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Ethnic diversity and economic development

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Abstract

This paper analyzes the role that different indices and dimensions of ethnicity play in the process of economic development. Firstly, we discuss the advantages and disadvantages of alternative data sources for the construction of indices of religious and ethnic heterogeneity. Secondly, we compare the index of fractionalization and the index of polarization. We argue that an index of the family of discrete polarization measures is the adequate indicator to measure potential conflict. We find that ethnic (religious) polarization has a large and negative effect on economic development through the reduction of investment and the increase of government consumption and the probability of a civil conflict.
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1. Introduction

In recent years, there has been increasing interest in the economic consequences of ethnic heterogeneity. In many situations, ethnic polarization generates conflicts that could eventually lead to political instability and civil wars (CW), with long-lasting economic effects. In other cases, the potential conflict represented by an ethnically polarized society

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can affect negatively the rate of investment and induce rent-seeking behavior that increases public consumption. These situations—armed conflicts, reduced investment, or higher government consumption—have been shown to have a negative effect on economic development (Barro, 1991; Tavares and Wacziarg, 2001).

This paper analyzes the effects of ethnic heterogeneity on economic development. For this purpose, we compare the empirical performance of different dimensions of ethnicity as well as alternative indices to measure diversity and potential conflict. There is a growing body of literature on the relationship between ethnic diversity, the quality of institutions, and economic growth. Mauro (1995) shows that a high level of ethno-linguistic diversity implies a lower level of investment. Easterly and Levine (1997) show that ethnic diversity has a direct negative effect on economic growth. La Porta et al. (1999) suggest that ethnic diversity is one of the factors explaining the quality of government. Bluedorn (2001), based on the study of Easterly and Levine (1997), presents empirical evidence of democracy's positive role in ameliorating the negative growth effects of ethnic diversity. All these studies use the index of ethnolinguistic fractionalization (ELF), also called ELF, calculated using the data of the Atlas Narodov Mira (Taylor and Hudson, 1972).

More recently, the economic research agenda on ethnic diversity has studied the relationship between religious diversity, democracy, and economic development. Barro (1997a,b) includes the proportion of population affiliated to each religious group as explanatory variables for the level of democracy. Tavares and Wacziarg (2001) use the index of ethnolinguistic fractionalization and religious dummies to examine the indirect channels for the effect of democracy on growth. With a few exceptions, they find that the religious dummies have no effect on the basic channels. Collier and Hoeffler (2002) find that religious fractionalization has no effect on the risk of conflict. Alesina et al. (2003) argue that while ethnic and linguistic fractionalization have a negative effect on the quality of government, religious fractionalization has no effect. They also find that religious diversity has no effect on growth, using the basic regression of Easterly and Levine (1997). Therefore, the general result is that religious diversity, measured as a fractionalization index, has no effect on economic growth or quality of government.

However, both ethnolinguistic and religious diversity can potentially have a strong conflict dimension. For this reason, we propose a new measure of potential conflict in heterogeneous societies based on an index of polarization instead of the traditional fractionalization index. Several authors have argued theoretically in terms of "polarization" but used as an empirical proxy the index of fractionalization. We argue that polarization and fractionalization are two different, and on occasion, conflicting concepts. We also show how to derive our polarization index as the representation of the total resources devoted to lobbying in a simple rent-seeking model.

Given the importance of the conflict dimension of ethnic and religious diversity, we explore empirically the indirect effects of ethnolinguistic and religious polarization on growth through their impact on civil wars, investment, and government consumption. Civil wars are tragic events for economic development having a long-run impact on income per capita. Consistent with previous research, we find that religious fractionalization has no direct effect on economic growth, while ethnolinguistic fractionalization does.

However, we find no strong empirical evidence to argue that the negative effect of fractionalization on growth is due to its impact on the indirect channels above mentioned. By contrast, we do find an important effect of polarization in the explanation of economic development, through its impact on civil wars, the rate of investment, and the proportion of government consumption over GDP. In fact, the indirect effect of polarization on economic growth is as large as the direct effect of fractionalization.

The paper is organized as follows. Section 2 describes the sources for the data on ethnolinguistic and religious diversity. Section 3 introduces the indices of fractionalization and polarization and compares their basic properties. Section 3 also shows how to derive the discrete polarization index from a simple rent-seeking model. Section 4 reports the empirical results obtained by using the alternative indices and dimensions of ethnicity. Section 5 concludes.

2. The measurement of religious and ethnic diversity

In this section, we present the criteria for the selection of the basic data on religious and ethnic diversity for a large sample of countries. We describe the alternative sources available as well as their differences and relative strengths and weaknesses. We should initially notice that the measurement of ethnic diversity is a very difficult task. Characteristics like "race" or "color" are, to some extent, socially constructed. For instance, Williamson (1984)[1] points out that in the antebellum South "there were some people that were significantly black, visibly black, known to be black, but by the law of the land and the rulings of the courts had the privileges of whites". We do agree that racial and ethnic identities are, to some extent, fluid. However, there are not good data on the degree of "fluidity" of races and ethnic groups with the exception of a few countries and cases. Because we want to study the effect of ethnic diversity in a large set of countries, we adopt a definition of ethnicity based on a purely biological or genetic point of view.[2]

2.1. Sources for the measurement of religious diversity

One of the most cited sources of data for religious diversity across countries is Barret's (1982) **World Christian Encyclopedia (WCE)**, which provides information for a large cross-section of countries in 1970, 1975, and 1980. The WCE has several well-known shortcomings when dealing with data on religion.[3] For instance, this source does not compute the followers of Syncretic cults[4] in Latin American countries. In addition, it underreports, by comparison with national sources, the followers of Animist cults and

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[1] Quote taken from Bodenhorn and Ruebeck (2003).

