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Abstract

This paper examines the lasting impact of the alignment of African countries during the Cold War on their modern economic development. We find that the division of the continent into two blocs (East/West) led to two clusters of development outcomes that reflect the Cold War's ideological divide. To determine alignment, we introduce a non-cooperative game of social interactions where each country chooses one of the two existing blocs based on its predetermined bilateral similarities with other members of the bloc. We show the existence of a strong Nash equilibrium in our game and apply the celebrated MaxCut method to identify such a partition. The alignment predicts UN General Assembly voting patterns during the Cold War but not after. Our approach, linking global political interdependence to distinct development paths in Africa, relies on history to extract a micro-founded treatment assignment, while allowing for an endogenous, process-oriented view of historical events.

Keywords: Cold War, Political Alliances, Africa, Blocs, Development Clusters, Strong Nash Equilibrium, Landscape Theory.
JEL codes: C62, C72, F54, F55, N47, O19, O57, N47, Y10.

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1 Introduction

Global politics and external influences feature prominently in theories of African economic development. However, in spite of the well-documented interest in the legacy of colonization in Africa (Alesina et al., 2011; Nunn, 2008), the impact of the post-colonial political landscape of the Cold War has received undeservedly little attention (Michalopoulos and Papaioannou, 2020). Since the Cold War period coincided with several dramatic waves of independence on the continent, it presented opportunities for African countries to adopt new development policies and institutions, and to form new international alliances (Mazrui and Tidy, 1984; Cooper, 2002). Given the fact that the superpowers, the US and the USSR, represented different and possibly incompatible modes of economic organization, i.e. capitalism and communism (Engerman, 2010; Gould-Davies, 2003), due to the path-dependent nature of development policies, even temporary alignments could have differential economic consequences outlasting the Cold War. On the other hand, conventional wisdom on the Cold War points to superpower conduct that inflicted widespread political and economic turmoil in Africa independently of alignment (Latham, 2010).

To address this important issue, we examine whether Cold War alignments indeed affected the pattern of African economic development. Employing i) game-theoretical, ii) computational, and iii) econometric methods, step by step, we uncover current development clusters in Africa that reflect the ideological lines of the Cold War. For instance, Western-aligned African countries have greater inequality (inequality cluster) coupled with deeper financial penetration (market cluster), in line with two distinguishing features of the prototypical economies of each Cold War bloc. This finding highlights at once the variety of development paths and the reach of politics in disciplining the development trajectories of African countries.

Identifying political alliances in the Cold War faces a common challenge of the assignment rule of any historical treatment. Without a general history of the Cold War in Africa, there are multiple, incomplete, and endogenous interpretations of alignment (Leffler and Westad, 2010; Immerman and Goedde, 2013). Available information is obtained via the filter of experts' knowledge, which is itself inherently interlinked with post-treatment outcomes. Historical events, especially large and protracted ones unfolding over time, such as the Cold War, increase the complexity and interdependence of potential outcomes. African countries' ties with the superpowers were fluid and represented diverse interests, leading to ambiguous and changing bloc affiliation during the Cold War (Brzezinski, 1963; Legvold, 1970; Mazrui and Wondji, 1993). Ignoring these features of the data introduces bias in standard estimation methods or forces researchers to make strong assumptions about potential outcomes.

Central to our approach to overcoming this challenge is a game-theoretic interpretation of the Cold War. We model the formation of international alliances during the Cold War as a game of social interactions between African countries, whose decisions on bloc affiliation are solely based on their bilateral links between African countries and purposively ignore the ideology of the Cold War and the superpowers as actors. We derive a unique alignment that we call *the focal partition* to justify the use of an exclusion restriction to enable causal analysis. Our partition merely splits the continent and does not label treatment status, providing a framework for well-defined counterfactual analysis. To obtain our partition, we show the existence of a unique *strong Nash equilibrium (SNE)* which is immune to deviations by any country or groups of countries (Aumann, 1959; Bennett, 2000) and maximizes (size-weighted) social welfare.

Since the identification of the focal partition is an NP-hard problem, we must address this computational challenge. To compute the equilibrium alignment, we first show that the alliance game can be recast as a MaxCut problem.[1] After constructing the matrix of pairwise payoffs from a set of predetermined characteristics,[2] we employ a branch and bound algorithm based on the MaxCut method to derive the unique focal partition of African countries into two blocs (out of 2^{47} possible configurations of Cold War alignment) (Goemans and Williamson, 1995).[3] We stress that our algorithm provides a global solution and hence differs from commonly used local search algorithms such as *k-means*.

The focal partition follows a striking geographical pattern roughly cutting the continent in two, North vs. South. Well-known cases of African countries' purported alignments are often grouped together, such as Liberia paired with South Africa and Algeria with Ethiopia. We show that the focal partition significantly predicts countries' voting patterns in the UN General Assembly, where one can view a particular UN resolution vote as a realized partition at one point in time. After labeling the blocs, pseudo-Western (pseudo-Eastern bloc) countries were more likely to vote with the US (USSR) at UN resolutions between 1960-1991. The relationship is robust to restricting the sample to relevant votes and different time periods and when we control for Cold War events. We also demonstrate that the focal partition outperforms over 90% of randomly generated partitions. Importantly, we compare the robustness of the estimated effects of the focal partition with other possible equilibrium partitions of varying levels of stability, represented by the minimum number of countries required to jointly switch their bloc affiliations to make all of the deviating coalition better

[1]The problem identifies a partition (the *maximal cut*) of a given weighted graph that gives the maximal aggregate weight of common wedges between two disjoint subsets of vertices of the graph.

[2]These are contiguity, common colonizer and geodesic, genetic, linguistic and religious distances.

[3]While generating a lot of interest in the operations research literature (Palagi et al., 2012), the MaxCut method was largely, and, in our view, unjustifiably ignored in economics.

off. Only nine of the over 80 Nash equilibria are 2-stable.[4] We show that the focal partition outperforms the other stable partitions. Our microfounded notion of alignment is, thus, an effective aggregator of the complexity of Cold War history in Africa.

From an econometric point of view, our theoretical approach reduces the ratio of potential outcomes to each actual observation to two and, since the assignment rule assigns treatment at the bloc level, our estimates will be less biased in the presence of social interactions than if the treatment were assigned at the individual level (under some regularity assumptions). Additionally, the reliance of the menu of payoffs on pre-determined characteristics eliminates dependence on ex-post information and individual countries do not select into assignment on the basis of expectations about potential outcomes. Due to the lack of experimental control over assignment, unconfoundedness of our treatment may still be a concern and, therefore, we draw on propensity scores obtained from the UN voting partitions to account for time-invariant, individual country-level observable and unobservable factors that influence the probability of treatment assignment.

Having introduced our method, we now address the main question examined in this paper: did Cold War political alliances produce development clusters in Africa? Following Besley and Persson (2014), we use the term development clusters to refer to the correlation of important characteristics of development and focus on ideologically-driven features of development. Bates (2017) argues that politics profoundly affected African economic development post-WWII. In a fascinating account of development strategies across the continent, Young (1982) persuasively argues that ideology was not simply rhetoric and affected the policy choices of African countries in important ways. In addition, Gorman (1984) documents that ideology strengthened ties among African countries, reinforcing these policy choices.

Our analysis is driven by three distinct hypotheses. First, the level of economic development did not vary widely on the continent on the eve of the independence movements (Young, 1982) and both ideologies shared the view that economic growth was a central objective (Engerman, 2004). In the spirit of the famous bet between Nkrumah and Houphouët-Boigny on which country's development path would lead to higher levels of economic output per capita, we ask whether the focal partition gives rise to a winners-and-losers cluster in terms of development levels.[5] Controlling for the initial level of development, we regress income per capita, averaged over $1990-2016$, on the focal partition and find that we are unable to statistically distinguish between the levels of development in the two blocs. Therefore, the pseudo-Western bloc affiliation did not yield higher incomes in Africa.

[4] I.e., at least three countries need to jointly switch to make a deviation worth it for all deviators.
[5] We realize "winners and losers" may mischaracterize the resolution of the Cold War.

Second, we scrutinize whether the focal partition produces development clusters that reflect the ideological differences of the superpowers' development strategies. Following Bergson (1984), we view the level of economic inequality (inequality cluster) and financial penetration (market cluster) as two necessary distinguishing features of the prototypical economies associated with each Cold War bloc. The separation of production and income under socialism makes equality feasible, whereas the accumulation of financial assets drives inequality in a market economy. We document that the pseudo-Western-bloc countries have greater inequality coupled with deeper financial penetration, a result in line with the ideologically-driven pathways of the superpowers.

Finally, we inquire about the emergence of other clusters related to investments in human capital, physical capital and inclusive institutions. For these intermediary outcomes, ideological differences do not provide us with strong priors on the correspondence of development outcomes with alignment. The different investment strategies encouraged by superpowers, however, should have produced systematic differences given that the two sides clashed over the methods of reaching greater production (Engerman, 2004). We demonstrate that pseudo-Western-bloc countries have greater human capital, measured by the literacy rate and gender parity in education, coupled with greater education expenditure share in the government budget, and do better on democracy score. In contrast, they have lower infrastructure levels, proxied by electrification.

For robustness, we account for any possible individual differences in a country's likelihood to be aligned with the US/USSR. The particular nature of our assignment rule allows for a powerful construction of propensity score using UN voting alignment that can account for both observable and unobservable time-invariant factors that influence a country's likelihood of being treated. No matter if we match on propensity score, weight using propensity score or simply control for it in our regressions, our results are robust. As with any one-off experimental or observational study with a small sample size, the treatment effect could be biased by happenstance correlations. We check the stability of our estimate to controlling for each pre-determined characteristic of our payoff matrix and the main results hold. Finally, since we assign treatment at the bloc level with only two treatment clusters, we perform randomization inference to obtain exact p-values for each development outcome.[6] For most outcomes, the focal partition outperforms over 90% of random partitions.

Our research contributes to the growing literature on the relevance of history for present outcomes (Nunn, 2009, 2014; O'Rourke, 1994). Among the few studies on historical political alignment, Akee et al. (2015) find that the political party of the US president affected the type

[6]The conventional adjustment to standard errors to allow for intracluster correlations is not feasible. MacKinnon and Webb (2019) show that randomization inference is a valid alternative.

of constitution adopted by American Indian Nations with long-run effects on development. Within the Cold War context, previous research documents the effect of political alliances on trade and conflict (Gokmen, 2017, 2018), as well as the impact of political influence on increased imports from the US (Berger et al., 2013). We instead provide evidence that political alliances shape the patterns of long-run development. We differ from the previous literature in our approach to using history to construct a historical treatment variable.

From a theoretical viewpoint, this paper is part of the literature on formation of groups, coalitions, and alliances. Specifically, our framework belongs to the class of hedonic games (Banerjee et al., 2001; Bogomolnaia and Jackson, 2002), where players' payoffs depend solely on the group they belong to. In our setting, we apply the *landscape theory* (Axelrod and Bennett, 1993; Bennett, 2000), where each player evaluates every potential partner and ranks two possible blocs by the sum of its individual evaluations of group members. The dependence of individuals' utility on the actions and identity of other players has been recognized in studies of social interactions and networks as dyadic externalities from player's peers.[7] In these settings, gains from cooperation increase as the distances among players in the coalition decrease (Le Breton and Weber, 1995).[8]

Lastly, we add to the literature on African development (Easterly and Levine, 1997; Alesina et al., 2003; Nunn, 2008; Michalopoulos and Papaioannou, 2013). While the previous literature focused on the role of colonization or pre-colonial ethnic institutions in African development (Acemoglu et al., 2001; Alesina et al., 2011; Nunn, 2008; Michalopoulos and Papaioannou, 2013, 2020), the influence of the post-colonial political landscape has received little attention. In their review, Michalopoulos and Papaioannou (2020) call for more research on post-independence politics and economic trajectories. In response to this challenge, we add to the literature by studying how international political alliances during the Cold War shaped the development trajectories of African nations. To our knowledge, we are the first to systematically study the effect of the Cold War on long-run development in Africa.

[7]The strategic choice of a side in an international conflict is part of an extensive literature where players' strategies are represented as the choice of one among two existing alternatives. A celebrated example of the analysis of the social influence channels in the dichotomic setting is the threshold model of collective action (Schelling, 1978) (see also Granovetter (1978)), where participation of an individual in an action depends on the fraction of the population engaged in the action (Durlauf and Ioannides, 2010; Le Breton and Weber, 2011).

[8]Desmet et al. (2011) consider a nation formation game with pairwise hedonic heterogeneity based on the genetic distances between nations. In international relations, Bueno de Mesquita (1975, 1981) calculates the proximity between pairs of nations based on their defense alliances to evaluate war proneness. Other rational-choice theories of alliance formation differ from landscape theory, e.g., Altfeld and De Mesquita (1979).

The next section discusses our approach. Section 3 briefly describes the history of the Cold War in Africa and presents several case studies. Section 4 presents the model and the result on the existence of a SNE. Section 5 presents the focal partition. Section 6 performs an econometric validation exercise. Our main results on development outcomes are in Section 7. Section 8 concludes.

2 Our Approach

In this section, we provide a more detailed account of our approach and its advantages. We first discuss why the features of the data present difficulties for standard estimation methods. Note that we do not suggest that these features preclude causal analysis. Historians develop causal claims under imperfect information.[9] A researcher wading through the contingencies and interconnectedness of historical processes typically encounters two types of problems: i) an indeterminate assignment rule and ii) interdependence.

First, the ambiguity and multiplicity of treatment presents the researcher with more than two potential outcomes for each observation. Potential outcomes increase when there are incomplete assignment of a relevant treatment, equally meaningful treatment variants or multiple plausible counterfactual scenarios. In this case, the Stable Unit Treatment Value Assumption (SUTVA), implicit in standard treatment effect analysis, is violated (VanderWeele and Hernán, 2013). One solution to this problem is to ignore multiplicity and commit to a single version of the treatment.[10] We do not pursue this route for three reasons. First, with incomplete information on assignment, one needs to assume that the treatment is measured with error, which brings about the challenge of identifying valid instruments.[11] Second, fixing one version runs the risk of drawing conclusions from an arbitrary interpretation of Cold War assignment (even when there is complete information on assignment). Third, the multiplicity of historical paths muddies what absence of treatment means for a particular country and, without an explicit approach to counterfactual assignment, using weighted outcomes of the control group to construct a counterfactual for a particular country becomes suspect (Fearon, 1991; Hernán, 2016).

Second, treatment assignment needs to consider the agency of African countries in confronting the political problem of alignment during the Cold War. Ignoring these important

[9] See Landes (1994) for a discussion of these issues.

[10] One expert attempt to partition Africa into Cold War blocs is based on arms trade with the superpowers (Fearon and Hansen, 2018), whose partition is uncorrelated with ours.

[11] For example, in order to use the arms trade as in Fearon and Hansen (2018) to determine assignment, one would need to find a variable that is correlated with the arms trade but only affects development outcomes through bloc affiliation.

social interactions would constitute another violation of SUTVA. The continent was looking inward toward forging African unity and nation building vis-à-vis the superpowers' desire to influence. As the Pan-Africanist George Padmore writes, "[t]here is a growing feeling among the politically conscious Africans throughout the continent that their destiny is one, that what happens in one part of Africa to Africans must affect Africans living in other parts (Padmore, 1956, p. 22)." Due to colonial legacies, newly independent African countries were initially wary of being influenced by superpowers even though both the US and the USSR were formally in favor of decolonization and independence (Leffler and Westad, 2010). Clearly, the superpowers' economic and military assistance and occasional openly hostile military interventions also influenced the formation of alliances. In fact, we have identified 800 instances of interventions by either the US or the USSR during the Cold War.[12] However, African countries' first and enduring instinct was to look toward each other as examples and collaborators to navigate the Cold War environment.[13] This observation reinforces the argument that the assignment rule should take into account the push for African unity and the freedom of individual countries to choose the alliance of their choice.

We address these issues drawing on theory, which allows us to carry out a causal analysis based on a unique alignment, *the focal partition*. To establish such a partition that incorporates collective and individual aspirations, and to bridge the gap between efficiency and stability, we utilize the notion of *strong Nash equilibrium –SNE–* that is immune to any deviations by any country or groups of countries (Aumann, 1959; Bennett, 2000). While this refinement, in general, does not generate a unique assignment rule, it does yield a unique focal partition in our setting. In addition, the focal partition has an attractive feature from a social welfare point of view as it maximizes the weighted sum of the countries' payoffs with weights being sizes of countries. This feature allows us to unequivocally link predetermined characteristics of African countries with a stable equilibrium partition of the continent, avoiding an ambiguous aggregation of the data at hand and permitting counterfactual analysis with only two potential outcomes.

Theoretical properties of the focal partition provide further justification for our econometric assumptions. The focal partition, besides being immune to group deviations of any size, possesses robust empirical properties for equilibrium selection (Ui, 2001). To more fully appreciate this point, the game yields over 80 Nash equilibria, far too many potential

[12]Over a third of African countries experienced military interventions by the superpowers (Schmidt, 2013).

[13]There are several examples of attempted cooperation among African countries, such as Senegal and Soudan forming the Federation of Mali; Ivory Coast, Burkina Faso, Niger, and Benin joining together in a loose organization; Ghana and Guinea establishing a union, as well as the cooperation of Brazzaville countries (Berg, 1960).

outcomes to empirically consider. That is, the payoff structure given by the predetermined characteristics is consistent with over 80 distinct alignments had our solution been Nash equilibrium, where no individual country has incentives to deviate from a given partition. Since individual shocks in the Cold War environment could have temporarily altered a country's preferences, it is unlikely that an assignment rule based on mere Nash equilibria would have remained intact. In contrast, it is unlikely that even a coordinated superpower intervention or a widespread economic shock would have disrupted the focal partition.

Because we only use general historical knowledge on the problem of Cold War alignment for African countries, we need to validate our theory and label treatment status using ex-interim information. The unique solution merely indicates how the continent would split itself into two groups without attributing any affiliation with the superpowers. Each bloc has the same ex-ante probability of being assigned treatment, providing theoretical grounds for the assumption that treatment assignment is independent of potential outcomes of an individual country. The sign of the coefficient on the focal partition in UN voting regressions enables us to assign a label to the alignment, ensuring that we employ a probabilistic assignment rule as well as assign treatment at the bloc level given the social interactions. Since these votes are not binding, and hence, impose little direct cost, UN voting patterns are useful in revealing the tacit alignment. At the same time, the votes are highly politicized, and thus, the focal partition should have predictive power if the tacit alignment mattered. Moreover, by excluding the focal partition, we can estimate country fixed effects that summarize the correlations between UN voting alignment and time-invariant observable and unobservable factors at the country level influencing the probability of treatment assignment, enabling us a propensity score analysis of the effect of the focal partition on development outcomes.

