared to the cost of the military. In this case the metropole does not invest in state capacity, nor in the military. Therefore the colonizer is willing to sacrifice a productive gain in order to destroy the possibility of peace in case of independence, thus lowering the incentive of the local groups in the colony to become independent. This strategy has been named "scorched earth" strategy, because it recalls the military decision of burning fields and supplies belonging to the protected population, in order to higher the cost for the invader.

An exogenous shock is added to the game, after decisions about state capacity and military have already taken place. The metropole is forced to leave the colony at the end of the period. The shock models the independence wave after 1945. If there had been investment in state capacity before the shock, the colony becomes independent and no civil conflict arises. Otherwise the colonial power proposes a decolonization process to the local groups in the colony. Decolonization gives a working state machine to local groups, thus no civil conflict after independence, but it delivers also a perpetual rent to the metropole. In equilibrium local groups can be induced to refuse decolonization, if the decolonization process is too inefficient. Moreover colonies take divergent paths: the ones that receive high state capacity enjoy the productive gain and have no civil conflict after independence, the ones with low state capacity do not receive the productive gain and face a costly civil conflict.

Further research on the topic can be done collecting data on the size of the military in the colony, and on the potential productivity gain in the colonial economies. These data can be used to verify the results of the model.

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