[2] Even using this definition of ethnicity, it is very difficult to find good estimates of the size of ethnic groups in many countries.

[3] See L'État des Religions dans le Monde (1987) pages 7–9.

[4] Syncretic cults combine elements from different cults like Yourba, baKongo, and Catholic rites. These religions include Santeria, Voodoo, or Espiritismo.

primitive religions[5] in Sub-Saharan African countries. In some countries, particularly in Latin America and Sub-Saharan Africa, part of the population is affiliated with a large religion although they practice another religion. This is because the WCE counts as Christians people who follow authocton religions, like animism or syncretic cults, possibly because they have received baptism or because they live in a region with missions. However, this treatment is not consistent with Wilson (1972): magical ideas persist among some people of long-settled Christian areas. Following this approach, the followers of primitive religions should not be counted as Christians because primitive religions also identify a particular group.[6]

When compared to other sources of information on religions affiliation, the WCE data seem clearly biased, not surprisingly, toward Christian religion. For example, in the case of Zaire, the WCE reports a distribution of religions very similar to that of Spain or Italy. The distribution of religious groups reported by the WCE between 1970 and 1980 is quite stable in many countries. The countries where there is a change coincide with those with a high proportion of Animists, as reported by national sources, and the change usually implies an increase in the percentage of Christians. For all these reasons, we believe that the data from the WCE has to be cross-checked with other sources before using it to construct a religious indicator.

A second source for data on religious affiliation by countries is the **Encyclopedia Britannica (EB)** and, in particular, the **Britannica World Data (BWD)**. The EB provides statistical information on 220 countries including data on population, social indicators, agriculture, labor, manufacturing, trade, finance, transportation, etc. It also includes, as part of the social indicators, the religious distribution of the society. The BWD uses the "best available figures, which can be census data, membership figures of the churches concerned, or estimates by external analysts". However, it uses as the basic source the WCE and, therefore, it is subject to most of the same biases. There are several examples in the economic literature where the EB is used as the source to construct religious variables. Tavares and Wacziarg (2001) rely on it to construct dummy variables for the largest religion in each country. Recently, Alesina et al. (2003) used the EB data to construct an index of religious fractionalization.

A third source of data on religious diversity is **'l'État des Religions Dans le Monde"(ET)**. The ET contains information from the World Christian Encyclopedia, and then corrected using national sources. The ET considers explicitly the proportion of Animist followers (mainly in Sub-Saharan African countries) and the proportion of Syncretic cult followers (specially in Latin American countries).

There are two other sources of religious diversity that provide limited information on religious followers based on national sources: The Statesman's Yearbook, and the World Factbook. The proportions of Animist and Syncretic cults followers reported by these two

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[5] Many primitive religions are associated with animism, the belief that everything (rocks, rivers, plants, animals, and so forth) has an "anima", or spirit, that can help or hurt people, including the souls of the dead. Animists frequently convert animals or stars in Gods and practice astrology and witchcraft using magic, talismans, or charms.

[6] In fact, as discussed later, other data sources are very careful about categorizing followers of primitive religions.

Table 1
Comparison of the treatment of Animist and Syncretic cults in different sources

	Large religions	Animists cult	Syncretic cult
World Christian Enc. (WCE)	YES	only some countries	NO
Statesman's Yearbook (ST)	sometimes	very detailed	sometimes
World Factbook (WF)	often	YES	NO
L'Etat des Religions (ET)	YES	YES	YES

sources are very similar to the proportions reported by the ET. **The Statesman's Yearbook (ST)** is not as complete as the ET or the WCE but it is totally based on national sources. For this reason, it gives very detailed information on Animist followers in African countries. For the ST, someone who has received baptism, but practices a Syncretic cult, is counted as a Syncretic cult follower. **The World Factbook (WF)** is more detailed than the ST, but less than the ET or the WCE. It also gives information on the proportions of Animist and traditional religions mainly in African countries. However, it does not consider the Syncretic cults in Latin American countries.

Table 1 summarizes the basic differences among the main sources of data on religion.