To summarize, our approach has several attractive features. First, given the multitude of pairs of potential outcomes for each actual observation, each representing different versions of the treatment, our theoretical approach employs an exclusion restriction to reduce the number of potential outcomes that we need to consider. Specifically, the game yields a structural interpretation of this global historical event of creating a "tacit pattern of alignment among states" that reflects the history of the Cold War in Africa. Second, the reliance of the menu of payoffs on pre-determined characteristics eliminates dependence on ex-post information and makes plausible the assumption that the assignment rule is independent of potential outcomes since individual countries do not select into assignment on the basis of expectations about potential outcomes. Finally, the assignment rule accounts for social interactions by assigning treatment at the bloc level.

Our approach differs from the previous literature that often employs a narrow concept of history (typically for identification purposes), where historical events are equated with a

shock or a quasi-experimental intervention. This use of history offers a stark contrast to a more complex, process-oriented view of history as a highly differentiated product that resists aggregation. Thus, there is a dilemma: whether to use a unique mapping from history onto economic shocks or to allow for multiple interpretations relaxing the requirement to describe the impact of a historical event as an average tendency toward a particular outcome. This paper presents a middle ground: we allow history to be dynamic and endogenous with multiple potential paths, while we extract a quantifiable and identifiable causal factor to understand the impact of history on outcomes today. The advantage of our approach is that we do not need to assume a unique mapping and instead offer a microfounded understanding of history to support our causal claims. This alternative method is generalizable to other settings and is especially attractive in the absence of consensus among historians.

3 Cold War in Africa

Schmidt (2013) writes, "Of all the Cold War battlegrounds, Africa is the least well known."[14] As such, there is no sufficient general history of the Cold War in Africa that can guide and inform our assignment rule and we face imperfect verification of our model-based partitioning. That said, several important themes and some consensus about political alliances in certain cases emerge from the literature.

Historians situate the Cold War events in the context of other major periods of external interest in Africa, such as the slave trade or colonialism. What sets the Cold War apart is the post-WWII independence movements, together with the growing importance of international alliances and the role of ideology in these alliances. The number of alignment groups was exogenously imposed by the superpowers. The Western bloc, USA and Western Europe, opposed communism and encouraged the establishment of free markets open to globalization. The Eastern bloc, the USSR, supported regimes in favor of Soviet-style development and, to some extent, were anti-colonialist.[15] The superpowers viewed competition for Africa as a zero-sum game and any neutral status of a particular African country as temporary (Allison et al., 1989). Although the colonial legacy left many leaders wary of alliances

[14]In the 2010 three volume Cambridge History of the Cold War, there are only two chapters that mention Africa specifically (Leffler and Westad, 2010) –the first on the Cold War in the Third World and the second on the Cold War in Southern Africa. The Oxford Handbook of the Cold War has a single chapter on Africa (Immerman and Goedde, 2013).

[15]In principle, one can also look at roles played by China and Cuba. The former clashed with the Soviet Union on some occasions, e.g., Angola, but was similarly the proponent of anti-imperialist and pro-socialist development. Cuba has also supported the pro-socialist development, being a Soviet surrogate in eyes of the US. Therefore, we restrict attention to two groups only.

with the superpowers, the waves of independence and decolonization left a void of political and economic influence that the superpowers were eager to fill. Such strategic alliances implied development and military assistance as well as economic and political opportunities for African leaders (Latham, 2010). Moreover, assistance was often given with little accountability provided that there was ideological alignment. As we indicated above, over a third of African countries experienced foreign military interventions by the superpowers. Moreover, various forms of economic, military and technical assistance were quite common all across the continent throughout the Cold War period (Schmidt, 2013).

3.1 Examples

Ghana. We start off with an example of the fluidity of alignments and the importance of leadership for political alignment. A leader's preferences might drive the observable alliances and these observable alliances may deviate from the underlying tacit alignment among African countries. Thus, when the leader changes, a different set of political alliances could emerge.

Ghana gained independence from the UK in 1957. Both the USSR and the US courted the first president of Ghana, Kwame Nkrumah, who received his education in both countries. For example, the US Vice-President Richard Nixon attended the independence celebrations in Ghana, while Nkrumah was awarded Lenin Peace Prize in 1962. Yet, Nkrumah had an affinity for the USSR. Nkrumah, with Soviet assistance, set upon implementing socialist policies and invited Soviet specialists to demonstrate agriculture techniques adapted to Ghana (Iandolo, 2012). In 1966, a US-supported military coup overthrew Nkrumah while he was touring Vietnam and China. The new government drastically changed the mode of development by inviting the IMF/World Bank to manage the economy and by opening to western markets, a policy that British had been advocating since independence. Thereafter, under the Busia government, western ties were affirmed (Gebe, 2008).

Ghana's alliance was therefore subject to the preferences of their leader. Both development paths were clearly open to the young nation and both superpowers clearly aimed to influence the direction Ghana took.

Guinea and Kenya. We now turn to two case studies on how the Cold War influenced the development patterns and policies under Soviet and American modes of development.

Guinea is an example of the Eastern mode of development. It gained independence from France in 1958. The USSR quickly recognized its government. The first president, Ahmed Sékou Touré, was a nationalist and wanted to implement Marxist policies. By 1959, Guinea signed bilateral trade agreements with five Eastern Bloc countries. The USSR delegation

was invited to visit, draw up objectives, and actually base development policy on socialist principles of: 1) modern agriculture in both collective and state farms, 2) investment in industry and infrastructure, 3) nationalization and restriction of foreign capital. Touré's presidency survived until 1984, and along the way, he outlawed other parties and was the only candidate for several elections.[16]

In contrast, Kenya, an example of Western mode, gained independence in 1963 from the UK. US immediately recognized it, and shortly after, established diplomatic relations and a military base in Mombasa. USAID has conducted education programs, including scholarships to Kenyan students to study in the US. US development programs emphasized technology transfer, infrastructure, democracy, market reforms, and health care. There was rapid growth in the number of firms and firm size in the post-independence period. This system provided a means by which individuals could accumulate capital and wealth, but ultimately led to an increase in total production and production per head. Nevertheless, Kenya experiences a high level of income inequality with a high poverty rate, where 65% of the population lives on less than \$2/day.[17]

These two cases clearly demonstrate the influence of the Cold War on the modes of economic development.

4 The Model

Our theoretical setting is built on two main assumptions. One is the two-bloc structure where all countries are partitioned into two blocs, which will be called E (for pseudo-Eastern) and W (for pseudo-Western). The second premise of our model is that a country makes a bloc choice based on the identity of and the bilateral relationships with other members of the bloc. This approach was pioneered by the "landscape theory" (Axelrod and Bennett, 1993), which bases its predictions on historical, political, and other types of bilateral links between every pair of countries.

Formally, we consider a bloc-formation game Γ where players (African states), denoted by $N = \{1, 2, \ldots, n\}$, choose between two blocs, E and W. Countries' decisions are based on their proximity to other members of the bloc. That is, for every two countries i and j, the level of their propensity to be together is denoted by $p_{ij} = p_{ji}$ with $p_{ii} = 0$ for all $i \in N$. The propensity p_{ij} is assumed to be the reverse of alienation between two countries, $d_{ij} \geq 0$, i.e. $p_{ij} = -d_{ij}$, which may capture historical, ethnic, and linguistic differences between i

[16]Department of State (1959); New York Times (1964); World Bank (1984); WTO (2011).

[17]Hetherington (1993); Department of State (2018); Omolo et al. (2016); USAID (2019); The Guardian (2013).

and j.[18] As noted by Bennett (2000), "measuring size and actors' propensities is a key part of applying landscape theory to real situations.[...]Landscape theory does not have as part of it a theory of propensity, but such a theory (which is domain specific) is crucial to landscape's theory and application and testing". In their application of landscape theory to the examination of European alliances, *Axis* and *Allies*, prior to the Second World War, Axelrod and Bennett (1993) construct a propensity matrix P by aggregating (with equal weights) indicators spanning both positive and negative values for every pair of countries.[19] Hence, the propensity values can be either positive or negative –unlike in our model.[20] Additional parameter of relevance is the size s_i of country i. It is reasonable to assume that the relationship with a larger country is more important than having a proper relationship with a smaller one. We assume that the payoff of a country that belongs to bloc E would be represented by the size-weighted sum of propensities of working together with other members of that bloc. That is, for $i \in E$ we have the utility of i as

$$U_i(E) = \sum_{j \in E} s_j p_{ij}.$$

Similarly, for every $i \in W$, we have

$$U_i(W) = \sum_{j \in W} s_j p_{ij}.$$

In this game, countries are allowed to change their bloc affiliation. In the Nash setting, only individual countries can switch to another bloc. A partition of all countries in two blocs is Nash stable (or constitutes a Nash equilibrium) if there are no countries for which the individual switch would be beneficial.

Definition 1: A partition of all countries in two blocs E and W is a Nash equilibrium if there is no $i \in E$ such that

$$U_i(E) < U_i(W \cup i), \quad \text{or} \quad \sum_{j \in E} s_j p_{ij} < \sum_{j \in W} s_j p_{ij},$$

[18] It implies that all propensities are negative, meaning that countries assign negative values to their partnerships.

[19] They use the following five indicators: the presence of ethnic conflict, the existence of a border disagreement, and the recent history of wars between the two, the similarity of the religions of their populations, and the similarity of the types of governments.

[20] Out of the 272 non-diagonal entries of the 17×17 matrix computed by Axelrod and Bennett (1993), 98 of them are negative and 46 are positive. The rest are zeroes, and many of the non-zero entries are very close to 0. We wish to take this opportunity to thank Robert Axelrod for sharing with us their propensity matrix.

and there is no $i \in W$ such that

$$U_i(W) < U_i(E \cup i), \text{ or } \sum_{j \in W} s_j p_{ij} < \sum_{j \in E} s_j p_{ij}.$$

To account for possible group bloc-switching, we consider a stronger concept of strong Nash equilibrium that allows for any group deviations rather than only individual ones (Aumann, 1959). In particular, we permit bloc-swapping where a group of countries S in E wishes to move to W, while another group T in W would move in the opposite direction. Obviously, either S or T could be empty, and the one-sided movement is also feasible.

Definition 2: A partition of all countries in two blocs E and W is a strong Nash equilibrium (SNE) if there are no sets $S \subset E$ and $T \subset W$ (one of which could be empty) such that

$$U_i(E) < U_i(W \cup S \setminus T), \text{ or } \sum_{j \in E} s_j p_{ij} < \sum_{j \in W \cup S \setminus T} s_j p_{ij},$$

for every i in S and

$$U_i(W) < U_i(E \cup T \setminus S), \text{ or } \sum_{j \in W} s_j p_{ij} < \sum_{j \in E \cup T \setminus S} s_j p_{ij}.$$

for every i in T.

Then, we have the following proposition:

Proposition: Γ admits a SNE.

A complete proof of this proposition is relegated to Online Appendix C. The proof utilizes the notion of a potential function formalized by Monderer and Shapley (1996) and its generalization to strong potential (Holzman and Law-Yone, 1997), which encompasses the incentive of individuals or groups of players to change their bloc affiliation in one single function. Monderer and Shapley (1996) distinguish between three types of potential games: *exact potential* or, simply, *potential* games where the difference in individual payoffs for each player from changing her strategy is equal to the difference in values for the potential function; *weighted potential* games, for which the difference in individual payoffs for each deviating player, is equal to the weighted difference in values for the potential function with respect to some vector of positive weights; and *ordinal potential* games, where only the signs of the differences have to be the same. Obviously, the set of exact potential games is a subset of weighted potential games, which, in turn, is a subset of ordinal potential games.

Naturally, a maximum of an ordinal potential, and thus, of exact and weighted potential games, yields a pure strategies Nash equilibrium. Similarly, a maximum of strong potential function yields a strong Nash equilibrium of the corresponding game.

To prove our proposition, we show that Γ is a weighted strong potential game, whose weighted potential is given by the sum of players' payoffs:

$$P(E,W) = \sum_{i\in E} U_i(E) + \sum_{i\in W} U_i(W).$$

We show that for pair of deviating sets $S \subset E$ and $T \subset W$ the following equalities hold:

$$U_i(W \cup S \setminus T) - U_i(E) = s_i(P(E \cup T \setminus S, W \cup S \setminus T)$$

for all $i \in E$ and

$$U_i(E \cup T \setminus S) - U_i(W) = s_i(P(E \cup T \setminus S, W \cup S \setminus T)$$

for all $i \in W$. That is, the game Γ is a weighted potential game where the weights are given by the size parameters s_i.[21] The last observation allows us to define the game $\hat{\Gamma}$ where the utilities of individuals are given by

$$\widehat{U}_i(E) = s_i U_i(E) = \sum_{j\in E} s_i s_j p_{ij} \text{ for every } i \in E,$$

and

$$\widehat{U}_i(W) = s_i U_i(W) = \sum_{j\in W} s_i s_j p_{ij} \text{ for every } i \in W.$$

Note that the difference between payoffs in the two games is that countries' payoffs in the game $\hat{\Gamma}$ are weighted by their own size. The games are strategically equivalent, and, thus, possess the same sets of equilibria. However, while Γ is a weighted strong potential game, $\hat{\Gamma}$ is an exact strong potential one, whose exact potential $\hat{P}$ is given by:

$$\hat{P}(E,W) = \sum_{i\in E} \hat{U}_i(E) + \sum_{i\in W} \hat{U}_i(W) = \sum_{i\in E} s_i U_i(E) + \sum_{i\in W} s_i U_i(W).$$

In our empirical part of examination, we focus on strong equilibria of both games and show that our data yields a unique strong potential maximizer that yields the *focal*

[21] It worth mentioning that for weighted potential games, the set of of potential maximizers does not depend on a particular choice of a weighted potential. See Monderer and Shapley (1996), footnote 13.

partition for $\hat{\Gamma}$. Monderer and Shapley (1996) point out that the selection of exact potential maximizers from the equilibrium, which represents an equilibrium refinement, has garnered strong empirical and theoretical support. The equilibrium selection predicted by maximizers of the potential is the one that is supported by the experimental results of Van Huyck et al. (1990) (see also Crawford (1991)). Ui (2001) shows that Nash equilibria that maximize potential functions are generically robust in the sense of Kajii and Morris (1997). Robustness of potential maximizers was further explored by Carbonell-Nicolau and McLean (2014) who demonstrate that the set of maximizers of an upper semicontinuous potential contains a strategically stable (in the sense of Kohlberg and Mertens (1986)) set of pure-strategy Nash equilibria. Hofbauer and Sorger (2002) show that the potential maximizer is the unique profile which is absorbing and globally accessible in the dynamic model of Matsui and Matsuyama (1995).

Somewhat surprisingly, since $p_{ij} = -d_{ij}$ where $d_{ij} \geq 0$ for all i, j with $i \neq j$, the determination of the exact potential maximizer of $\hat{\Gamma}$ is equivalent to a famous problem in combinatorial optimization known as the MaxCut problem. The latter can be described simply as follows. Let an undirected graph $\mathcal{G}$ with a set of vertices N be given. Assume also, that there are nonnegative weights w_{ij} for all edges (i, j) of the graph, where $w_{ij} = w_{ji}$ for every pair of vertices i and j. The MaxCut problem is that of finding the subset of vertices S that maximize the weight of the edges in the cut $(S, N\backslash S)$, that is the weight of the edges with one endpoint in S and the other in $N\backslash S$. In other words, the MaxCut is the maximization of the following expression over all subsets of the set vertices N:

$$\sum_{i\in S}\sum_{j\in N\backslash S} w_{ij} + \sum_{i\in N\backslash S}\sum_{j\in S} w_{ij}.$$

Noting that $w_{ij} = s_i s_j d_{ij}$ for all i, j, we obtain the equality

$$\begin{aligned}
\underbrace{\sum_{i=1}^{n}\sum_{j=1}^{n} s_i s_j d_{ij}}_{\text{a constant}} &= \sum_{i\in S}\sum_{j\in S} s_i s_j d_{ij} + \sum_{i\in N\backslash S}\sum_{j\in N\backslash S} s_i s_j d_{ij} + \sum_{i\in S}\sum_{j\in N\backslash S} s_i s_j d_{ij} + \sum_{i\in N\backslash S}\sum_{j\in S} s_i s_j d_{ij} \\
&= \underbrace{\sum_{i\in S}\sum_{j\in S} s_i s_j d_{ij} + \sum_{i\in N\backslash S}\sum_{j\in N\backslash S} s_i s_j d_{ij}}_{\text{(negation of) exact potential of } \hat{\Gamma}} + \underbrace{2\sum_{i\in S}\sum_{j\in N\backslash S} s_i s_j d_{ij}}_{\text{MaxCut maximand}}
\end{aligned}$$

Since the left-hand side of this equality is independent of a choice of set S, we observe that the minimization of $\sum_{i\in S}\sum_{j\in S} s_i s_j d_{ij} + \sum_{i\in N\backslash S}\sum_{j\in N\backslash S} s_i s_j d_{ij}$ with respect to $(S, N\backslash S)$ is equivalent to the maximization of $\sum_{i\in S}\sum_{j\in N\backslash S} s_i s_j d_{ij}$ with respect to $(S, N\backslash S)$.

5 The Partition

After having demonstrated the existence of a SNE for a class of coalition formation games, we now operationalize the theory and turn to the computational aspects attached to the determination of these Nash equilibria and the algorithms to perform this task. To that end, we first need to construct a matrix of bilateral propensities to cooperate, whose typical element is $(p_{ij})_{1\leq i,j\leq n}$, which we have assumed to be opposite to the average bilateral societal "distance" as measured across various dimensions.

In the baseline analysis of propensity to cooperate, we employ the following dimensions of societal distance: contiguity, common colonizer,[22] bilateral geodesic distance, genetic distance, linguistic distance, and religious distance between countries. Following Axelrod and Bennett (1993), we weight the average distances by the national material capabilities of the two countries to adjust for varying degrees of size, power and influence countries have.[23] This addresses the issue that distance with a small country is not as important for determining alignments as an equivalent distance with a large country. Finally, the rescaled "distance" between any two countries is defined as follows:[24]

$$\begin{aligned} Distance_{ij} = MaterialCapabilities_i * MaterialCapabilities_j * mean((1 - Contiguity_{ij}) + \\ (1 - CommonColonizer_{ij}) + GeodesicDistance_{ij} + GeneticDistance_{ij} + \\ LinguisticDistance_{ij} + ReligiousDistance_{ij}) \end{aligned}$$

In order to find a focal partition in the game with 2^{47} different configurations, we make use of the fact that our game admits a potential. Since the maximization of the potential is, as we show above, equivalent to the well documented combinatorial optimization problem known as Max-Cut, we are able to take advantage of recent advances in computer science that allow us to search over these combinations in a relatively efficient manner.[25] Specifically, we employ a branch and bound algorithm, which imposes a set of inequality constraints.

[22] While constructing the distance index, we employ (1-contiguity) and (1-common colonizer) to render these variables in distance terms.

[23] National Material Capabilities Index combines components of demographic, industrial and military power. See Online Appendix A for more details on the data sources.

[24] As alluded to in the preceding section, we multiply each country's weighted sum of distances by the "size" of the country to obtain the rescaled propensity matrix. Given the distances d_{ij} calculated here, we could switch to propensities to cooperate by denoting $p_{ij} = d - d_{ij}$, where d is a constant satisfying $d \leq \max_{i,j}$. Depending on the values of d, some (but not all) entries of the propensity matrix may become positive.

[25] The fact that the entries of the propensity matrix are negative allows us to exploit the connection to the MaxCut problem. If some of the entries are positive, then the MaxCut problem

This algorithm embeds the discrete choice of deciding which bloc to join into a semi-definite program with a continuous choice giving an upper bound on the maximum potential. The lower bound is obtained using an approximation algorithm with random cuts in the same vein as the Goemans-Williamson algorithm. These bounds are then used to rule out different subproblems (branches), e.g., eliminating branches with upper bounds that are lower than the incumbent lower bound. The conclusion of this process provides an exact solution for the maximal potential, which yields the focal partition.

To expand our analysis, we also search for other equilibria, which, naturally, generate a lower size-weighted aggregate payoff than the focal partition. To do so, we employ a modification of the Goemans-Williamson approximation algorithm that includes local search algorithm. While this technique yields, according to Goemans and Williamson (1995), the total payoff of at least 0.87 of the global optimum in expectation, there is no guarantee that the NE that we subsequently identify are in the neighborhood of the optimum. For each of these equilibria, we then check the degree of its stability. For any positive integer k, a partition of the entire set into two blocs is k-stable, if there is no group of k countries that can improve their payoff by changing their bloc affiliation. Formally,

Definition 3: A NE is *k-stable* if there is no group of k countries that can benefit by changing their bloc affiliations.

Note that any k-stable NE is also $k-1$-stable, and therefore, the set of k-stable equilibria is shrinking in k. After running our algorithm 10,000 times (each time, we follow Goemans-Williamson algorithm and then iterate to a Nash Equilibrium), we uncovered 86 Nash Equilibria,[26] of which only nine are 2-stable (see Table 1). Of these nine, only two are 4-, 5-, or 6- or 7-stable: the focal partition and another NE. Our focal partition is the unique one that is 8- (or any number larger than 8) stable! We view these results as rather remarkable in the Cold War context. Given all the opportunities for group deviation, the

has negative entries (see theorem 3.2.1 of Goemans and Williamson (1995) for a generalization of their result to arbitrary weights). Likely, another program/algorithm might need to be used.

[26]Note that this number is substantially larger than in the *Axis* and *Allies* the pre-WWII game examined by Axelrod and Bennett (1993), who found only two Nash equilibria (local minimizers). We suspect that this discrepancy is due to the fact that in their game a significant number of entries of the propensity matrix are either positive or equal to 0. As Bennett (2000) puts it: "The domains examined earlier shared the common feature that only a small number of optima were found suggesting a relatively smooth landscape. This may be partly a result of how propensity is constructed and of how the factors that contribute to propensity are clustered in the real world."In fact, Axelrod and Bennett (1993) also consider a variant of their landscape game where all entries of the propensity matrix are equal to -1 and notice that the new game, similarly to ours, generates a large number of local minimizers, namely, 209.

focus on stability is warranted. The fact that there are only a few relatively stable NE further justifies our emphasis on focusing on the SNE, which is presented in Table 2.

Table 1 Stability of Nash Equilibria

	1-stable	2-stable	3-stable	4-stable	...	7-stable	8-stable	...	SNE
Number of Nash Equilibria	86	9	4	2	...	2	1	...	1

Notes: This set of NE is potentially not exhaustive. We obtain this set from running our algorithm (details are in the appendix) 10,000 times. The concept of stability, k-stable, refers to a feature of the NE that requires that there is no coalition of size less than or equal to k such that if all the members deviated each of the members would be better off. SNE stands for strong Nash equilibrium.

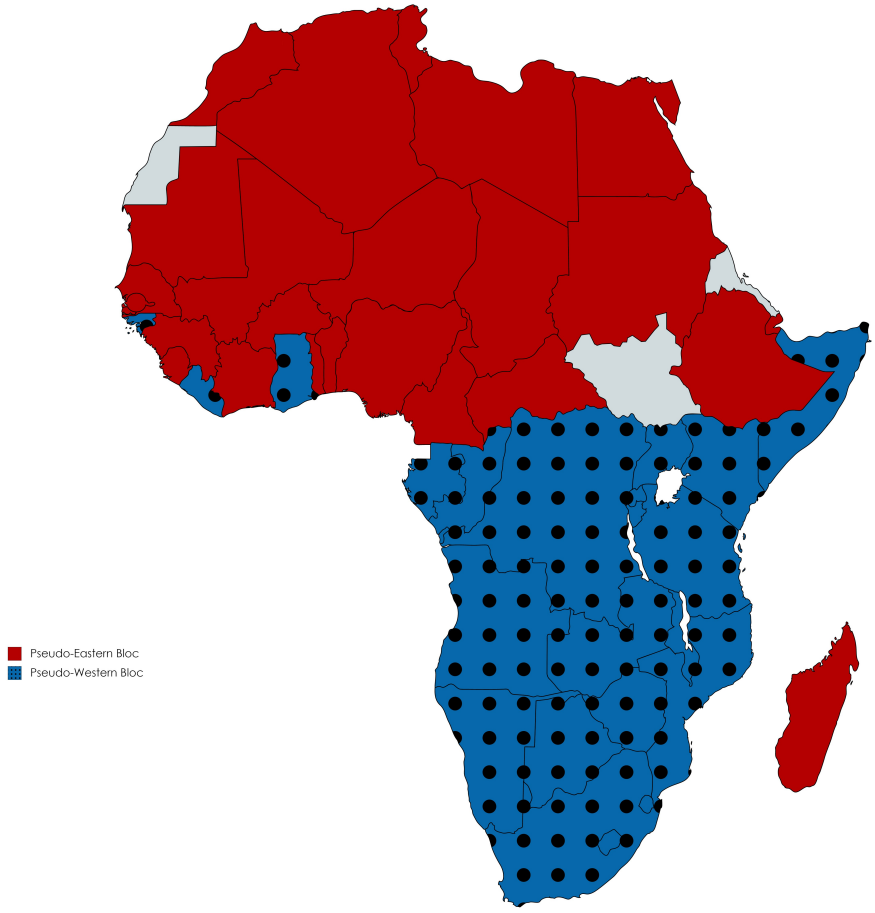
The above discussion on stability properties of equilibria also gives credence to focusing on the predictive power of the focal partition in the face of dynamic strategic considerations that would have altered the immediate interest to align with a particular bloc for one or more countries.

Table 2 Focal Partition (baseline distances)

Pseudo-Western Bloc:	*Angola, Botswana, Burundi, Congo, Democratic Republic of the Congo, Gabon, Ghana, Guinea-Bissau, Kenya, Lesotho, Liberia, Malawi, Mauritius, Mozambique, Namibia, Rwanda, Somalia, South Africa, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe*
Pseudo-Eastern Bloc:	*Algeria, Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Djibouti, Egypt, Ethiopia, Guinea, Gambia, Libya, Madagascar, Mali, Mauritania, Morocco, Niger, Nigeria, Senegal, Sierra Leone, Sudan, Togo, Tunisia*

How does this focal partition compare to what we know about the Cold War period in Africa? To proceed, let us call the bloc that is more likely to align with the US as the *Pseudo-Western Bloc* (and the opposite *Pseudo-Eastern Bloc*). Table 2 and Figure 1 inform us about the distribution of countries across the African continent. We first observe that some countries that one would deem as obviously Western aligned based on historical records and relationships are in the Pseudo-Western Bloc, such as Botswana, DRC, Kenya, Liberia, Rwanda, and South Africa. At the same time, some historically Eastern-aligned countries are in the Pseudo-Eastern Bloc, such as Algeria, Benin, Burkina Faso, Ethiopia, Guinea, Libya, Mali, and Morocco. Third, there are some interesting cases, such as Guinea-Bissau and Guinea splitting into two different blocs, or the cases of Ghana and Cote D'Ivoire being in the opposite of their predicted blocs (due to their leaders' preferences perhaps, such as the President Nkrumah of Ghana). Finally, there are some outliers that do not fit the historical account, such as Angola, Congo, Gambia, Mozambique. Interestingly, most of these countries had civil conflicts that involved both sides (arguably proxy wars).

Figure 1 Focal Partition (baseline distances)



This partition is useful in contributing to our understanding of unstable coalitions that emerged during the Cold War, such as the Monrovia and Casablanca groups. These groups were formed in 1961 but were quickly disbanded upon the establishment of the Organization of African Unity in 1963. The leaders of the Monrovia group had the vision of the newly independent African states retaining their autonomy and self-governing, while strengthening their own bureaucracies, militaries and economies. Whereas the Casablanca group was a strong proponent of Pan-Africanism with deep African integration and even African political unification or federation with a supranational pan-African authority. These two blocs represented two different visions of the Organization of African Unity but failed to maintain coordinated action to manifest their vision. While the Casablanca group was clearly aligned with the Eastern bloc, the Monrovia Group had ties with the Western Bloc.

We first point out that 6 of the 7 Casablanca countries are in the pseudo-Eastern Bloc (with the exception of Ghana), while the Monrovia group is scattered among both blocs (See Table 2 and Panel B of Table 3). However, the pseudo blocs of the focal partition are

Table 3 Focal Partition (baseline distances) Restricted to the 27 Countries in Casablanca and Monrovia Groups

	Panel A: Predicted Blocs
Predicted Bloc 1:	*Algeria, Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, Ivory Coast, Gabon, Guinea, Libya, Mali, Madagascar, Morocco, Mauritania, Niger, Senegal, Togo, Tunisia*
Predicted Bloc 2:	*Democratic Republic of the Congo, Egypt, Ethiopia, Ghana, Liberia, Nigeria, Sierra Leone, Somalia*
	Panel B: Realized Monrovia and Casablanca Groups
Monrovia:	Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, Ivory Coast, Democratic Republic of the Congo, Ethiopia, Gabon, Liberia, Madagascar, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Somalia, Togo, Tunisia
Casablanca:	Algeria, Egypt, Ghana, Guinea, Libya, Mali, Morocco

formed using the full matrix of pairwise distances. Therefore, we rerun the alignment game for the 27 countries that were members of either group. The potential maximizer, given in Panel A of Table 3, represents the realized partition poorly, suggesting either that the realized partition was unstable given the bilateral relationships among the 27 countries or that the restriction to the 27 countries does not take into account the fact that the countries in Casablanca or Monrovia undertook their alignment decisions with the whole continent in mind. Either way, this result clearly demonstrates that the theory is falsifiable.

6 UN Voting Patterns During the Cold War Among African Countries

6.1 Data

UN roll-call votes illustrate well the nature of political alliances in the Cold War environment. In general, the US and the USSR did not align in UN voting, meaning that voting with the

US or USSR was a signal of alignment in one of the two blocs.[27] To capture political alignment patterns at the international level during the Cold War, we employ a dataset of roll-call votes in the United Nations General Assembly between 1946-2017 (Voeten, 2013).[28] This dataset provides us with information on each country's vote for a given resolution. A vote can take values of 1 (Yes), 2 (Abstain), or 3 (No) if a country voted on a particular resolution. These votes aggregate diverse interests across varied themes and voting similarity reveals compatible preferences or views (Gartzke and Gleditsch, 2006). Each vote is a realized partition, but one with little to no commitment to realized alignment. 11.3% of the votes cast were with the US. Of those not voting with the US, 68.2% vote with the USSR and 20.4% vote with neither.

To construct our dependent variable, we compare how each country voted relative to the US. Our main dependent variable then takes a value of one when a country votes in the same way as the US, and zero otherwise.[29] We define

$$vote_{it}^{USA} = \mathbf{1}[vote_{it} = vote_{USAt}]$$

where $vote_{it}$ captures country i's vote on resolution t and $\mathbf{1}[\cdot]$ is an indicator function.

There were 4485 roll call votes over the entire period (1946-2017). There were 318 votes in the 50s, 407 in the 60s, 729 in the 70s and 1258 in the 80s. We restrict attention to votes between 1960-1991 for baseline specifications since most African countries gained independence from 1960s onwards and there were only a few African countries who were members of the UN during the 1950s.[30]

We can classify the votes by cold war topic. There were 921 votes relating to the Palestinian conflict, 498 votes relating to nuclear weapons and nuclear material, 685 votes relating to arms control and disarmament, 871 votes relating to colonialism, 843 votes relating to human rights and 591 votes relating to (economic) development.

[27] Of course, there were some votes for which there was US/USSR alignment. One example is the UN Security Council resolution calling on Israel to withdraw from Sinai Peninsula in October 1956.

[28] Available at https://dataverse.harvard.edu/dataset.xhtml?persistentId=hdl:1902.1/12379.

[29] One could also define the dependent variable with respect to the USSR. When US and the USSR always vote differently and there are no countries that vote differently than both the US and USSR, these two ways of defining the dependent variable would coincide. In practice, there are instances of both. By necessity, we exclude all votes for which the US and USSR vote alike. In a robustness check, we exclude those countries' votes that disagree with both the US and USSR. Results are unaltered.

[30] Alternative start and end points for the Cold War do not change our results. If anything, adding 1950s strengthens the results, and there is little change if we move the end point earlier to 1989 or 1985.

We also coded up various Cold War interventions in Africa by the superpowers. We classified events affecting a particular country in a given year by eight intervention types, whether the intervention was by the US or USSR, whether the intervention was economic or military and whether the intervention was hostile or not.

6.2 Econometric specification

If our theory predicts Cold War alliances, then we would expect the focal partition to have predictive power for UN voting patterns. In particular, we should reject the null hypothesis that the coefficient on the indicator of the focal partition is zero. The labeling of the partition is data driven as we code the indicator variable as $PseudoWestern$ so that the partition dummy is positively correlated with voting with the USA. Thus, our first test is merely to investigate whether the pseudo-Western and Eastern Blocs have predictive power for UN voting patterns. Specifically, we would like to know whether alignment in the focal partition solution, on average, manifests a tendency to vote similarly as the USA (or the Soviet Union).

$$vote_{it}^{USA} = \alpha + \beta * PseudoWestern_i + \eta_t + \epsilon_{it} \tag{1}$$

Here, β, the average marginal effect of being aligned in the focal partition on voting with the USA, is interpreted as the difference in the probabilities of voting with the USA between the two blocs.[31] Voting alignment is a function of the 'tacit alignment' of African countries captured by our configuration of blocs, unobservable idiosyncratic (country-vote) factors, country-specific preferences and vote-specific factors. Pseudo-Western bloc is defined to be such that it is positively correlated with voting with the USA.

We next estimate the following specification:

$$vote_{it}^{USA} = \alpha_i + \gamma_W * Payoff_{SNit}^{USA\neg i} + \gamma_E * Payoff_{SNit}^{USSR\neg i} + \eta_t + \epsilon_{it} \tag{2}$$

where i indexes countries and t indexes votes (where we control for vote and country fixed effects).[32] $Payoff_{SN}^{USA\neg i}$ is calculated as follows:

$$\sum_{\forall j \neq i \cap PseudoWestern} s_i s_j d_{ij} * vote_{jt}^{USA} \tag{3}$$

Whereas $Payoff_{SN}^{USSR\neg i}$ is calculated as follows:

[31] We assume that $E[\epsilon|PseudoWestern, \eta_t] = 0$.

[32] We assume that $E[\epsilon|Payoff, \eta_t, \alpha_i] = 0$. Recall also that the focal partition is a function of predetermined characteristics.

$$\sum_{\forall j \neq i \cap PseudoEastern} s_i s_j d_{ij} * vote_{jt}^{USSR} \tag{4}$$

Here, the Payoffs are restricted to blocs and the labeling of the blocs is fixed from the previous regression (i.e., the PseudoWestern indicator is positively related to US voting) and γ is interpreted as the average marginal effect on the probability of voting with the USA of a marginal change in the sum of the bilateral distances between countries in a bloc. We expect the Pseudo-Western (Eastern) Payoff restricted to the intersection with Pseudo-Western (Eastern) bloc of the focal partition to be negatively (positively) correlated with voting with the USA.

One can also calculate an unrestricted form of Payoff as follows,

$$Payoff^{b \neg i} = \sum_{\forall j \neq i} s_i s_j d_{ij} * vote_{jt}^{s}$$

where b is either USA or USSR.

In certain specifications, we also control for the Cold War interventions collected from various sources. These include eight possible intervention types: East/West; Economic/Military; Hostile/Non-hostile.

6.3 Validation results

In columns 1 and 2 of Table 4, we present the results of directly using an indicator for which pseudo-group a country belongs to in the focal solution for all votes between 1960 and 1991, both unconditional (column 1) and controlling for the Cold War interventions (column 2). The coefficient of interest is positive (by design) and statistically significant at the 1% level. Controlling for the Cold War interventions does not alter the coefficient, which can be interpreted as an indication of the stability of the focal partition. The magnitude suggests that being in the pseudo-Western Bloc means that the country is 1.5 percentage points more likely to vote with the US than a country in the pseudo-Eastern Bloc in an average vote. Given that the mean of the dependent variable is 15.5%, this effect is not small.

In columns 3 and 4, we present the results of using the Payoff in a vote's realized partition to predict a country's voting alignment. As predicted, the coefficient on the Payoff in the votes with the US bloc has a negative and statistically significant coefficient. A decrease of one standard deviation in the sum of Pseudo-Western distances increases the likelihood of voting with the US by 2.9 percentage points (26% of the mean). It is important to notice that this is an order of magnitude larger than the effect of a Western hostile military intervention (0.24 percentage points). Instead, an increase in one standard deviation of Pseudo-Eastern

Table 4 Cold War Alliances and UN Voting Patterns

Dep. Var. =	Vote with the US					
	(1)	(2)	(3)	(4)	(5)	(6)
Pseudo-Western Bloc	0.015	0.016				
	[0.001]	[0.001]				
Pseudo-Western Payoff (SN)			-0.075	-0.074		
			[0.0035]	[0.0036]		
Pseudo-Eastern Payoff (SN)			0.026	0.025		
			[0.0013]	[0.0013]		
Pseudo-Western Payoff (Unrestricted)					-0.001	-0.006
					[0.005]	[0.005]
Pseudo-Eastern Payoff (Unrestricted)					0.034	0.029
					[0.004]	[0.004]
$\beta^W + \beta^E = 0$: $\chi^2(1)$			3.27	3.32	0.75	0.48
SN = Unrestricted: $\chi^2(1)$					3.87	3.68
Cold War Interventions	NO	YES	NO	YES	NO	YES
Vote FE	YES	YES	YES	YES	YES	YES
Country FE	NO	NO	YES	YES	YES	YES
Sample	Roll call votes between 1960-1991					
Observations	99944	99944	99944	99944	99944	99944

Robust standard errors in brackets.

energy increases the likelihood of voting with the US by 4.9 percentage points (43% of the mean), nearly an order of magnitude larger than the effect size of an Eastern non-hostile economic intervention (-0.66 percentage points).