Some examples may help to illustrate the main differences among these data sources. First, let us consider two cases of Sub-Saharan Africa: Angola and Burundi. The WCE reports that 80.5% of Angola's population are Christians, and only 19,4% are Animist. However, the ET and the ST report that Angola has 64% of Christians followers, and 34% of Animists. In Burundi, the WCE reports that 74% are Christians and 25% are Animist, while the ET and the ST report that 60% are Christians and 39% are Animist. Secondly, let us consider two cases of Latin America: Bolivia and Santo Domingo. The WCE reports that in Bolivia 95,3% of the population are Christians, while the ET and the ST reports that only 43% are Christians and around 40% are followers of Syncretic traditional religions. In the Dominican Republic, the WCE reports that 98,9% of population are Christians, while the ET and the ST report that only 48,9% are Christians and 51% are followers of Syncretic cults.

We construct our data set using two sources of information. Our primary source is **L'Etat des Religions Dans le Monde (ET)** because, as we argued before, it provides information on the proportions of followers of Animist and Syncretic cults which we believe are important for the calculation of indices of diversity. Our secondary source is **The Statesman's Yearbook (ST)** which is based on national sources. In most of the countries, the two sources coincide. The great advantage of the ST is its extremely detailed account of Animist religions.[7] According to the common classification of religions adopted by all the sources considered above (WCE, ET, and ST), we consider the following religious groups: **Animist religions, Bahaism, Buddhism, Chinese Religion, Christians, Confucianism, Hinduism, Jews, Muslims, Syncretic cults, Taoism, and other religions**.[8]

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[7] In some special cases, we used other national sources in order to improve the reliability of this information and reconcile small differences across sources.

[8] Include small collectives as the "black church".

2.2. Data on ethnolinguistic diversity

From a descriptive perspective, there are six distinct characteristics of an individual that matter for ethnolinguistic classification. Two of them (race and color) are inherited whereas two (culture and language) are learned. The fifth characteristic (the ethnic origin) is more difficult to define and refers to the main name by which people are known. Finally, the sixth component (nationality) may be inherited or acquired and, by contrast with the other characteristics, can be changed. From these six characteristics, the ones that are clearly defined and more useful for classification purposes are race and language.[9] However, the fact that language and race overlap in many instances complicates the task of generating an uncontrovertible classification.

As in the case of religion, there are several possible sources of data for ethnolinguistic diversity across countries. One of the most detailed sources of data on ethnic diversity is the **World Christian Encyclopedia (WCE)** which presents a classification that is neither purely racial nor linguistic nor cultural, but ethnolinguistic. The WCE classification is based on the various extant schemes of nearness of languages plus nearness of racial, ethnic, cultural, and cultural-area characteristics.[10] It combines race, language, and culture in a single classification, denominated ethnolinguistic, that includes several progressively more detailed levels: 5 major races, 7 colors, 13 geographical races and 4 subraces, 71 ethnolinguistic families[11], 432 major peoples[12], 7010 distinct languages, 8990 subpeoples, and 17,000 dialects. It is difficult to be consistent in the classification of ethnic groups at the global scale because in different countries their respective censuses have different emphasis on each dimension of ethnicity. The main criteria adopted by the WCE in ambiguous situations is the answer of each person to the question: "What is the first, or main, or primary ethnic or ethnolinguistic term by which persons identify themselves, or are identified by people around them?".

The WCE details for each country the most diverse classification level. In some countries, the most diverse classification may coincide with races, while in others, could be subpeoples. Vanhanen (1999) argues that it is important to take into account only the most important ethnic divisions and not all the possible ethnic differences or groups. He uses an informal measure of genetic distance to separate different degrees of ethnic cleavage. The proxy for genetic distance is "the period of time that two or more compared groups have been separated from each other, in the sense that intergroup marriage has been very rare. The longer the period of endogamous separation the more groups have had time to differentiate." Following Vanhanen (1999) and most of the literature, we consider the ethnolinguistic families as the relevant level of disaggregation. Therefore, for the countries

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[9] Notice that, strictly speaking, when we described in the previous section the classification of religions, we already considered a cultural characteristic.

[10] For more information, see the World Christian Encyclopedia (1982), pages 107–115. Because the ethnolinguistic classification is not based on religion, there is less concern than in the case of religious diversity about possible biases of the WCE in the proportion of different groups.

[11] An ethnolinguistic family refers to an ethnic or racial group speaking its own language or mother (primary) tongue, excluding near variants and dialect.

[12] These correspond to subfamilies or ethnic cultural areas.

in which the WCE reports proportions of groups of peoples or subpeoples, we aggregate them into ethnolinguistic families.[13]

Another source of data on ethnic diversity is the **Encyclopedia Britannica (EB)** which uses the concept of geographical race.[14] However, the EB does not provide a precise explanation of the criteria to separate the different groups, nor does it describe any concept of cultural distance. A third source of data on ethnolinguistic diversity is provided by the Atlas Narodov Mira (1964), the result of a large project of the Department of Geodesy and Cartography of the State Geological Committee of the old USSR. The classification adopted by the Atlas is based on geographical ethnolinguistic groups. For this reason, in some countries, the Atlas classifies at the same level what we have called ethnolinguistic families and subgroups of those families (what the WCE refers as peoples), which are separated geographically.