In columns 5 and 6, we present the results with unrestricted Payoffs. As hypothesized above, unrestricted Payoff does not have good predictive power for the voting patterns. Pseudo-Western Payoff is both economically and statistically insignificant. And the test of whether the summation of the coefficients of the Pseudo-Western Payoff and the Pseudo-Eastern Payoff is zero cannot be rejected. A following test also reveals that the Pareto efficient coefficients are statistically different than the unrestricted coefficients. All in all, the results from Table 4 reveal that the Payoff restricted to the focal partition outperforms Payoff of a particular vote configuration.

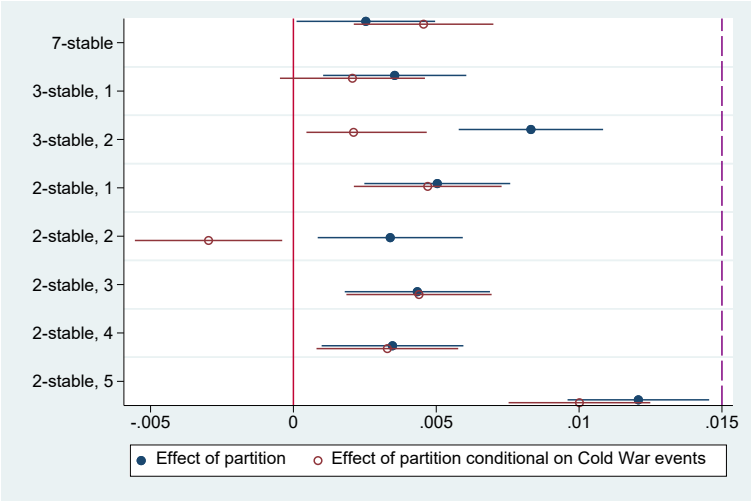
6.4 Stability and Propensity Score

In this section, we explore the stability of other equilibria in the game and how stability is related to the UN voting patterns. Up to this point, we have focused on the focal partition. As we have previously argued, the stability of the focal partition is critical in providing predictive power in the Cold War environment. If our concerns about stability are warranted, then we should expect that equilibria that are less stable than SNE to have less predictive power when analyzing UN voting patterns. In Figure 2, we present the marginal effects of these partitions (inferring the bloc from the sign as before). Importantly, we present both with and without intervention controls as we would expect the controls to affect the magnitude and even the sign of the coefficients of less stable equilibria. We see that the magnitude of the focal partition (represented by the dashed line) is larger than all the relatively stable NE. In addition, most of the marginal effects are sensitive to Cold War interventions.

In Figure 3 instead, we present the total effect of Payoff (inferring the bloc from the sign as before). Again, we see that the magnitude is much larger for the effects of the focal partition. In addition, several effects of Payoff are positive which goes against the theoretical prediction. This exercise reinforces our confidence in the focal partition and its predictive power for our results.

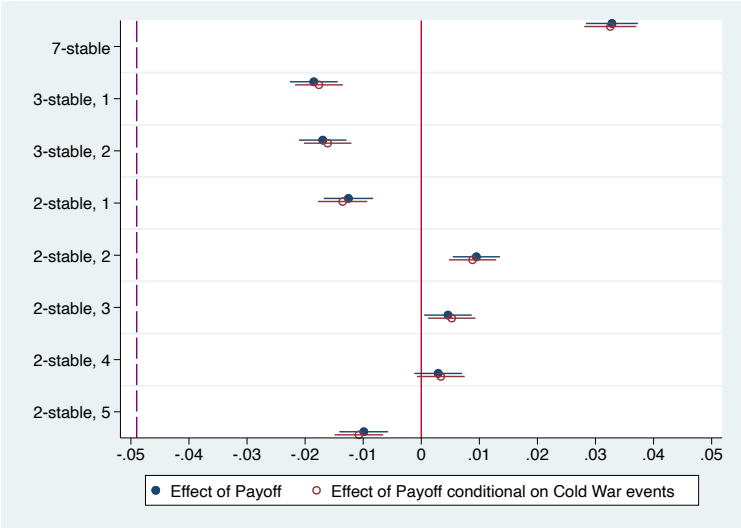
Finally, looking at the data in a slightly different way is instructive for our approach. Important for our analysis is that the focal partition does not correlate with individual country observable or unobservable variables that might be correlated with development outcomes and treatment status. By using propensity score methods, we can compare countries of different blocs with similar likelihoods of being treated. The UN voting alignment gives a

Figure 2 Effects of Partitions by Stability



Notes: This figure plots the estimates of the effects of the partition for all equilibria that are k-stable for $k > 1$. The equilibria are arranged in descending order of stability and energy. The dashed line represents the effect of focal partition.

Figure 3 Total Effects of Payoffs by Stability



Notes: This figure plots the estimates of the effects of Payoff (the sum of the coefficients on $Payoff^{US}$ and $Payoff^{USSR}$) for all equilibria that are k-stable for $k > 1$. The equilibria are arranged in descending order of stability and energy. The dashed line represents the effect of focal Payoff.

powerful tool to construct the propensity score. We regress UN voting alignment on country and vote fixed effects (excluding the focal partition indicator) to estimate each country's

likelihood of aligning with the West (or East) and hence of being assigned treatment. Table 5 presents correlations between the values of the country fixed effects and the various Nash equilibria that are greater than 1-stable. The focal partition is positively correlated and statistically significant at the 10% level, which is what we would expect given the previous analysis. However, what is not expected and serves to bolster the confidence in our approach is the fact that all the other partitions' correlations are statistically insignificant at conventional levels, uniformly distributed around zero and less than the magnitude of the focal partition's correlation. Since these are solutions to the game of social interactions, albeit ones that satisfy fewer attractive game-theoretic properties, it is clear that there is no pre-ordained relationship between solutions to the game and voting outcomes. Put differently, the pre-determined characteristics that make up the payoff of distances do not necessarily correlate with the probability of being treated in other equilibrium partitions than the focal one.

Table 5 Stable Nash Equilibria and Correlation with Country Fixed Effects

	2-stable 1	2-stable 2	2-stable 3	2-stable 4	2-stable 5	3-stable 1	3-stable 2	7-stable	SNE
Correlation	0.15	-0.08	-0.13	-0.11	0.16	0.07	0.04	-0.09	0.18
p-value	0.14	0.47	0.23	0.28	0.12	0.51	0.68	0.40	0.08

Notes: SNE stands for strong Nash equilibrium.

6.5 Robustness checks

In this subsection, we explore whether our results are robust to reasonable variations.

The intensity of the Cold War influence on Africa varied over time. In the historical section, we argued that the Cold War experience should have a stronger and more bipolar influence earlier in the Cold War. Table A.1 presents results on the effects of the focal partition for different time periods. Indeed, we find a stronger effect for the 1950s and 1960s than for subsequent periods.

Our results are robust to restricting the sample to those votes on salient and relevant Cold War issues (Table A.2). Relevant votes are those identified by the UN relating to the Palestinian conflict, nuclear weapons and nuclear material, arms control and disarmament, colonialism, human rights, (economic) development, plus any of the votes concerning issues related to China, Korea, Cuba, Tibet and Hungary as identified by Gareau (1970), and those votes identified as important by the U.S. State Department report Voting Practices in the United Nations.

We also explore how our results change if we exclude those country-votes that disagree with both the US and USSR. This exercise should make our results more precise. We observe in Table A.3 that the results are qualitatively the same.

The last robustness check that we undertake is using an alternative matrix of bilateral distances between countries. We modify the bilateral distances by adding the dimension of pre-colonial governance based on jurisdictional hierarchy. Jurisdictional hierarchy is at the ethnographic society level (Murdock, 1965). We first average these to the country level, and then, take the absolute difference between the average jurisdictional hierarchy levels of two countries. We finally normalize it to lie between zero and one. This added dimension should better ground the bilateral distances in deep-rooted institutional factors that affect the propensity to cooperate. We then again solve for the maximizer of the weighted sum of payoffs and this gives us a new alignment for the focal partition. The results are quantitatively and qualitatively similar and, if anything, are stronger (see Table A.4).

6.6 Randomization inference

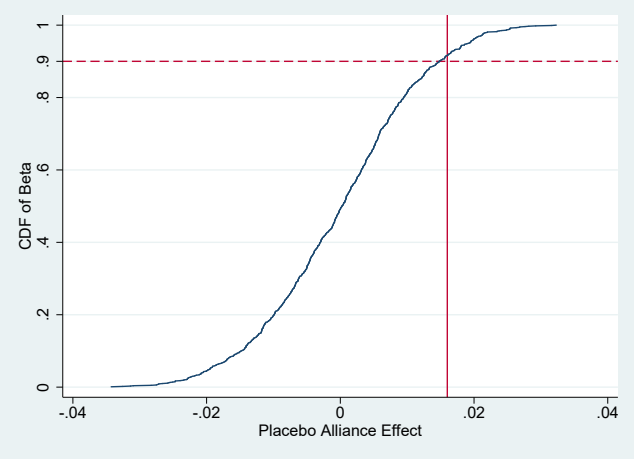
We perform randomized inference exercises by randomly drawing a partition and substituting this partition for the focal partition. The advantage of randomized inference in this setting is that it provides valid p-values under the null hypothesis that there is no effect. The randomization assigns equal probabilities of being assigned to the pseudo-Western (denoted by one) and pseudo-Eastern groups (denoted by zero). We construct 1000 such partitions and then rerun our UN voting regressions.

Figure 4 shows the results of 1000 placebo partitions on the probability of voting with the US, where the estimated effect of the focal partition is marked with a vertical solid line. More than 90% of the regressions produce an effect size that is smaller than what we observe for the focal partition, reassuring us about its predictive power.

We now turn to the estimates based on Payoffs. In Figure 5, we present a scatter plot of each pair of placebo effects of both $Payoff^{US}$ and $Payoff^{USSR}$, where Payoffs are calculated as before. It is particularly apparent that our results represent an extreme value vis-a-vis the placebo effects.

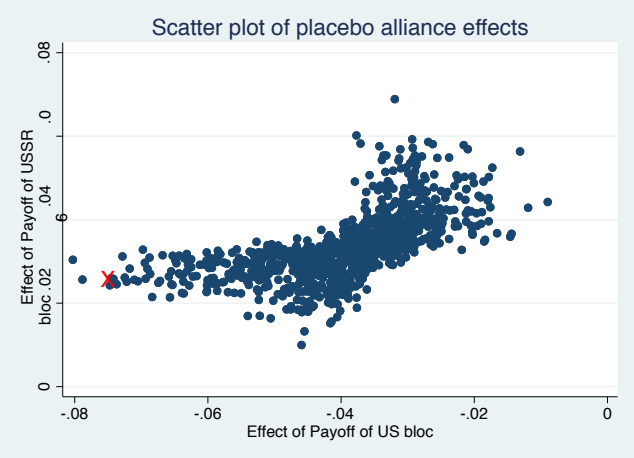
In Figure 6, we present the simulations for the main result. This figure plots the pair of estimates of the effects of 1000 simulations coming from placebo partitions. For each simulation, a random partition is drawn that becomes a placebo partition and is therefore fixed for the whole period. Then, the Payoffs are constructed as before for the placebo partition. We sum the effects and then multiple by negative one for ease of interpretability. The resulting estimated effects are interpreted as the marginal change in the likelihood of

Figure 4 Randomized Inference: Partition



Notes: This figure plots the estimates of the effects of 1000 placebo partitions on the probability of voting with the US. For each simulation, a random partition is drawn that becomes a placebo Pareto efficient partition and is therefore fixed for the whole period. The estimated effect for the focal partition is marked with a vertical solid red line. The horizontal dotted red line indicates the 90% level.

Figure 5 Randomization Inference: Payoff effects

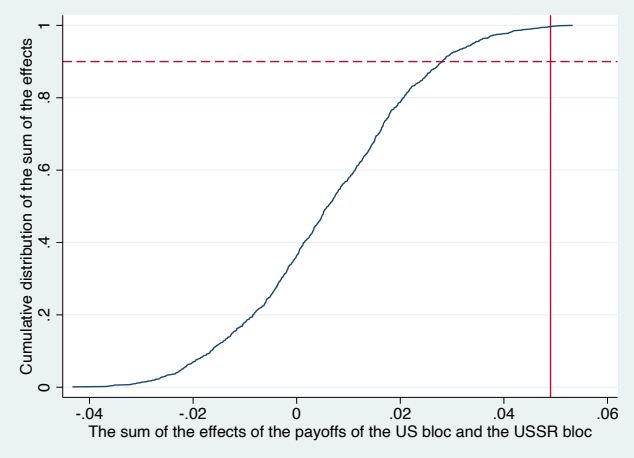


Notes: This figure plots the pair of estimates of the effects of the Payoffs for 1000 placebo simulations. For each simulation, a random partition is drawn that becomes a placebo partition and is therefore fixed for the whole period. Then, the Payoffs are constructed as before for the placebo partition. The pair of estimates for the focal partition is marked with a red "X".

voting with the US when the energy of the USSR bloc is increased relative to the energy of the US bloc. The estimated effect for the focal partition is marked with a vertical solid line.

The horizontal dotted red line indicates the 90% level. It is clear that the effect of the focal partition is markedly different than the placebo effects.

Figure 6 Randomization Inference: Difference in Payoff



Notes: This figure plots the estimates of the effects from 1000 simulations on the probability of voting with the US. For each simulation, a random partition is drawn that becomes a placebo partition and is therefore fixed for the whole period. Then, the Payoffs are constructed as before for the placebo partition. We sum the effects and then multiple by negative one for the ease of interpretability. The estimated effects of the interpretation of the marginal change in the likelihood of voting with the US when the Payoff of the USSR bloc is increased relative to the Payoff of the US bloc. The estimated effect for the focal partition is marked with a vertical solid red line. The horizontal dotted red line indicates the 90% level.

7 The Cold War and Development Clusters

Having established in the previous section that our game of social interactions predicts political alliances as measured by UN voting patterns, we now turn to the main objective of this paper. Given that the Cold War coincided with post-WWII independence for many African countries and that the superpowers had ideological differences in their preferred modes of economic organization, one might expect that strategic political alliances would have constrained subsequent development trajectories. In this section, we provide evidence on whether these Cold War alliances produce development clusters in Africa today.

Our analysis relies on sorting the conditional expectation of various measures related to economic development according to whether our game and validation exercise assign a country to the Western-aligned group or the Eastern-aligned one. The first such cluster to consider is naturally based on GDP per capita, which we term the winners-and-losers cluster.

David C. Engerman provides succinct motivation for this hypothesis: "Widespread desire for higher levels of economic production, as well as conflicts over the path to higher production, defined the shape of international relations in the Cold War as well as the experiences of those who lived through it (Engerman, 2004)." The Western superpower believed that capitalism would ultimately lead to sustained economic growth and communism would ultimately be a failure. In contrast, the Eastern superpower believed that an economy based on communism would be able to catch up and surpass capitalist economies. One might expect that the countries that aligned with the West, as the victor of the Cold War, to have a higher level of development than those that aligned with the East.

Hypothesis 1. Western-aligned countries have greater income per capita than Eastern-aligned countries.

This first hypothesis is purely about the level of development. However, given the stark ideological differences involved in the Cold War, the focal partition may also have influenced the shape of development by changing intermediate and primary inputs in the development process. Therefore, the second development cluster that we consider is based on the different development paths chosen and encouraged by the superpowers. The Western mode, organized on the basis of capitalism, relies on the market economy to allocate resources and requires basic freedoms to support decentralized decision-making. The Eastern mode, organized on the basis of communism, focused instead on the perfection and equality of man and centralized decision-making. While both development paths could have had similar objectives as investing in human capital, promoting democratic governance and encouraging large-scale investment, we argue that we can distinguish between the two, first and foremost, using a development cluster based on economic inequality (the inequality cluster) and one based on the market economy and financial penetration (market cluster). Following Bergson (1984), we consider the level of economic inequality and financial penetration as two necessary distinguishing features of the prototypical economies associated with each Cold War bloc.

Hypothesis 2. Western-aligned countries have greater income inequality and financial penetration than Eastern-aligned countries.

Pushing the development narratives further, we also expect to see systematic differences across the two groups in terms of human capital, physical capital and institutions. The constrained optimization of these two different aggregate production functions likely implied qualitatively and quantitatively different levels and types of investments. After all, the two

sides clashed over the methods of reaching greater production and development (Engerman, 2004). For example, according to Lenin, Коммунизм = Совецкя Власть + Электрификаця ("Communism is Soviet power plus electrification"). Taken quite literally, this would imply a different set of investments than the Western formula for successful capitalist development, which emphasized investment in public goods, protection of private property rights and democratic governance. Since human capital, physical capital and institutions were important factors in the development strategies of both of the superpowers, it is difficult to definitively sign which side would outperform the other in these development outcomes. However, we can meaningfully test against the null of no effect.

Hypothesis 3. Western-aligned countries have systematically different levels of human capital, physical capital and institutional quality than Eastern-aligned countries.

To test these hypotheses, we run regressions using country-level data, averaged over the post-Cold War period until today, of the following form:

$$Outcome_i^j = \alpha^j + \beta^j * PseudoWestern_i + \delta^j * GDPp.c._i^{1950} + \epsilon_i^j \quad (5)$$

We test Hypothesis 1 by regressing average GDP p.c. on the PseudoWestern indicator, controlling for initial GDP p.c.. The coefficient on the Pseudo-Western variable is the effect of interest and we test this hypothesis against the null hypothesis that Pseudo-Western has no impact on the level of development. Hypothesis 2 is tested by running a seemingly unrelated regression for inequality and financial penetration as two outcomes. We then test the joint significance of the two β^j's.[33] Hypothesis 3 is tested in a similar way as Hypothesis 1, although we remain agnostic about the expected sign.

7.1 Main results

For the reader's convenience, we show results for a range of possible development outcomes. Table 6 shows the OLS estimate of the relationship between Pareto-efficient alignment and different types of development outcomes, conditional on initial levels of GDP per capita.

We have split these variables into three panels. In Panels A, B and C of Table 6, respectively, we consider standard development outcomes, outcomes that should reflect differences in development policies, and institutional outcomes.

The first and second columns of Panel A show that initial economic outcomes were not correlated with the alignment. We test Hypothesis 1 in column 3. We find that the

[33]Alternatively, we also employ a bootstrap procedure to perform a joint, one-sided test.

Table 6 Cold War Alliances and Long-run Outcomes

Dep. Var. =	Panel A: GDP per capita (1950)	Life Exp. At Birth (1965)	GDP per capita (Avg. 1990-2016)	Life Exp. At birth (Avg. 1990-2016)	Poverty Head Count Ratio (Avg. 1990-2016)	Measles Immunity (Avg. 1990-2016)	Urban Share of Population (Avg. 1990-2016)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Pseudo-Western Bloc	183.77	1.91	-381.95	-4.88	6.88	4.67	-7.29
(Strong Nash)	[144.005]	[1.414]	[1,404.311]	[1.880]	[6.322]	[5.030]	[4.313]
GDP per capita, 1950		0.01	4.47	0.01	-0.03	0.00	0.02
(Maddison)		[0.002]	[0.863]	[0.002]	[0.005]	[0.004]	[0.004]
Observations	45	45	44	45	41	45	45
R-squared	0.037	0.387	0.186	0.318	0.331	0.050	0.250

Dep. Var. =	Panel B: Income Inequality (Avg. 1990-2016)	Financial Account Holders (Avg. 1990-2016)	Net ODA (Avg. 1990-2016)	Adult Literacy Rate (Avg. 1990-2016)	Educ. Exp. % Govt. Exp. (Avg. 1990-2016)	Gender Parity Index (Educ.) (Avg. 1990-2016)	Access to Electricity (Avg. 1990-2016)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Pseudo-Western Bloc	5.37	9.90	16.75	19.90	1.92	0.09	-14.12
(Strong Nash)	[2.022]	[3.965]	[6.402]	[4.491]	[0.985]	[0.042]	[7.642]
GDP per capita, 1950	-0.00	0.02	-0.00	0.01	0.00	0.00	0.04
(Maddison)	[0.003]	[0.005]	[0.007]	[0.003]	[0.001]	[0.000]	[0.006]
Observations	41	41	45	44	43	44	45
R-squared	0.143	0.498	0.131	0.440	0.096	0.208	0.337

Dep. Var. =	Panel C: Govt. Exp. % GDP (Avg. 1990-2016)	Agriculture Share of Value Added (Avg. 1990-2016)	Polity IV Index (Avg. 1990-2016)	Disappearances CIRI (Avg. 1990-2010)	Rule of Law WGI (Avg. 1990-2016)	Govt. Effectiveness WGI (Avg. 1990-2016)	Corruption TI (Avg. 1990-2016)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Pseudo-Western Bloc	2.25	-1.82	2.30	-0.03	-0.10	-0.05	0.19
(Strong Nash)	[1.372]	[4.465]	[1.262]	[0.142]	[0.196]	[0.179]	[0.283]
GDP per capita, 1950	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
(Maddison)	[0.001]	[0.003]	[0.002]	[0.002]	[0.000]	[0.000]	[0.000]
Observations	44	44	45	45	45	45	45
R-squared	0.112	0.232	0.127	0.003	0.110	0.182	0.207

Robust standard errors in brackets.

PseudoWestern alliance did not lead to greater income, leading us to fail to reject the null, and we must tentatively abandon Hypothesis 1 since we find no evidence in favor of the Cold War producing a winners-and-losers development cluster in Africa. If anything, the Pseudo-Western alliance performed worse in some of the standard development indicators, with lower life expectancy and urbanization. In terms of improvements in poverty and measles immunity, there is no systematic difference.

Intermediary outcomes, however, differ (Panels B and C of Table 6). Western-allied have greater inequality and deeper financial penetration (columns 1 and 2 of Panel B). Our joint significance test of Hypothesis 2 gives a χ^2 statistic of 10.1 with a p-value of 0.006.[34] Therefore, we can reject the null hypothesis and tentatively accept Hypothesis 2.

[34]The bootstrap procedure yields 10 out of 1000 cases in which at least one of the β^j's is less than or equal to zero, giving a p-value of 0.01.

The Cold War appears to have indeed produced development clusters in Africa in line with the ideological objectives of the superpowers. Western-aligned also have received greater amounts of official development assistance (Net ODA, column 3 of Panel B). Western-allied have greater human capital, measured by the literacy rate and gender parity in primary and secondary education, coupled with greater education expenditure share in the government budget. In contrast, the Western-allied seem to have lower infrastructure, proxied by electrification.

Finally, in Panel C, we observe that while government's size and the emphasis on a strong agricultural economy do not differ, the Western-allied do better in certain political institutions, such as democratic rights. Supporting this, column 3 of Panel C suggests that the Western-allied have on average a higher democracy score. Evaluating Hypothesis 3 in light of the findings from Panels B and C, we can state that there are systematically different levels of human capital, physical capital and political institutional quality between the two groups. The Western-allied have greater democracy and human capital, while their level of electrification is lower.

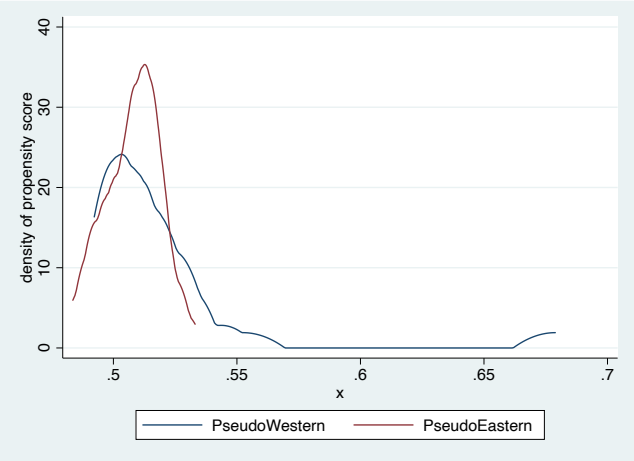
Taking stock of the literature and these results, greater democracy, human capital, and financial penetration might suggest better economic outcomes going forward in the former Western-allied countries. However, this could be counteracted by a lower level of infrastructure and the potential negative impact of income inequality.

7.2 Propensity score estimation

Since our theoretical approach simply creates two blocs without assigning treatment, each country has the same ex-ante probability of receiving treatment. Then, the ex-interim assignment using UN voting alignment could violate the unconfoundedness assumption if individual country's voting alignment is correlated with factors that are correlated with development outcomes conditional on treatment. In particular, the true effect of the focal partition may be null, but due to its correlation with UN voting, we may reject the null hypothesis if unaccounted for factors (in our case, this is basically anything not accounted for by initial level of GDP per capita) that are correlated with UN voting, including UN Voting itself, are correlated with development outcomes. Fortunately, we can use propensity score methods to control for the difference in the probability of treatment assignment. Figure 7 shows the distribution of the propensity score for Pseudo-Eastern and Pseudo-Western blocs. The overlap is considerable and the distribution for the Pseudo-Western is, as expected, on the right of the distribution for the Pseudo-Eastern bloc. There are six countries outside the common support, but only one or two countries in PseudoWestern group have values

that are relatively high. For the analysis below, to keep the degrees of freedom as high as possible, we leave all these countries in the estimation, but all our results are robust to their exclusion.

Figure 7 Propensity Score



Notes: Normal transformation of the value of the point estimate of a country fixed effect in a regression of UN voting alignment on country and vote fixed effects. We use a transformation because some fixed effects are negative by construction. Similar results are obtained taking a uniform transformation.

Given that we have relatively small number of observations, we prefer to present several approaches to the propensity score, each with their own advantages and disadvantages. In particular, we use the propensity score as weights (in Panel A of Table 7), simply controlling for the propensity score (in Panel B of Table 7), and nearest neighbor matching on the propensity score and initial level of GDP p.c. (in Panel C of Table 7). We present the results for the main outcomes of interest related to the three hypotheses, relegating other outcomes to the appendix.[35]

If anything, our results become stronger when we account for the likelihood of being treated. Again, we fail to reject the null for the winner/losers clusters in all three approaches with even smaller point estimates (column 1). We confirm the inequality and market clusters and the effects are more precisely estimated (columns 2 and 3). Moreover, in line with our third hypothesis, pseudo-Western countries have higher human capital (columns 4 and 5) and democracy (column 7), with lower infrastructure (column 6). Therefore, differences in time-invariant observable and unobservable factors that affect the likelihood of being treated do not explain away the relationships that we uncover. Of course, we can not entirely rule

[35]In the appendix, we report each outcome in Table A.6 using each estimation method.

out the possibility that there is some factor that changed post-1991 that is correlated with the focal partition and development outcomes.

Table 7 Cold War Alliances and Long-run Outcomes: Propensity Score Estimation

Dep. Var. =	GDP per capita (Avg. 1990-2016)	Income Inequality (Avg. 1990-2016)	Financial Account Holders (Avg. 1990-2016)	Adult Literacy Rate (Avg. 1990-2016)	Gender Parity Index (Educ.) (Avg. 1990-2016)	Access to Electricity (Avg. 1990-2016)	Polity IV Index (Avg. 1990-2016)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Propensity Score Weights							
Pseudo-Western Bloc (Strong Nash)	-352.50	5.22	9.97	19.98	0.09	-13.85	2.23
	[1,380.563]	[2.011]	[3.973]	[4.472]	[0.042]	[7.600]	[1.253]
GDP per capita, 1950	4.42	-0.00	0.02	0.01	0.00	0.04	0.00
	[0.896]	[0.003]	[0.005]	[0.003]	[0.000]	[0.007]	[0.002]
Observations	44	41	41	44	44	45	45
R-squared	0.177	0.138	0.482	0.433	0.200	0.327	0.114
Panel B: Controlling for Propensity Score							
Pseudo-Western Bloc (Strong Nash)	-321.74	4.95	9.93	20.09	0.09	-13.42	2.05
	[1,367.486]	[1.941]	[4.127]	[4.507]	[0.042]	[7.574]	[1.222]
GDP per capita, 1950	4.64	-0.00	0.02	0.01	0.00	0.04	0.00
	[1.007]	[0.003]	[0.005]	[0.004]	[0.000]	[0.007]	[0.002]
Propensity score	-8,483.87	109.24	-4.47	-26.62	0.34	-109.31	39.12
	[15,014.634]	[23.578]	[57.994]	[52.768]	[0.412]	[90.644]	[14.565]
Observations	44	41	41	44	44	45	45
R-squared	0.188	0.313	0.498	0.441	0.212	0.347	0.185
Panel C: Nearest Neighbor Matching on Propensity Score and initial GDP p.c.							
Pseudo-Western Bloc (Strong Nash)	-357.04	6.03	12.14	21.75	0.10	-10.87	2.85
	[1,517.334]	[2.039]	[4.169]	[4.790]	[0.041]	[7.998]	[1.579]
Observations	44	41	41	44	44	45	45

Robust standard errors in brackets.

7.3 Robustness checks

Given the small sample, we are limited in the types of robustness checks that we can do. First, we perform randomization inference exercises as before by randomly drawing a partition and substituting it for the focal one. As discussed above, this procedure performs valid inference when there are few treatment clusters as is our case. In 1000 regressions of a corresponding outcome from Table 6 on placebo partitions, our conclusions above are confirmed (see Figure A.1 in the Online Appendix). The only difference is that government expenditure share seems to be higher for pseudo-Western allied.

Second, we rerun our main specifications with a set of control variables, each added one at a time, for each outcome in Table 6. The set of control variables corresponds to

the country-level counterparts of the components that make up the pairwise payoff matrix. This exercise assesses the robustness of the correlations between the focal partition and the development outcomes. A summary of the results is presented in Table A.5. We code a zero for when the sign and statistical significance of the correlation between the focal partition and the development outcome (in rows) remain unchanged with the inclusion of the control variable (in columns) and a one for when there is such a change. Importantly, the key outcomes that bifurcate the development clusters along the two stylized paths of development mostly remain unchanged. The last two columns report the proportion of tests that result in a change, one for all factors and one that excludes factors that have a relatively high correlation with the focal partition. In short, we interpret this summary of results as rather strong evidence that the correlations are robust.

Finally, in Table A.7, we present results from running our main outcome variables averaged by each of the three post-Cold War decades. The results are consistent with the impact of the Cold War having a persistent effect. The one exception is the gender parity index since the effect of the Cold War appears to fade over time. This is most likely due to the global push toward gender equality.

8 Conclusion

International alliances in Africa during the Cold War were fluid and dynamic. Yet, we uncover a stable and efficient structure to these alliances using a game of social interactions that takes payoffs based on similarities across a set of predetermined characteristics. We then use this structure to assign a treatment of Cold War political alignment that has strong theoretical and empirical justification for the exogeneity assumption. We find that the treatment of Cold War alignment produces development clusters in Africa today. Surprisingly, we find no evidence that the Cold War treatment resulted in a cluster of winners and losers. Specifically, we find that there is no statistically significant difference in GDP per capita between Western-assigned and Eastern-assigned countries. However, Cold War alignment did produce an inequality cluster and a market cluster that is in line with the superpowers' self-professed development objectives. Western-assigned countries have greater income inequality and financial penetration than Eastern-assigned countries. The magnitudes are economically significant: the impacts on inequality and financial penetration correspond to jumps from the median to the 75th percentile and to the 70th percentile, respectively. Moreover, Western and Eastern countries also differ in their human and physical capital as well as institutions. Western-assigned countries have greater human capital and democracy, with lower infrastructure levels.

In sum, our findings suggest that important intermediary outcomes for long-run growth, such as human capital, financial penetration and democratic institutions, favor pseudo-Western-bloc African countries. However, the effect of those factors has been mitigated by greater inequality. It is important to understand this conclusion by recalling that, in our theoretical setting, the formation of two blocs is not a result of direct actions or influence of the superpowers at any point in time. The focal partition is a latent structure that influences the course of events. While we do not rule out superpowers' interventions as a mechanism, Cold War politics could equally have served an indirect causal role by shaping the common lens through which these two groups of countries viewed the difficult problem of decolonization and development.

Our findings support the growing empirical literature on how historical variables affect outcomes today and provide some evidence for the "past of the present" thesis (Cooper, 2002). The predetermined characteristics that we use to predict alignment are themselves aggregators of the past and interact with the Cold War environment to influence post-independence development paths and present outcomes.

The enduring impact of the Cold War underscores the importance of politics in the process of development and points to the need for more research on the Cold War as a "third world" phenomenon. Politics typically restricts the feasible set of policy options and the Cold War is a particularly stark example. In reality, Cold War politics may have afforded African countries a greater range of policy choices than our bifurcation suggests. The nonaligned movement is one potential candidate to coalesce development policies through strategic political alliances, leading to potentially a more refined understanding of development clusters. To what extent the nonaligned movement affected the latent structure of political alliances in Africa is an empirical question and we have research underway to determine whether two or three groups better represent UN voting patterns.

Our engagement with history in this paper deserves some further discussion. This literature often employs a narrow concept of history, typically for the purposes of identification, by equating a particular history with a quasi-experimental intervention. This use of history contrasts starkly with a more complex, process-oriented view that models history as a highly differentiated product that resists aggregation and quantification (Diamond and Robinson, 2010). Historians embrace multiplicity and require contextual and process-oriented information to comment on causality (Landes, 1994). Our work presents a middle ground in the spirit of Greif and Laitin (2004). We consider all possible configurations of Cold War alignment, 2^{47} of them to be precise, and then use a theoretical model of social interactions to wade through this multiplicity to arrive at treatment assignment. In this sense, we allow for an endogenous, process-oriented meaning of historical events, but we also

extract from history a microfounded, quantifiable and identifiable causal factor that can be used to understand the aggregate impact of history on economic and political outcomes today. In our context, the focal partition is particularly intriguing as an aggregator of historical processes because of its special game-theoretic properties of stability and efficiency.

Finally, our approach can be extended to other important contexts, many of which are now computationally feasible due to recent advances in the operations research literature on the MaxCut problem. Pairwise hedonic heterogeneity is also used (implicitly or explicitly) in examination of ethnic conflicts (see, e.g., Duclos et al. (2004), Esteban and Ray (2008a,b, 2011), Horowitz (1985), Montalvo and Reynal-Querol (2005), Reynal-Querol (2002)). In the analysis of conflict and cooperation among ethnic groups, the major concern is to understand the causes of civil wars or other forms of violent bilateral or multilateral disputes among these groups. The methodology used to analyze the war proneness of the international system can be applied for the examination of this problem. The current research on this topic emphasizes the role of heterogeneity across groups. If a civil war is viewed as a coalition formation game with two sides, the framework developed here could be useful as well.

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Online Appendix

A Data Appendix

A.1 Data for the Partition Matrix

Contiguity Data on contiguity can be accessed on CEPII's or Thierry Mayer's webpage (`http://econ.sciences-po.fr/node/131`). While constructing the distance index, we employ (1-contiguity) to render the variable in distance terms.

Common colonizer Data on common colonizer can be accessed on CEPII's or Thierry Mayer's webpage (`http://econ.sciences-po.fr/node/131`). While constructing the distance index, we employ (1-common colonizer) to render the variable in distance terms.

Log of Geodesic distance Data on geodesic distance can be accessed on CEPII's or Thierry Mayer's webpage (`http://econ.sciences-po.fr/node/131`). We normalize the log distance to lie between zero and one.

Genetic distance Genetic distance is a measure of distance to the most recent common ancestors of two populations, i.e. their degree of genealogical relatedness, or equivalently, the length of time since two populations split apart (Spolaore and Wacziarg, 2009). This measure of genetic distance, also called F_{ST} distance, is constructed using information on 128 alleles related to 45 selectively neutral genes. It includes alleles coding for blood groups, immunoglobulin, hemoglobin, enzymes and lymphocyte antigens. We refer the interested reader to Spolaore and Wacziarg (2009) for a more comprehensive overview and a formal definition of genetic distance. See also Cavalli-Sforza et al. (1994).

By measuring the time since two populations shared common ancestors, genetic distance provides an ideal summary of differences in slowly changing genealogically transmitted cultural characteristics, including habits and customs (Spolaore and Wacziarg, 2009). We normalize the variable to lie between zero and one.

Linguistic distance Data on linguistic distance are based on Spolaore and Wacziarg (2015). We normalize the variable to lie between zero and one.

Religious distance Data on religious distance are based on Spolaore and Wacziarg (2015). We normalize the variable to lie between zero and one.