2.3. Other sources of data on ethnic heterogeneity

Recently, several authors have proposed specific combination of basic sources on ethnic heterogeneity to construct indices of fractionalization. Fearon (2003) discusses conceptual and practical problems involved in constructing a cross-national list of ethnic groups and presents a database of ethnic and cultural fractionalization. His basic sources are the CIA's World Factbook that he compares with the figures in the Encyclopedia Britannica (EB) and the Library of Congress Country Study (LCCS). Fearon (2003) notices significant discrepancies between these sources, especially with the figures of the World Factbook for Latin American and African countries. He proposes to overcome these problems using national sources. This strategy is similar to the role of the WCE, which is totally based on national sources, in our own dataset.

Fearon (2003) goes one step forward and constructs a measure of cultural diversity, introducing measures of distances among groups. It is reasonable to think that the distance across all ethnic groups is not the same. However, the measurement of such distances is very difficult and, at times, somehow arbitrary. For these reasons, Fearon (2003) points out that the list he offers should be seen as a continual work in progress to be improved with more country specific expertise. As we argued before, we do not consider specific distances across groups in out dataset. We believe that the measurement error can be reduced by following Vanhanen's (1999) criterion which identifies the relevant ethnic divisions.

Alesina et al.(2003) distinguish between ethnic, linguistic, and religious groups. The descriptive statistics of the ethnic measure of Alesina et al. (2003) look broadly similar to the ethnic measure of Fearon (2003) despite the different criteria in data gathering and index construction. The data on languages and religions of Alesina et al. (2003) are based exclusively on the information in the Encyclopedia Britannica. The main criterion in their

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[13] We cross-checked the proportion of the largest ethnolinguistic families with Vanhanen (1999) and the World Factbook when there was need for aggregation of ethnolinguistic peoples into ethnolinguistic families.

[14] In the next section, we show that the indices constructed using the EB and the WCE have a high correlation and produce similar results.

construction of the list of ethnic groups is to reach the highest level of disaggregation[15], which requires the use of multiple sources of data. Alesina et al. (2003) used the information in the Encyclopedia Britannica (2001), the CIA (2000), Levinson (1998), and Minority Rights Group International (1997). The main differences between these data and our data have to do with the level of disaggregation of ethnic groups. While we follow Vanhaven in order to identify the relevant level of disaggregation, Alesina et al. (2003) capture the more disaggregated level.[16]

3. Measuring ethnic diversity: polarization versus fractionalization

We have identified different dimensions or concepts of ethnicity and sources of data. Once a researcher has decided what dimension, or dimensions, of ethnicity to analyze, the next step is to decide what kind of indicator to use. One way to summarize the information is to construct a dummy that captures the largest ethnic group in each country, or the percentage of the largest ethnic group or the percentage of the largest ethnic minority in the country. However, if we are interested in measuring religious and ethnic heterogeneity within countries, these measures are far from perfect. Researchers have generally used two types of synthetic indices in order to capture religious and ethnic diversity: indices of fractionalization and indices of polarization. The choice of the most appropriate index depends on the purpose of the study, the dimension analyzed, and the effect that one wants to capture. In this section, we discuss the selection of a single index to capture religious and ethnic heterogeneity in order to analyze the relationship between potential ethnic conflict and economic development.

3.1. The index of fractionalization

Most of the empirical literature on ethnic diversity uses the index of fractionalization. Perhaps the most famous and widely used is the index of ethnolinguistic fractionalization, also called ELF, constructed by Taylor and Hudson (1972) using the data of the Atlas Nadorov Mira. A fractionalization index, *FRAC*, is defined as

$$FRAC = 1 - \sum_{i=1}^{N} \pi_i^2 \tag{1}$$

where, if we consider religious (or ethnic) diversity, π_i is the proportion of people who professes religion i (or belongs to ethnic group i). Basically, this indicator can be interpreted as measuring the probability that two randomly selected individuals in a country will belong to different ethnolinguistic groups. Therefore, FRAC increases when the number of groups increases.

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[15] Alesina et al. (2003), page 160.

[16] The next section compares the correlation of indices of fractionalization and polarization constructed using alternative sources of data.

3.2. Polarization indices

Another class of indices is the family of polarization measures. Montalvo and Reynal-Querol (2002) used an index that measured the normalized distance of a particular distribution of ethnic and religious groups from a bimodal distribution, originally constructed in Reynal-Querol (1998).

$$Q = 1 - \sum_{i=1}^{N} \left(\frac{0.5 - \pi_i}{0.5} \right)^2 \pi_i = 4 \sum_{i=1}^{N} \sum_{j \neq i} \pi_i^2 \pi_j$$