National Material Capabilities We employ National Material Capabilities data set from the Correlates of War Project. The widely-used Composite Index of National Capability (CINC) index is based on six variables in the data set: total population, urban population, iron and steel production, energy consumption, military personnel, and military expenditure of all state members. We normalize the variable to lie between zero and one. For details see also Singer (1988) and Singer et al. (1972).

A.2 Data for Development Outcomes

GDP per capita These data are from the World Development Indicators Database of the World Bank. GDP per capita is gross domestic product divided by midyear population. Data are in constant 2010 U.S. dollars.

Life Expectancy at Birth These data are from the Africa Development Indicators Database of the World Bank. Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.

Poverty Head Count Ratio These data are from the Millennium Development Goals Database of the World Bank. National poverty headcount ratio is the percentage of the population living below the national poverty lines. National estimates are based on population-weighted subgroup estimates from household surveys.

Measles Immunity These data are from the Statistical Capacity Indicators Database of the World Bank. The proportion of one-year-old children immunized against measles, which is the proportion of children aged one who received one dose of measles vaccine.

Urban Share of Population These data are from the World Development Indicators Database of the World Bank. Urban population refers to people living in urban areas as defined by national statistical offices.

Income Inequality (Gini) These data are from the Africa Development Indicators Database of the World Bank. Gini index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution.

Financial Account Holders These data are from the World Development Indicators Database of the World Bank. Account at a financial institution denotes the percentage of respondents who report having an account (by themselves or together with someone else) at a bank or another type of financial institution.

Net ODA (Official Development Assistance) These data are from the Africa Development Indicators Database of the World Bank. Net official development assistance (ODA) consists of disbursements of loans made on concessional terms (net of repayments of principal) and grants by official agencies of the members of the Development Assistance Committee (DAC), by multilateral institutions, and by non-DAC countries to promote economic development and welfare in countries and territories in the DAC list of ODA recipients.

Adult Literacy Rate These data are from the Education Statistics Database of the World Bank. Percentage of the population age 15 and above who can, with understanding, read and write a short, simple statement on their everyday life.

Education Expenditure as a Share of Government Expenditure These data are from the Education Statistics Database of the World Bank. Total general (local, regional and central) government expenditure on education (current, capital, and transfers), expressed as a percentage of total general government expenditure on all sectors (including health, education, social services, etc.).

Gender Parity Index (Education) These data are from the Education Statistics Database of the World Bank. Ratio of female gross enrollment ratio for primary and secondary to male gross enrollment ratio for primary and secondary.

Access to Electricity These data are from the World Development Indicators Database of the World Bank. Access to electricity is the percentage of population with access to electricity.

Government Expenditure as a Share of GDP These data are from the World Development Indicators Database of the World Bank. General government final consumption expenditure (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees).

Agriculture Share of Value Added (% of GDP) These data are from the World Development Indicators Database of the World Bank. Agriculture corresponds to ISIC divisions 1-5 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs.

Polity IV Index These data are from the Africa Development Indicators Database of the World Bank. The Combined Polity score is computed by subtracting the AUTOCRACY score from the DEMOCRACY score; the resulting unified polity scale ranges from +10 (strongly democratic) to -10 (strongly autocratic).

Disappearances CIRI These data are from the CIRI Human Rights Data Project Database. Disappearances are cases in which people have disappeared, political motivation appears likely, and the victims have not been found. Knowledge of the whereabouts of the disappeared is, by definition, not public knowledge. However, while there is typically no way of knowing where victims are, it is typically known by whom they were taken and under what circumstances. A score of 0 indicates that disappearances have occurred frequently in a given year; a score of 1 indicates that disappearances occasionally occurred; and a score of 2 indicates that disappearances did not occur in a given year.

Rule of Law WGI These data are from the World Governance Indicators Database of the World Bank. Rule of Law measures the extent to which agents have confidence in and abide by the rules of society, in particular the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence. Coded from -2.5 to 2.5 with higher values corresponding with better governance outcomes.

Government Effectiveness WGI These data are from the World Governance Indicators Database of the World Bank. Government Effectiveness measures the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Coded from -2.5 to 2.5 with higher values corresponding with better governance outcomes.

Corruption TI These data are from the Africa Development Indicators Database of the World Bank. This information is from the http://www.transparency.org Transparency International web site. More information may be available there. Corruption Perception

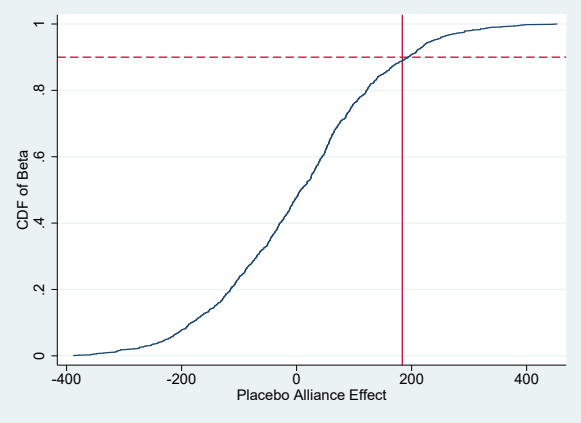
Index score relates to perceptions of the degree of corruption as seen by business people and country analysts, and ranges between 10 (highly clean) and 0 (highly corrupt).

A.3 Data for the Cold War Interventions

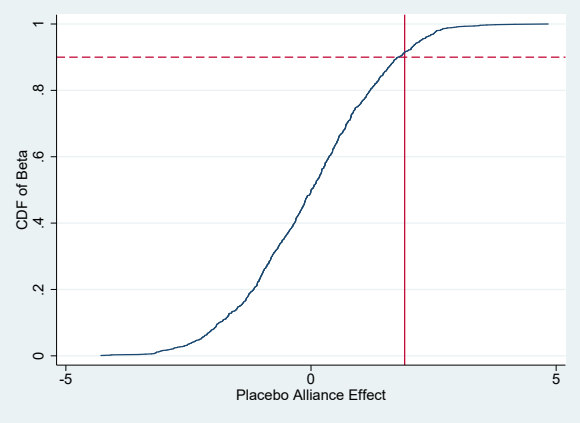
These data come from a variety of sources: government documents, such as declassified CIA documents and U.S. treaty agreements, expert reports, books and articles (Porter, 1984; Schmidt, 2013; Shubin, 2007), and online sources (http://countrystudies.us , http://www.country-data.com, etc.). Each intervention is categorized by which superpower intervened, the type of intervention and whether this intervention was hostile. The type of intervention is either military (arms deliveries or sales, military training, invasion, etc.) or economic (e.g., economic aid, non-military technical assistance and training , etc.). Hostility is determined by whether the intervention was approved of by the recipient country.

B Appendix Figures and Tables

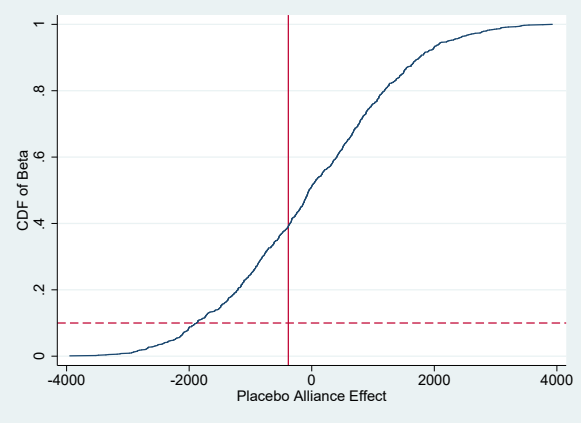
Figure A.1 Randomized Inference with Country Level Outcomes



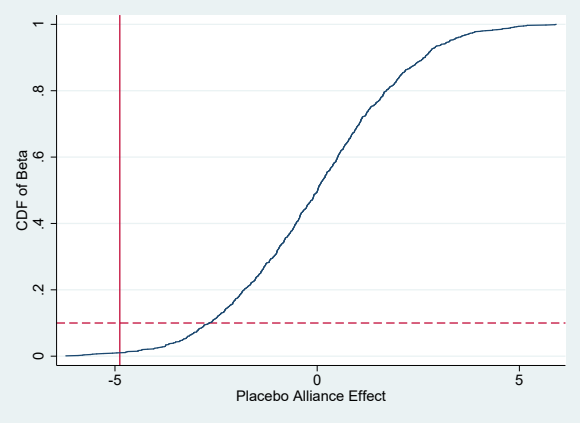
(a) GDPpc (1950)



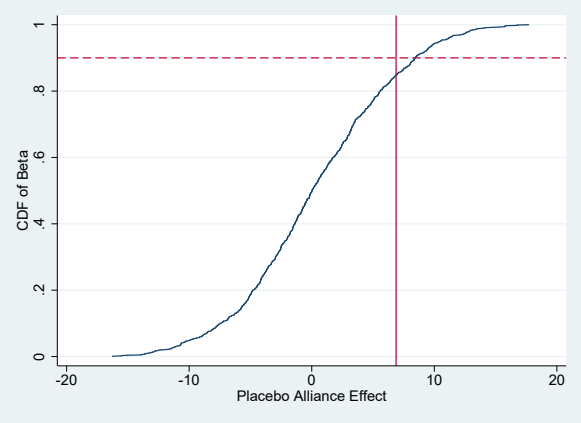
(b) Life Exp. At Birth (1965)



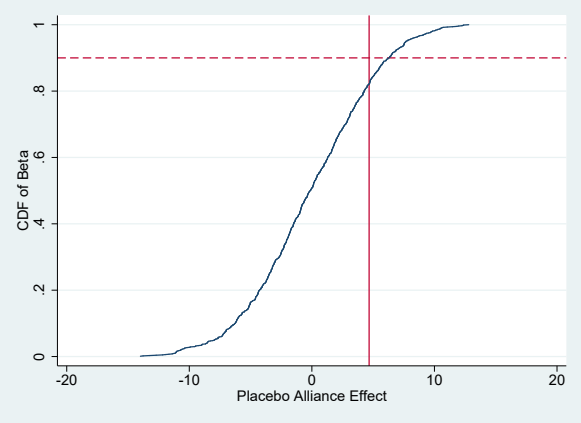
(c) GDPpc (1990-2016)



(d) Life Exp. At Birth (1990-2016)

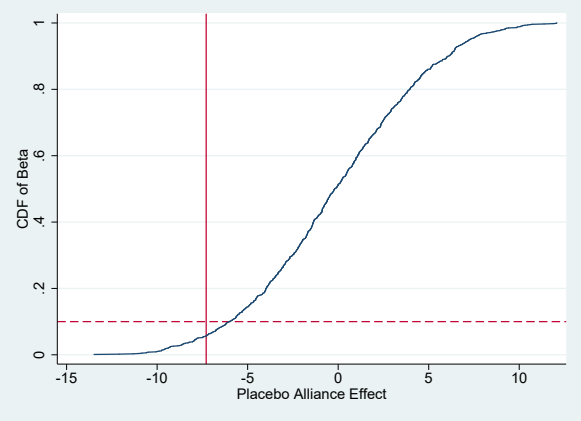


(e) Poverty Head Count Ratio (1990-2016)

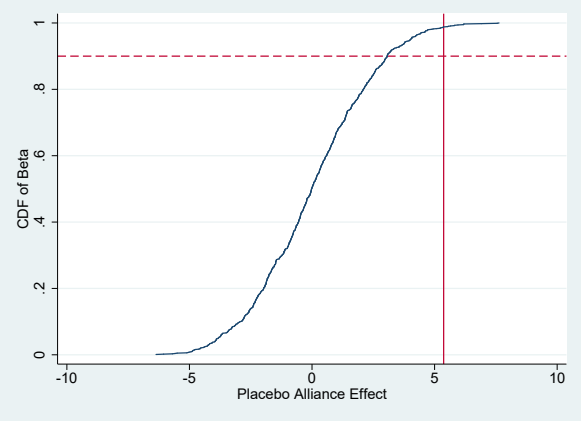


(f) Measles Immunity (1990-2016)

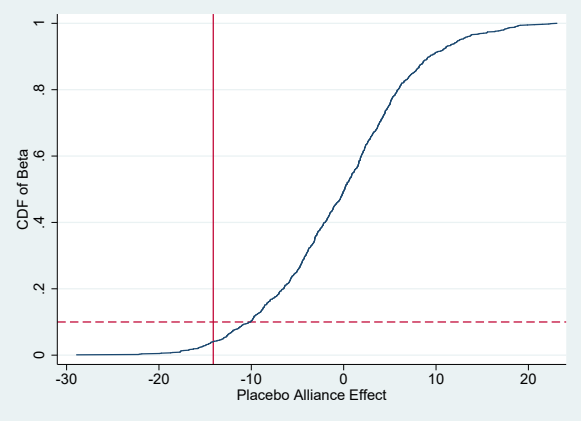
Figure A.2 (Continued) Randomized Inference with Country Level Outcomes



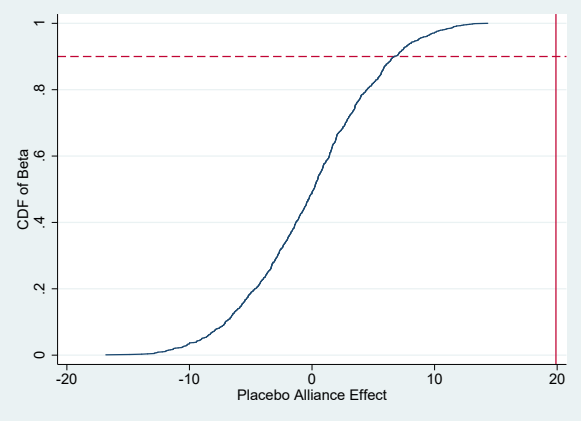
(a) Urban Share of Population (1990-2016)



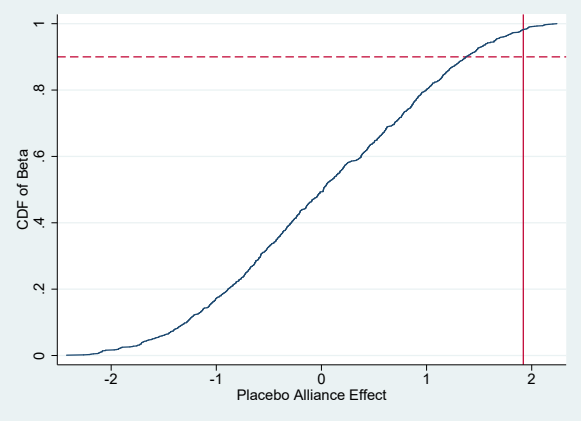
(b) Income Inequality (1990-2016)



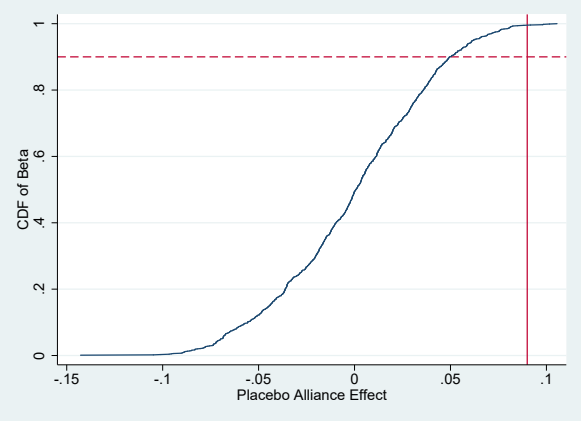
(c) Access to Electricity (1990-2016)



(d) Adult Literacy Rate (1990-2016)

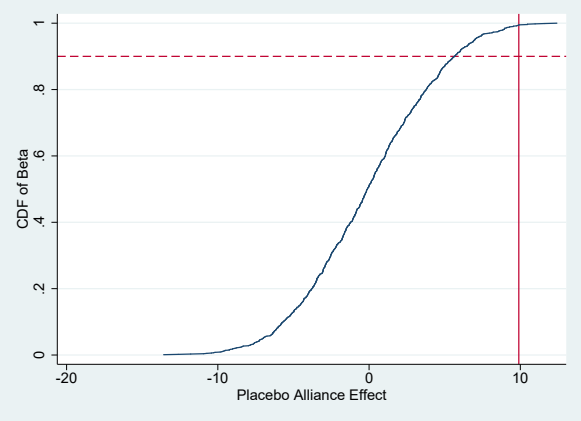


(e) Educ. Exp. % Govt. Exp. (1990-2016)

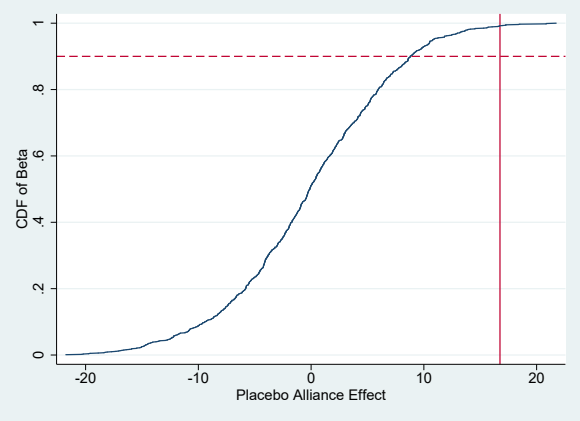


(f) Gender Parity Index (Educ.) (1990-2016)

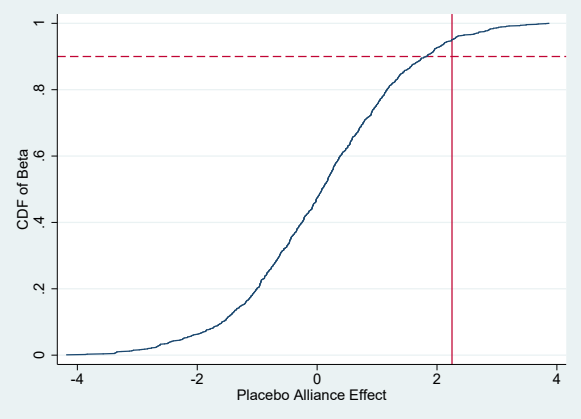
Figure A.3 (Continued) Randomized Inference with Country Level Outcomes



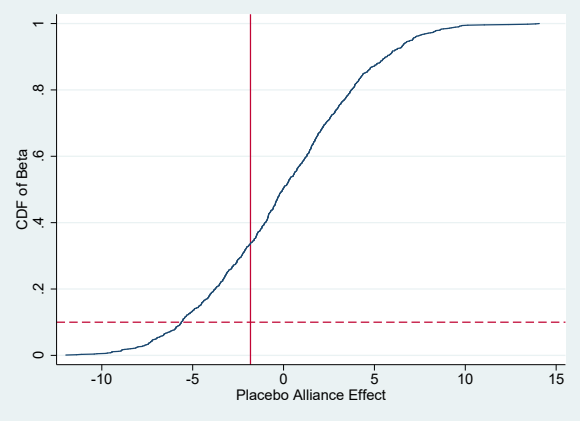
(a) Financial Account Holders (1990-2016)



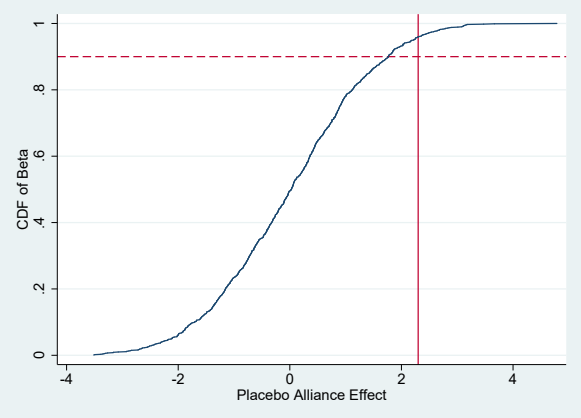
(b) Net ODA (1990-2016)



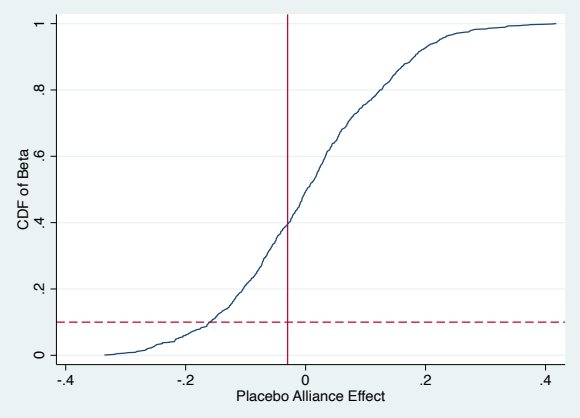
(c) Govt. Exp. % GDP (1990-2016)



(d) Agriculture Share of Value Added (1990-2016)

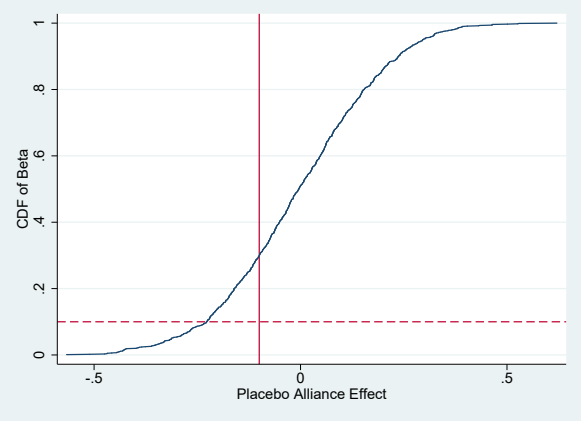


(e) Polity 2 Index (1990-2016)

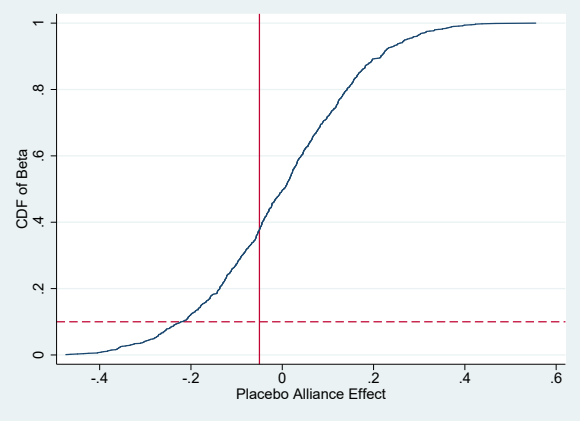


(f) Disappearances CIRI (1990-2016)

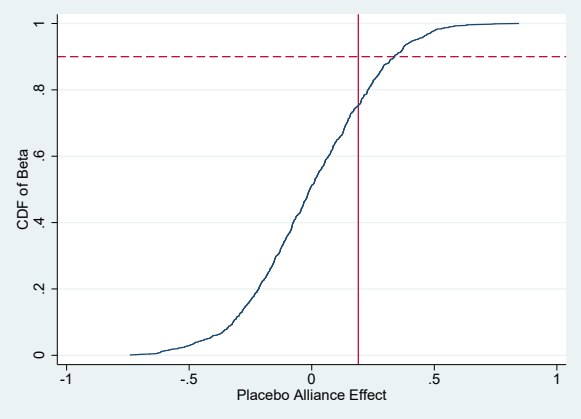
Figure A.4 (Continued) Randomized Inference with Country Level Outcomes



(a) Rule of Law WGI (1990-2016)



(b) Govt. Effectiveness WGI (1990-2016)



(c) Corruption TI (1990-2016)

Notes: This figure plots the estimates of the effects of 1000 placebo partitions on the corresponding outcome variables as in Table 6. For each simulation, a random partition is drawn that becomes a placebo partition. The estimated effect for the focal partition is marked with a vertical solid red line. The horizontal dotted red line indicates the 90% level.

Table A.1 Cold War Alliances and UN Voting Patterns by Decade

Dep. Var. =	Vote with the US									
	1950s		1960s		1970s		1980s		post-1990	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Pseudo-Western Bloc	0.279		0.075		0.024		-0.0003		-0.001	
	(0.021)		(0.0071)		(0.0027)		(0.0011)		(0.00097)	
Pseudo-Western Payoff		-0.686		-0.201		-0.044		-0.067		-0.042
		(0.067)		(0.014)		(0.0047)		(0.0062)		(0.0057)
Pseudo-Eastern Payoff		0.169		0.066		0.011		0.025		0.013
		(0.033)		(0.0057)		(0.0017)		(0.0026)		(0.0034)
Vote FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
Observations	1818	1818	12456	12456	27987	27987	53906	53906	54932	54932

Robust standard errors in parentheses.

Table A.2 Cold War Alliances and UN Voting Patterns, Robustness to Restricting the Sample to Relevant Votes

Dep. Var. =	Vote with the US			
	(1)	(2)	(3)	(4)
Pseudo-Western Bloc	0.0097	0.011		
	(0.0015)	(0.0015)		
Pseudo-Western Payoff			-0.08	-0.079
			(0.0047)	(0.0047)
Pseudo-Eastern Payoff			0.025	0.024
			(0.0017)	(0.0017)
Cold War Interventions	NO	YES	NO	YES
Vote FE	YES	YES	YES	YES
Country FE	NO	NO	YES	YES
Sample	Relevant roll call votes between 1960-1991			
Observations	67533	67533	67533	67533

Robust standard errors in parentheses.

Relevant votes are those identified by the UN relating to the Palestinian conflict, nuclear weapons and nuclear material, arms control and disarmament, colonialism, human rights, (economic) development, plus any of the votes concerning issues related to China, Korea, Cuba, Tibet and Hungary as identified by (Gareau, 1970), and those votes identified as important by the U.S. State Department report Voting Practices in the United Nations.

Table A.3 Cold War Alliances and UN Voting Patterns, Robustness to Excluding Countries That Do Not Agree with the US or the USSR

Dep. Var. =	Vote with the US			
	(1)	(2)	(3)	(4)
Pseudo-Western Bloc	0.015	0.016		
	(0.001)	(0.001)		
Pseudo-Western Payoff			-0.066	-0.065
			(0.003)	(0.003)
Pseudo-Eastern Payoff			0.021	0.020
			(0.001)	(0.001)
Cold War Interventions	NO	YES	NO	YES
Vote FE	YES	YES	YES	YES
Country FE	NO	NO	YES	YES
Sample	Roll call votes between 1960-1991			
Observations	89050	89050	89050	89050

Robust standard errors in parentheses.

Table A.4 Cold War Alliances and UN Voting Patterns, Robustness to Accounting for Pre-Colonial Institutions in the Partition

Dep. Var. =	Vote with the US			
	(1)	(2)	(3)	(4)
Pseudo-Western Bloc	0.020	0.020		
	(0.001)	(0.001)		
Pseudo-Western Payoff			-0.094	-0.092
			(0.004)	(0.004)
Pseudo-Eastern Payoff			0.031	0.029
			(0.001)	(0.001)
Cold War Interventions	NO	YES	NO	YES
Vote FE	YES	YES	YES	YES
Country FE	NO	NO	YES	YES
Sample	Roll call votes between 1960-1991			
Observations	92368	92368	92368	92368

Robust standard errors in parentheses.

Table A.5 Robustness of Development Outcomes

DepVar (rows)/Controls (columns)	(1) Size COW	(2) Ethnic Fractionalization	(3) Religious Fractionalization	(4) Landlocked	(5) Tropics	(6) Malaria 1966	(7) Dominant Religion	(8) Official Language E	(9) Official Language F	(10) Official Language A	(11) Official Language S	(12) Proportion unstable	(13) Proportion unstable (excluding factors w/ > 0.2 correlation)
GDP per capita (1950)	184.70	151.70	195.83	228.82	223.81	145.99	183.26	174.13	143.54	253.99	180.09	0.181818182	0.142857143
	[142.857]	[153.400]	[138.632]	[135.649]	[146.674]	[145.510]	[144.840]	[132.262]	[145.396]	[137.043]	[150.884]		
Life Exp. At Birth (1965)	1.96	2.66	2.58	1.66	2.94	2.91	1.91	1.38	1.28	3.04	1.75	0.454545455	0.428571429
	[1.420]	[1.235]	[1.416]	[1.422]	[1.093]	[1.167]	[1.431]	[1.484]	[1.484]	[1.569]	[1.455]		
GDP per capita (Avg. 1990-2016)	-413.88	672.77	1,337.37	-113.29	427.30	527.18	-353.75	211.46	-859.70	1,558.44	-255.96	0	0
	[1,411.246]	[1,045.312]	[1,108.403]	[1,345.035]	[1,154.891]	[1,142.106]	[1,389.153]	[1,381.994]	[1,729.028]	[980.229]	[1,442.927]		
Life Exp. At Birth (Avg. 1990-2016)	-4.89	-3.96	-2.97	-4.21	-3.52	-3.50	-4.87	-4.26	-5.89	-2.53	-4.60	0.090909091	0
	[1.906]	[1.689]	[1.666]	[1.760]	[1.636]	[1.721]	[1.896]	[1.874]	[2.135]	[1.830]	[1.899]		
Poverty Head Count Ratio (Avg. 1990-2016)	6.77	7.20	4.21	6.06	6.48	5.66	7.06	7.79	11.83	1.37	8.03	0.090909091	0
	[6.378]	[6.483]	[6.433]	[6.555]	[6.121]	[6.137]	[6.285]	[6.870]	[6.305]	[6.450]	[6.442]		
Measles Immunity (Avg. 1990-2016)	4.64	7.13	7.45	4.70	8.18	7.16	4.67	2.25	0.80	7.29	4.31	0.181818182	0.142857143
	[5.063]	[4.821]	[5.562]	[5.369]	[4.241]	[4.093]	[5.087]	[5.353]	[5.191]	[6.020]	[5.186]		
Urban Share of Population (Avg. 1990-2016)	-7.53	-5.81	-3.04	-4.60	-5.37	-5.48	-7.28	-4.86	-8.35	-4.86	-7.09	0.909090909	0.857142857
	[4.223]	[4.106]	[4.218]	[3.993]	[4.204]	[4.206]	[4.377]	[4.589]	[5.178]	[4.104]	[4.472]		
Income Inequality (Avg. 1990-2016)	5.36	4.91	5.16	4.94	5.65	5.92	5.28	4.77	5.34	4.63	5.56	0	0
	[2.074]	[2.012]	[2.058]	[1.982]	[2.001]	[2.111]	[2.002]	[1.929]	[2.078]	[2.180]	[2.115]		
Financial Account Holders (Avg. 1990-2016)	10.66	9.45	8.76	9.53	10.95	10.79	9.75	5.46	6.29	9.44	10.03	0.090909091	0
	[3.796]	[4.064]	[4.171]	[4.387]	[3.832]	[3.849]	[4.044]	[4.494]	[3.756]	[4.604]	[4.149]		
Net ODA (Avg. 1990-2016)	15.68	13.87	14.87	17.13	15.02	14.87	16.73	17.26	17.67	11.85	17.66	0	0
	[5.368]	[6.332]	[5.798]	[6.597]	[6.557]	[6.155]	[6.361]	[6.824]	[7.331]	[6.646]	[6.585]		
Adult Literacy Rate (Avg. 1990-2016)	20.08	21.88	24.09	21.41	22.90	22.50	19.97	17.46	17.39	25.96	19.34	0	0
	[4.520]	[3.801]	[4.284]	[4.681]	[3.880]	[4.107]	[4.458]	[4.007]	[4.289]	[4.666]	[4.585]		
Educ. Exp. % Govt. Exp. (Avg. 1990-2016)	1.91	2.10	2.12	1.55	2.31	2.28	1.93	1.45	1.59	2.07	1.20	0	0
	[0.993]	[1.013]	[1.076]	[0.776]	[0.903]	[0.958]	[0.981]	[0.817]	[0.874]	[1.010]	[0.698]		
Gender Parity Index (Educ.) (Avg. 1990-2016)	0.09	0.10	0.10	0.08	0.11	0.11	0.09	0.05	0.07	0.09	0.09	0.181818182	0
	[0.043]	[0.039]	[0.050]	[0.044]	[0.036]	[0.036]	[0.042]	[0.037]	[0.039]	[0.054]	[0.044]		
Access to Electricity (Avg. 1990-2016)	-13.76	-10.65	-6.94	-11.17	-8.53	-9.19	-14.10	-10.98	-18.97	-5.23	-14.16	0.636363636	0.571428571
	[7.593]	[6.981]	[6.534]	[7.415]	[6.645]	[6.578]	[7.710]	[7.608]	[8.379]	[6.590]	[7.844]		
Govt. Exp. % GDP (Avg. 1990-2016)	2.24	2.81	2.59	2.07	3.36	3.18	2.25	2.97	2.08	1.90	2.20	0.363636364	0.285714286
	[1.392]	[1.348]	[1.618]	[1.435]	[1.355]	[1.360]	[1.394]	[1.512]	[1.395]	[1.579]	[1.431]		
Agriculture Share of Value Added (Avg. 1990-2016)	-1.82	-2.95	-3.92	-2.26	-4.48	-4.32	-1.68	-1.73	-1.13	-1.95	-1.49	0	0
	[4.503]	[4.548]	[5.365]	[4.636]	[3.801]	[4.120]	[4.449]	[4.950]	[4.542]	[5.776]	[4.645]		
Polity 2 Index (Avg. 1990-2016)	2.28	1.83	1.39	1.95	2.12	1.85	2.29	1.78	2.56	0.80	2.59	0.636363636	0.571428571
	[1.264]	[1.312]	[1.282]	[1.191]	[1.351]	[1.365]	[1.274]	[1.243]	[1.323]	[1.257]	[1.268]		
Disappearances CIRI (Avg. 1990-2016)	-0.04	-0.02	-0.00	-0.04	-0.01	-0.03	-0.03	-0.03	-0.06	-0.08	-0.03	0	0
	[0.139]	[0.151]	[0.152]	[0.155]	[0.143]	[0.140]	[0.143]	[0.176]	[0.160]	[0.146]	[0.148]		
Rule of Law WGI (Avg. 1990-2016)	-0.11	-0.09	-0.11	-0.16	-0.01	-0.01	-0.10	-0.22	-0.18	-0.17	-0.07	0	0
	[0.195]	[0.201]	[0.224]	[0.195]	[0.179]	[0.177]	[0.198]	[0.205]	[0.192]	[0.227]	[0.202]		
Govt. Effectiveness WGI (Avg. 1990-2016)	-0.04	-0.04	-0.05	-0.09	0.06	0.07	-0.04	-0.15	-0.13	-0.10	-0.03	0	0
	[0.181]	[0.182]	[0.204]	[0.182]	[0.161]	[0.161]	[0.181]	[0.183]	[0.174]	[0.208]	[0.186]		
Corruption TI (Avg. 1990-2016)	0.18	0.22	0.17	0.09	0.35	0.33	0.19	0.07	0.10	0.15	0.21	0	0
	[0.279]	[0.270]	[0.302]	[0.258]	[0.267]	[0.262]	[0.285]	[0.271]	[0.273]	[0.303]	[0.295]		
Correlation with SN partition	-0.0091	0.0096	0.1939	0.111	0.133	0.2071	0.0111	0.3612	-0.3335	-0.3682	0.1059		

Notes: This table reports the coefficients on the Pseudo-Western Bloc variable in regressions of development outcomes when additional variables are controlled for. For each development outcome (reported in rows), we rerun the specification in Table 6 including an additional control (listed in columns). These control variables are the country-level counterparts, to the extent possible, of the bilateral relational components of the payoff matrix. We also calculate the number of times that there is a change in either the sign or the statistical significance of the variable of interest when an additional variable is controlled for and we report this as a proportion of the number of control variables tested (Proportion unstable in column 12). Due to the low number of observations, we also report this calculation excluding those control variables that are highly correlated with the focal partition (column 13). Robust standard errors are in brackets.