There are at least two different approaches to justify the appropriateness of the Q index in the context of polarization and conflict. The Q index can be seen as a polarization measure related to the class of measures proposed by Esteban and Ray (1994). The basic idea of the axiomatic approach in Esteban and Ray (1994) is to conceptualize an index closely related to the concept of social tensions. This is useful in our context because, as we argued before, ethnic and religious differences may generate very conflictive situations. The measure of polarization of Esteban and Ray (1994) is

$$P(\pi, \mathbf{y}, k, \alpha) = k \sum_{i=1}^{N} \sum_{j \neq i} \pi_i^{1+\alpha} \pi_j |y_i - y_j|$$

where the π's are the sizes of each group in proportion to the total population, the term $|y_i - y_j|$ measures the distance between two groups, i and j, and α and k are two parameters. If we want to calculate ethnic (religious) polarization using the index P, we need to calculate the distance between different ethnic (religious) groups, which is a very difficult task compared to what happens in the case of income or wealth. For this reason, in order to obtain a measure of ethnic (religious) polarization, Montalvo and Reynal-Querol (2002) assume that the absolute distance between two groups is equal. Therefore, because distances are equal among all groups, the polarization measures only depend on the size of the groups.[17] The discrete polarization measure can be written as:

$$DP(\alpha, k) = k \sum_{i=1}^{N} \sum_{j \neq i} \pi_i^{1+\alpha} \pi_j$$

Therefore, for each possible α, we have a different DP measure. For this measure to be a proper indicator of polarization, it has to fulfil two basic properties[18]:

(a) If we merge the two smallest groups into a new group, the new distribution is more polarized than the original one.

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[17] The fractionalization index with distances across groups measured in R is simply the traditional Gini index (see Montalvo and Reynal-Querol, 2002).

[18] These conditions are obtained by analogy with the ones exposed in Esteban and Ray (1994). See Montalvo and Reynal-Querol (2002) for a detailed explanation of these conditions.

(b)   If we shift population mass for one group equally to other two groups, which have equal size, then polarization increases.

Montalvo and Reynal-Querol (2002) have shown that the only value of α admissible if the DP measure has to satisfy the basic properties of polarization is $\alpha=1$, and, therefore, DP(1,k). Notice that when $\alpha=1$, the only k that normalize DP between 0 (minimum) and 1 (maximum) is $k=4$[19]. Given these conditions the only discrete polarization measure that satisfies the properties of polarization and is normalized between 0 and 1 is DP(1,4). This index coincides with the Q measure of polarization used by Montalvo and Reynal-Querol (2002).

Rent-seeking models provide a second justifications for using the Q index in the context of conflicts. From a theoretical perspective, rent-seeking models point out that social costs are higher and social tensions emerge more easily when the population is distributed in two groups of equal size. In this section, we show that the Q index can be derived from a simple model of rent-seeking. Let us assume that the society is composed by N individuals distributed in M groups. Let us normalize $\Sigma n_i=N=1$. Then, π_i, the proportion of individuals in group i, will be equal to n_i, $\pi_i=n_i$. Society chooses an outcome over the M possible issues. We identify issue i as the outcome most preferred by group i. We think of each outcome as a pure public good for the group members. Define u_{ij} as the utility derived by a member of group i if issue j is chosen by society. As we want to describe a pure contest case, then $u_{ii}>u_{ij}=0$ for all i, j with $i\neq j$. Therefore, individuals will only spend resources in their most preferred outcome, i.

Because of the rent-seeking nature of the model we assume that agents can try to alter the outcome by spending resources in favor of their preferred outcome. Therefore, there will be M possible outcomes depending on the resources spend by each of the M groups. Let us define x_i as the effort or the resources expended by an individual or group i[20]. The total resources devoted to lobbying are $R = \sum_{i=1}^{M} \pi_i x_i$. Following this interpretation, R can be thought of as a measure of the intensity of social conflict. The cost of resources, or effort, x for each individual is $c(x)$. We are going to assume that the cost function, or effort disutility, is quadratic[21], $c(x)=(1/2)x^2$.

The basic element of any rent-seeking model is the contest success function, which defines the probability of success. We are going to use the traditional ratio form for the contest success function and define p_j as the probability that issue j is chosen, which depends on the resources spent by each group in favor of each outcome $j=1, \ldots, M$, provided that $R>0$.

$$p_j = \frac{\pi_j x_j}{\sum_{j=1}^{M} \pi_j x_j} = \frac{\pi_j x_j}{R}$$

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[19]   The fractionalization index ranges between 0 (minimum) and 1 (maximum).

[20]   We assume, as in Esteban and Ray (1999), that the individuals in each group act in a coordinated fashion. Therefore, we ignore the possibility of free riding within each group.

[21]   As in Esteban and Ray (1999).

This is a particular case of the ratio form of the contest success function[22]. Then, each member of group i has to decide the amount of resources s/he wants to expend in order to maximize the expected utility function taken into account that s/he does not care about nonpreferred outcomes and the contest success function is of the ratio form.

$$Eu_i = \sum_{j=1}^{M} p_j u_{ij} - c(x_i) = \sum_{j=1}^{M} p_j u_{ij} - (1/2)x_i^2 = p_i u_{ii} - (1/2)x_i^2$$

subject to $p_j = \pi_j x_j / R$. As we assume a pure contest case and, $u_{ij}=0$ for all $j \neq i$, and at least one group expend positive resources, $x_j > 0$, for some $j \neq i$, the first-order conditions that solve the problem are

$$\pi_i^2 (u_{ii} - u_{ii} p_i) = \pi_i x_i R$$

Adding all the first-order conditions, we obtain the following expression:

$$\sum_{i=1}^{M} \pi_i^2 (u_{ii} - u_{ii} p_i) = R^2$$

In the pure contest case, the individuals only have a positive utility from their most preferred issue. Say that the utility $u_{ii}=k$

Therefore

$$R^2 = \sum_{i=1}^{M} \pi_i^2 (k - k p_i)$$

Proposition 1. *If there are only two groups the normalize (squared) total cost can be written as $R^2 = 1 - \sum_{i=1}^{2} \left(\frac{0.5 - \pi_i}{0.5} \right)$ which is the Q index of polarization.*

Proof. It is easy to show that if $M=2$ then the resources spend by each individual of any group are the same, $x_1 = x_2$, therefore, $p_i = \pi_i$.