Table A.6 Cold War Alliances and Long-run Outcomes: Propensity Score Estimation

Panel A: Propensity Score Weights

Dep. Var. =	GDP per capita (1950)	Life Exp. At Birth (1965)	Life Exp. At Birth (Avg. 1990-2016)	Poverty Head Count Ratio (Avg. 1990-2016)	Measles Immunity (Avg. 1990-2016)	Urban Share of Population (Avg. 1990-2016)	Net ODA (Avg. 1990-2016)	Educ. Exp. % Govt. Exp. (Avg. 1990-2016)	Govt. Exp. % GDP (Avg. 1990-2016)	Agriculture Share of Value Added (Avg. 1990-2016)	Disappearances CIRI (Avg. 1990-2016)	Rule of Law WGI (Avg. 1990-2016)	Govt. Effectiveness WGI (Avg. 1990-2016)	Corruption TI (Avg. 1990-2016)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Pseudo-Western Bloc (Strong Nash)	170.82	1.92	-4.78	6.72	4.69	-7.27	16.72	1.91	2.27	-1.79	-0.04	-0.11	-0.05	0.18
	[138.66]	[1.416]	[1.880]	[6.316]	[5.028]	[4.297]	[6.371]	[0.991]	[1.380]	[4.463]	[0.142]	[0.196]	[0.178]	[0.281]
GDP per capita, 1950		0.01	0.01	-0.03	0.01	0.02	-0.00	0.00	0.00	-0.02	0.00	0.00	0.00	0.00
		[0.002]	[0.002]	[0.005]	[0.005]	[0.005]	[0.007]	[0.001]	[0.001]	[0.003]	[0.000]	[0.000]	[0.000]	[0.000]
Observations	45	45	45	41	45	45	45	43	44	44	45	45	45	45
R-squared	0.034	0.380	0.319	0.327	0.051	0.241	0.132	0.095	0.109	0.223	0.003	0.104	0.166	0.192

Panel B: Controlling for Propensity Score

Dep. Var. =	GDP per capita (1950)	Life Exp. At Birth (1965)	Life Exp. At Birth (Avg. 1990-2016)	Poverty Head Count Ratio (Avg. 1990-2016)	Measles Immunity (Avg. 1990-2016)	Urban Share of Population (Avg. 1990-2016)	Net ODA (Avg. 1990-2016)	Educ. Exp. % Govt. Exp. (Avg. 1990-2016)	Govt. Exp. % GDP (Avg. 1990-2016)	Agriculture Share of Value Added (Avg. 1990-2016)	Disappearances CIRI (Avg. 1990-2016)	Rule of Law WGI (Avg. 1990-2016)	Govt. Effectiveness WGI (Avg. 1990-2016)	Corruption TI (Avg. 1990-2016)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Pseudo-Western Bloc (Strong Nash)	127.47	2.00	-4.49	6.44	4.92	-7.28	17.45	1.90	2.28	-1.78	-0.04	-0.12	-0.07	0.14
	[137.10]	[1.443]	[1.875]	[6.353]	[5.117]	[4.378]	[6.581]	[1.029]	[1.414]	[4.548]	[0.143]	[0.198]	[0.178]	[0.277]
GDP per capita, 1950		0.01	0.01	-0.03	0.01	0.02	-0.00	-0.00	0.00	-0.01	0.00	0.00	0.00	0.00
		[0.002]	[0.002]	[0.005]	[0.005]	[0.005]	[0.006]	[0.001]	[0.001]	[0.004]	[0.000]	[0.000]	[0.000]	[0.000]
Propensity score	5602.08	-13.83	-61.16	113.11	-39.31	-0.22	-109.00	3.17	-5.69	-5.69	1.45	2.37	4.33	7.19
	[2345.48]	[16.808]	[20.753]	[56.335]	[62.724]	[52.127]	[120.626]	[10.402]	[18.706]	[44.377]	[1.650]	[2.463]	[1.996]	[2.924]
Observations	45	45	45	41	45	45	45	43	44	44	45	45	45	45
R-squared	0.145	0.391	0.366	0.349	0.054	0.250	0.147	0.096	0.113	0.232	0.011	0.119	0.217	0.248

Panel C: Nearest Neighbor Matching on Propensity Score and initial GDP p.c.

Dep. Var. =	GDP per capita (1950)	Life Exp. At Birth (1965)	Life Exp. At Birth (Avg. 1990-2016)	Poverty Head Count Ratio (Avg. 1990-2016)	Measles Immunity (Avg. 1990-2016)	Urban Share of Population (Avg. 1990-2016)	Net ODA (Avg. 1990-2016)	Educ. Exp. % Govt. Exp. (Avg. 1990-2016)	Govt. Exp. % GDP (Avg. 1990-2016)	Agriculture Share of Value Added (Avg. 1990-2016)	Disappearances CIRI (Avg. 1990-2016)	Rule of Law WGI (Avg. 1990-2016)	Govt. Effectiveness WGI (Avg. 1990-2016)	Corruption TI (Avg. 1990-2016)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Pseudo-Western Bloc (Strong Nash)	210	3.06	-4.27	7.77	5.50	-6.10	14.69	2.25	2.43	-3.24	0.08	-0.05	0.03	0.29
	[170.65]	[1.493]	[1.998]	[7.305]	[4.851]	[4.372]	[8.417]	[1.117]	[1.463]	[3.830]	[0.158]	[0.157]	[0.160]	[0.289]
Observations	45	45	45	41	45	45	45	43	44	44	45	45	45	45

Robust standard errors in brackets.

Table A.7 Cold War Alliances and Long-run Outcomes by Post-Cold War Decades

Dep. Var. =	GDP per capita (Avg. 1990-1999)	Income Inequality (Avg. 1990-1999)	Financial Account Holders (Avg. 1990-1999)	Adult Literacy Rate (Avg. 1990-1999)	Gender Parity Index (Educ.) (Avg. 1990-1999)	Access to Electricity (Avg. 1990-1999)	Polity IV Index (Avg. 1990-1999)
	Panel A: 1990–1999						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Pseudo-Western Bloc (Strong Nash)	467.21	6.34		24.89	0.196	-15.31	1.96
	[652.215]	[3.579]		[7.582]	[0.044]	[6.813]	[1.24]
GDP per capita, 1950	2.05	-0.00		0.01	0.00	0.03	0.00
	[0.401]	[0.004]		[0.003]	[0.000]	[0.006]	[0.001]
Observations	42	29		23	39	31	45
R-squared	0.222	0.126		0.538	0.447	0.315	0.152
	Panel B: 2000–2009						
Dep. Var. =	GDP per capita (Avg. 2000-2009)	Income Inequality (Avg. 2000-2009)	Financial Account Holders (Avg. 2000-2009)	Adult Literacy Rate (Avg. 2000-2009)	Gender Parity Index (Educ.) (Avg. 2000-2009)	Access to Electricity (Avg. 2000-2009)	Polity IV Index (Avg. 2000-2009)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Pseudo-Western Bloc (Strong Nash)	258.19	5.03		16.08	0.043	-18.91	2.92
	[666.578]	[2.313]		[5.169]	[0.046]	[6.938]	[1.40]
GDP per capita, 1950	2.47	0.00		0.01	0.00	0.04	0.00
	[0.435]	[0.004]		[0.004]	[0.000]	[0.005]	[0.001]
Observations	43	40		40	40	44	45
R-squared	0.265	0.158		0.372	0.112	0.425	0.114
	Panel C: 2010–2019						
Dep. Var. =	GDP per capita (Avg. 2010-2019)	Income Inequality (Avg. 2010-2019)	Financial Account Holders (Avg. 2010-2019)	Adult Literacy Rate (Avg. 2010-2019)	Gender Parity Index (Educ.) (Avg. 2010-2019)	Access to Electricity (Avg. 2010-2019)	Polity IV Index (Avg. 2010-2018)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Pseudo-Western Bloc (Strong Nash)	519.96	8.33	13.64	19.24	0.05	-14.58	2.52
	[667.667]	[2.007]	[4.406]	[4.495]	[0.035]	[6.810]	[1.22]
GDP per capita, 1950	3.01	0.00	0.02	0.02	0.00	0.04	0.00
	[0.585]	[0.003]	[0.005]	[0.003]	[0.000]	[0.005]	[0.001]
Observations	43	41	42	42	35	44	45
R-squared	0.377	0.311	0.431	0.490	0.092	0.382	0.136

Robust standard errors in brackets.

C Theory Appendix

To prove our result, we show that the sum of players' payoffs represents a strong potential function, the maximum of which yields a strong Nash equilibrium.

Proof: Note that

$$\widehat{U}_i(E) = \sum_{j \in E} \widehat{p}_{ij} \text{ for every } i \in E, \text{ and } \widehat{U}_i(W) = \sum_{j \in W} \widehat{p}_{ij} \text{ for every } i \in W.$$

where $\widehat{p}_{ij} = s_i s_j p_{ij}$ for all $i, j = 1, ..., n$. Let G be the set of all partitions of N into blocks, E and W. Since N is finite, so is G. Consider now the function $\mathbf{P}$ defined on G as follows:

$$\mathbf{P}(E, W) = \sum_{i \in E} \widehat{p}_{ij} + \sum_{i \in W} \sum_{j \in W} \widehat{p}_{ij}.$$

Since G is finite, the function $\mathbf{P}$ has a maximum over G. We claim that any such maximum is a strong Nash equilibrium. Let (E^*, W^*) be a maximum, and assume, on the contrary, that it is not a strong Nash equilibrium. Thus, there exist coalition $S \subset E^*$ and $T \subset W^*$ (one of the two could be empty), such that:

$$\widehat{U}_i\left((W^* \backslash T) \cup S\right) > \widehat{U}_i\left(E^*\right) \text{ for all } i \in S$$

and

$$\widehat{U}_i\left((E^* \backslash S) \cup T\right) > \widehat{U}_i\left(W^*\right) \text{ for all } i \in T.$$

These inequalities imply that the aggregate payoff changes of coalitions S and T can be presented as

$$\sum_{i \in S} \sum_{j \in (W^* \backslash T) \cup S} \widehat{p}_{ij} > \sum_{i \in S} \sum_{j \in E^*} \widehat{p}_{ij}$$

and

$$\sum_{i \in T} \sum_{j \in (E^* \backslash S) \cup T} \widehat{p}_{ij} > \sum_{i \in T} \sum_{j \in W^*} \widehat{p}_{ij},$$

respectively. By subtracting the common terms $\sum_{i \in S} \sum_{j \in S} \widehat{p}_{ij}$ and $\sum_{i \in T} \sum_{j \in T} \widehat{p}_{ij}$ from these two equations, respectively, we obtain

$$\sum_{i \in S} \sum_{j \in W^* \backslash T} \widehat{p}_{ij} - \sum_{i \in S} \sum_{j \in E^* \backslash S} \widehat{p}_{ij} > 0, \tag{6}$$

and

$$\sum_{i\in T}\sum_{j\in E^*\backslash S}\widehat{p}_{ij}-\sum_{i\in T}\sum_{j\in W^*\backslash T}\widehat{p}_{ij}>0 \tag{7}$$

Moreover, notice that the aggregate payoff changes of coalitions $E^*\backslash S$ and $W^*\backslash T$ are, respectively, equal to:

$$\sum_{i\in E^*\backslash S}\sum_{j\in T}\widehat{p}_{ij}-\sum_{i\in E^*\backslash S}\sum_{j\in S}\widehat{p}_{ij}$$

and

$$\sum_{i\in W^*\backslash T}\sum_{j\in S}\widehat{p}_{ij}-\sum_{i\in W^*\backslash T}\sum_{j\in T}\widehat{p}_{ij}.$$

Since $\widehat{p}_{ij}=\widehat{p}_{ji}$ for every i and j, these two expressions can be rewritten as follows:

$$\sum_{i\in T}\sum_{j\in E^*\backslash S}\widehat{p}_{ij}-\sum_{i\in S}\sum_{j\in E^*\backslash S}\widehat{p}_{ij} \tag{8}$$

and

$$\sum_{i\in S}\sum_{j\in W^*\backslash T}\widehat{p}_{ij}-\sum_{i\in T}\sum_{j\in W^*\backslash T}\widehat{p}_{ij} \tag{9}$$

Since the sum of the left hand sides of (3) and (4) is equal to the sum of the left hand sides of (1) and (2), we obtain:

$$\begin{aligned}
&\mathbf{P}\left(E^*\backslash S\cup T,W^*\backslash T\cup S\right)-\mathbf{P}\left(E^*,W^*\right)\\
=\;&\sum_{i\in S}\sum_{j\in W^*\backslash T}\widehat{p}_{ij}-\sum_{i\in S}\sum_{j\in E^*\backslash S}\widehat{p}_{ij}+\sum_{i\in T}\sum_{j\in E^*\backslash S}\widehat{p}_{ij}-\sum_{i\in T}\sum_{j\in E^*\backslash T}\widehat{p}_{ij}\\
&+\sum_{i\in T}\sum_{j\in E^*\backslash S}\widehat{p}_{ij}-\sum_{i\in S}\sum_{j\in E^*\backslash S}\widehat{p}_{ij}+\sum_{i\in S}\sum_{j\in W^*\backslash T}\widehat{p}_{ij}-\sum_{i\in T}\sum_{j\in W^*\backslash T}\widehat{p}_{ij}\\
=\;&2\left(\sum_{i\in S}\sum_{j\in W^*\backslash T}\widehat{p}_{ij}-\sum_{i\in S}\sum_{j\in E^*\backslash S}\widehat{p}_{ij}+\sum_{i\in T}\sum_{j\in E^*\backslash S}\widehat{p}_{ij}-\sum_{i\in T}\sum_{j\in E^*\backslash T}\widehat{p}_{ij}\right)>0
\end{aligned}$$

This contradicts our assumption that (E^*,W^*) is a maximizer of $\mathbf{P}$ and the proof is complete $\square$

The following example shows that there could be a strong Nash equilibrium that does not maximize the function $\mathbf{P}$.

Consider the case with 4 players with all s_i equal to one, the entries p_{ij} are given by the following matrix:

$$\begin{pmatrix} 0 & 2 & 0 & -1000 \\ 2 & 0 & 1000 & 0 \\ 0 & 1000 & 0 & 1 \\ -1000 & 0 & 1 & 0 \end{pmatrix}$$

Players 1 and 4 always avoid each other while players 2 and 3 always stay together. The only degree of freedom is either player 1 or 4 will join the coalition $\{2,3\}$. This gives rise to two partitions, $(\{1,2,3\},\{4\})$ and $(\{1\},\{2,3,4\})$. Both are strong Nash equilibria but only the first one maximizes the sum of the utilities.

The theoretical and empirical reasons to focus on the partition(s) that maximize the potential function $\mathbf{P}$ have been discussed in the the theory section Besides this motivation, it is also worthwhile to point out an interesting consequence of these considerations from an algorithmic/computational perspective. When $k = 1$, $1-$stable partitions (i.e. Nash equilibria) coincide with $1-$local maximizers. From an algorithmic point of view, this suggests the use of local search algorithms to find the local maximizers. When we move from $k = 1$, to $k \geq 2$, the size of the local neighborhood increases. This increases the complexity of the search but the basic idea remains the same. These issues are discussed further in the following appendix.

D Computational Issues

After demonstrating the existence of strong Nash equilibrium for our class of games, we now turn to the computational aspects attached to the determination of equilibria and the algorithms to perform this task.

The MaxCut problem can be equivalently formulated as the following integer quadratic program:

$$Max \sum_{i=1}^{n} \sum_{j=i+1}^{n} s_i s_j d_{ij}(1 - y_i y_j)$$

under the constraints

$$y_i \in \{-1, 1\} \text{ for all } i = 1, ..., n.$$

The MaxCut problem has long been known to be NP-complete. In absence of efficient algorithms for NP-hard maximization problems, a typical approach to solving such a problem would be to find a $\rho-$approximation algorithm. The latter is a polynomial-time algorithm that delivers a solution, whose value is at least ρ times the optimal value of the problem.

(The constant ρ is sometimes called the performance guarantee of the algorithm). The term "$\rho-$approximation algorithm" is also used for randomized polynomial-time algorithm that yields solutions whose expected value is at least ρ times the optimum. While we obtain an exact solution to our MaxCut problem, the seminal insight of Goemans and Williamson (1995)'s approximation algorithm is a key feature of the algorithms that we use (discussed in the next subsection). It is thus instructive to detail their approach. Goemans and Williamson (1995) present a randomized approximation algorithm based on a relaxation of the above problem, which replaces it with the problem[36]

$$Max \sum_{i=1}^{n} \sum_{j=i+1}^{n} s_i s_j d_{ij}(1 - \langle v_i, v_j \rangle) \qquad ((*))$$

under the constraints

$$v_i \in S_n \text{ for all } i = 1, ..., n,$$

where S_n is the $n-$dimensional unit sphere. Let $\{v_1^*, v_2^*, ..., v_n^*\}$ be an optimal set of vectors solution of the problem (*). Let r be a vector uniformly distributed on S_n and $S \equiv \{i \in N : \langle r, v_i^* \rangle \geq 0\}$. Let W be the value of the random cut produced in this way and $E[W]$ be its expectation. Goemans and Williamson (1995) demonstrate that for any set of vectors $\{v_1, v_2, \ldots, v_n\}$ such that $v_i \in S_n$ for all $i = 1, ..., n$:

$$E[W] \geq \lambda \sum_{i=1}^{n} \sum_{j=i+1}^{n} s_i s_j d_{ij}(1 - \langle v_i, v_j \rangle)$$

where

$$\lambda = Min_{0 \leq \theta \leq \pi} \frac{2}{\pi} \frac{\theta}{1 - \cos\theta} > 0.878$$

This algorithm has a performance guarantee of λ. To show that this algorithm can be implemented in polynomial time, using the Cholesky decomposition, they show that problem (*) is equivalent to the semi-definite program

$$Max \sum_{i=1}^{n} \sum_{j=i+1}^{n} s_i s_j d_{ij}(1 - v_{ij})$$

[36]Indeed, we can interpret the constraint $y_i \in \{-1, 1\}$ as restricting y_i to be a $1-$dimensional vector of unit norm. Some interesting relaxation can be defined by allowing y_i to be a multidimensional vector v_i of unit Euclidean norm. Since the linear space spanned by the vectors v_i has dimension at most n, it can be assumed that these vectors belong to $\mathbb{R}^m$ (or $\mathbb{R}^m$ for some $m \leq n$)

under the constraint that v is an $n \times n$ symmetric positive semi-definite matrix such that $v_{ii} = 1$ for all $i = 1, ..., n$.

D.1 Sketch of algorithms

D.1.1 Exact solution of optimum (branch and bound algorithm)

(Rodrigues de Sousa et al., 2019; Anjos et al., 2013)

1. Input pairwise payoffs matrix and construct graph and corresponding triangle and clique inequalities.
2. Solve convex relaxation of problem. Solution is the upper bound.
3. Impose the most likely to be violated clique and triangle inequalities to search for a tighter upper bound.
4. Use the multiple operator heuristic (MOH; (Ma and Hao, 2017)) to find a lower bound. The lower bound is always a feasible solution. If the lower bound is equal to the upper bound, then stop. If not, then commence branching.
5. Use the initial upper and lower bounds to form the root of the tree.
6. Select the node with the highest upper bound and remove it from the tree. If its lower bound exceeds the incumbent maximum value, update the incumbent solution. Delete (cut) all nodes whose upper bounds are lower than the incumbent max value.
7. The next pair to form a new node is picked using the least-decided rule: Create two subproblems: one that binds the pair of countries to be in one bloc and one that binds them to be in separate blocs.
8. Obtain upper and lower bounds of subproblems as above.
9. Repeat (starting at step 6) until there are no nodes left (hopefully in a reasonable amount of time). The end incumbent solution is the solution.

D.1.2 The search for other Nash Equilibria

(Palagi et al., 2012)

1. Input pairwise payoffs matrix and construct graph.
2. Apply GW approximation.

3. Use local search algorithm.

4. Repeat 10,000 times.

D.1.3 Checking k-stability (written by Alexander Petrov)

1. Take set of NE from above, 1-stable.

2. For $k \geq 2$, check for k-coalition most 'conducive-to-deviation' for each country.

3. If coalition satisfies condition, then NE is not k-stable.

4. If k-stable, then repeat for $k + 1$.

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