Therefore

$$R^2 = \sum_{i=1}^{2} \pi_i^2 (k - k\pi_i) = \sum_{i=1}^{2} \pi_i (k\pi_i - k\pi_i^2) = \sum_{i=1}^{2} \pi_i (1 - 1 + k\pi_i - k\pi_i^2)$$

$$= \sum_{i=1}^{2} \pi_i (1 - (1 - k\pi_i + k\pi_i^2)) = \sum_{i=1}^{2} \pi_i \left(1 - k \left(\frac{1}{k} - \pi_i + \pi_i^2 \right) \right)$$

$$= \sum_{i=1}^{2} \pi_i - \sum_{i=1}^{2} k \left(\frac{1}{k} - \pi_i + \pi_i^2 \right) \pi_i = 1 - \sum_{i=1}^{2} k \left(\frac{1}{k} - \pi_i + \pi_i^2 \right) \pi_i$$

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[22] In general, the ratio form of the contest success function takes the form $p_1/p_2 = (x_1/x_2)^z$ where z defines if there are diminishing returns ($z \leq 1$) to competitive efforts (x) or there are increasing returns ($z > 1$). In our case, we set $z=1$.

As R is a measure of the total resources spent, or effort, for lobbying purposes, then it can be interpreted as an index of (potential) conflict. Notice that, for $k=4$, this index is normalized between 0 and 1, and can be rewritten as

$$R^2 = 1 - \sum_{i=1}^{2} 4\left(\frac{1}{4} - \pi_i + \pi_i^2\right)\pi_i = 1 - \sum_{i=1}^{2} \left(\frac{0.5 - \pi_i}{0.5}\right)^2 \pi_i$$

which is precisely the Q index.   □

Proposition 2. *If there are M groups of equal size[23] $n_1=....=n_M$, the normalized (squared) total cost can be written as $R^2 = 1 - \sum_{i=1}^{M} \left(\frac{0.5-\pi_i}{0.5}\right)^2 \pi_i$*

Proof. Because all the groups have the same size then $p_i=\pi_i$.
Therefore

$$R^2 = \sum_{i=1}^{N} \pi_i^2(k - k\pi_i) = \sum_{i=1}^{N} \pi_i\left(k\pi_i - k\pi_i^2\right) = \sum_{i=1}^{N} \pi_i\left(1 - 1 + k\pi_i - k\pi_i^2\right)$$

For $k=4$ the index is normalized between 0 and 1.

$$R^2 = \sum_{i=1}^{N} \pi_i\left(1 - 1 + 4\pi_i - 4\pi_i^2\right) = \sum_{i=1}^{N} \pi_i\left(1 - \left(1 - 4\pi_i + 4\pi_i^2\right)\right)$$

$$= \sum_{i=1}^{N} \pi_i\left(1 - (1 - 2\pi_i)^2\right) = 1 - \sum_{i=1}^{N} \left[\frac{0.5 - \pi_i}{0.5}\right]^2 \pi_i$$

which is again the Q index.   □

We should notice that this derivation is constrained by many assumptions (pure contest and equal size groups) and, therefore, should be taken as an application that illustrates the relationship between the Q index and the rent-seeking literature. However, we should also point out that the usual derivation of Herfindahl's index[24] in the industrial organization literature uses a very constrained setup and relies strongly on the symmetry of the participants.

3.3. Fractionalization versus polarization

The relationship between social heterogeneity and social conflict is not an easy one. Initially, one could think that the increase in diversity increases the likelihood of social conflicts. However, this does not have to be the case. In fact, many researchers agree that the increase in ethnic heterogeneity initially increases potential conflict but, after some point, more diversity implies potential conflict. Horowitz (1985) argues that the relationship between ethnic diversity and civil wars is not monotonic: there is less violence in highly homogeneous and highly heterogeneous societies. Horowitz (1985)

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[23] Notice that, in the case of two groups, this condition was not needed.
[24] Herfindahl's index is equal to one minus the index of fractionalization.
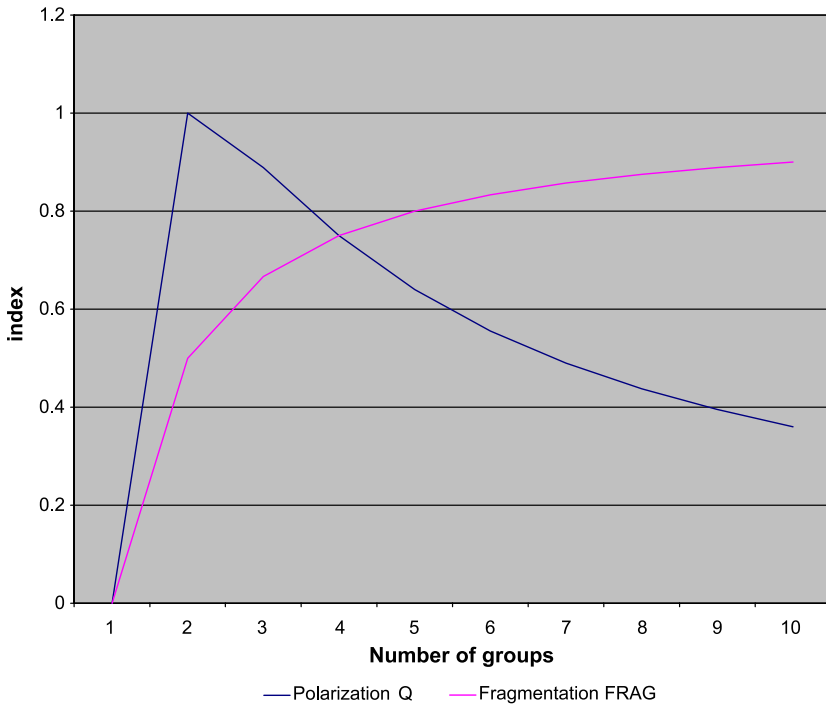
Fig. 1. Polarization and fractionalization as a function of the number of equal size groups.

points out that there are more conflicts in societies where a large ethnic minority faces an ethnic majority. If this is so, then the index of fractionalization is not the adequate measure to capture the likelihood of conflict or the intensity of potential conflict. Fig. 1 shows the graph of the fractionalization index and the polarization index as a function of the number of groups, when all of them have the same size. As we discussed in the previous section, while the polarization index has a maximum at two groups, the fractionalization index grows with the number of groups.

Table 2 compares the indices of religious fractionalization and polarization obtained from the alternative sources of data discussed in Section 2.[25] The religious fractionalization index EB is calculated using the data of the Encyclopedia Britannica. The WCE refers to the original data of the World Christian Encyclopedia. Our data, constructed using the ET and the ST, are included in the last column and row of the correlation matrices. Panel A in Table 2 shows the correlation of the fractionalization indices calculated with the alternative datasets. The religious fractionalization index using our data has a high correlation (0.84) with the WCE index but it also has a very high correlation with the fractionalization obtained using the EB data (0.76). Panel B of Table 2 shows the comparison of the correlation matrix of the religious polarization index using different

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[25] In the Appendix we present, by country, the indices of ethnic and religious fractionalization and polarization obtained using our preferred data sources (see Section 2).

Table 2
Comparing religious fractionalization and polarization using different sources

	EB	WCE	Ours
Panel A: Religious fractionalization			
EB	1	0.84	0.76
WCE		1	0.84
Ours			1
Panel B: Religious polarization			
EB	1	0.84	0.69
WCE		1	0.73
Ours			1

sources. In this case, we can see that, in general, the correlations are a little lower than in the case of the fractionalization index.

We can also check the effect of alternative sources of data for ethnic diversity. The correlation between the fractionalization index calculated using the original data of the Atlas Nadorov Mira (ELF) and the ethnolinguistic fractionalization obtained with our data (basically, the WCE) is 0.86[26]. The correlation of the index of ethnic fractionalization constructed using our data and the one obtained by Alesina et al. (2003) is also very high (0.83)[27]. The comparison of the ethnic polarization indices results in lower correlations. The correlation between the polarization index calculated using the original data from the Atlas Nadorov Mira and the one obtained using our ethnolinguistic dataset is 0.63[28]. The index of ethnic polarization calculated using the proportions of Alesina et al. (2003) has a correlation of 0.73 with our ethnic polarization index.

Up to this point, we have compared within fractionalization and polarization indices using data from different sources. However, are empirical measures of polarization and fractionalization very different when they are compared? In principlem, polarization and fractionalization should have a high correlation when the number of groups is two[29] but they may be very different if the number of groups is greater than two. Fig. 2 presents the relationship between ethnic polarization and ethnic fractionalization for a sample of 138 countries using our dataset on ethnolinguistic diversity. It shows that, for low levels of fractionalization, the relationship between ethnic fractionalization and ethnic polarization is positive and close to linear. However, for the medium range, the correlation is zero and for high levels of fractionalization the relationship with polarization is negative[30]. Fig. 3 presents the scatterplot of religious fractionalization versus religious polarization. It shows a similar pattern: for low levels of religious fractionalization the relationship with

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[26] If we only consider the data on linguistic diversity, the correlation between ELF and our fractionalization measure increases to 0.92.

[27] The correlation between ELF and the index of ethnic fractionalization of Alesina et al. (2003) is 0.76.

[28] The correlation increases to 0.70 if we compare it with our linguistic polarization index.

[29] Montalvo and Reynal-Querol (2002) show that the index of fractionalization and polarization are the same if the number of groups is 2.

[30] The figure looks very similar for any source of data on ethnic diversity (figures upon request).
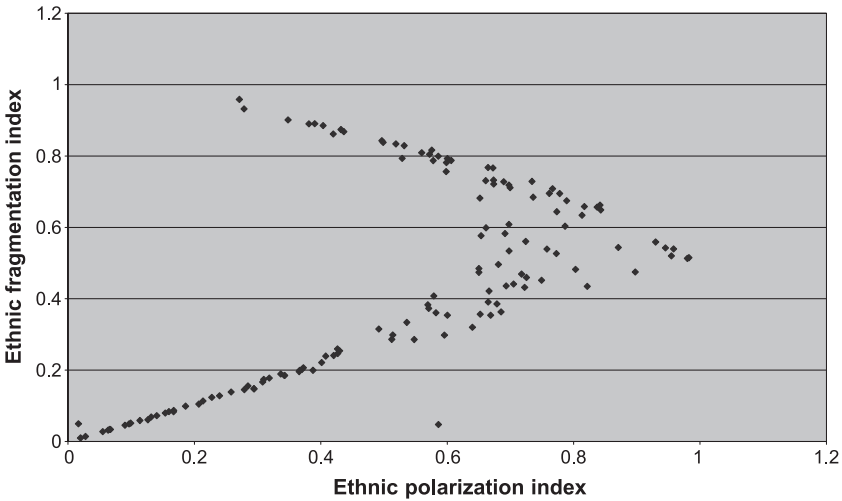
Fig. 2. Ethnic polarization versus fractionalization. Source: WCE.

polarization is positive and close to linear. However, for intermediate and higher levels of religious fractionalization the relationship is zero. Therefore, the correlation is low when there is high religious heterogeneity, which is the interesting case.

4. The empirics of ethnic diversity, conflict and growth

In this section, we discuss the empirical performance of indices of ethnic fractionalization and polarization. Most of the empirical applications have used the index
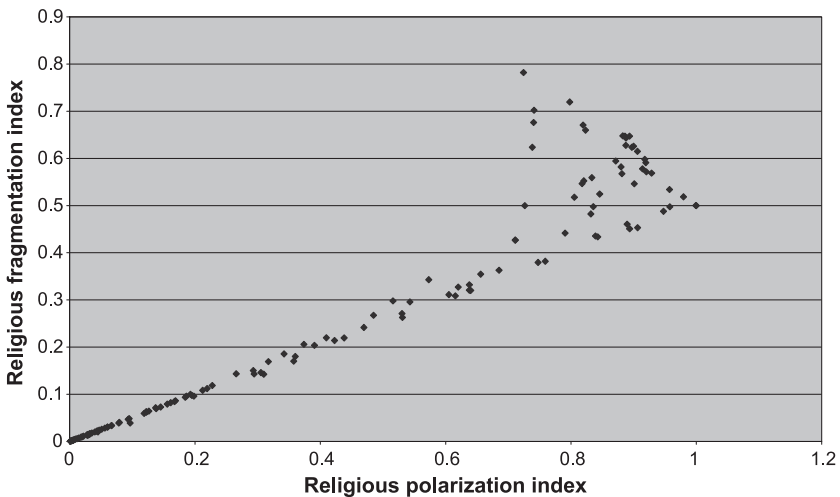
Fig. 3. Religious fractionalization versus polarization. Source: ET.

of fractionalization as a measure of ethnic and religious diversity. In particular, the use of ELF is widespread in recent empirical studies on the relationship between ethnic diversity and growth. Mauro (1995) finds a negative and significant correlation between ELF and institutional efficiency and, in particular, corruption. Easterly and Levine (1997) use this variable to show how African nations' unusually high linguistic fractionalization explains a significant part of their poor policies and slow growth. The inclusion of ethnolinguistic fractionalization in growth regressions modestly weakens the significance of the dummy for Africa. Collier and Hoeffler (1998, 2002) include ELF to capture the level of ethnic diversity of a country and analyze its effect on civil wars. Alesina et al. (1999) construct a measure of ethnic divisions based on color differences as an ethnic variable. The functional form of the index is the same as the index of ethnolinguistic fractionalization but using data on color[31]. More recently, Alesina et al. (2003) construct ethnic and linguistic fractionalization indices and show that, opposite to what happen with religious fractionalization, they are likely to belong to the set of determinants of economic success defined in terms of output, the quality of policies, and the quality of institutions. Vigdor (2002) derives an interpretation for ethnic fractionalization effects based on a model of differential altruism, and reports the implications for empirical specifications.

Only very recently have several studies used a polarization index to measure ethnic heterogeneity. Reynal-Querol (2002) analyzes the religious dimension of ethnicity and its effect on ethnic civil war. The results show that religious polarization is a very important ethnic dimension in explaining ethnic civil wars. Montalvo and Reynal-Querol (2003), using the empirical specification of Mankiw et al. (1992), show that religious polarization is statistically significant while religious fractionalization turns out to be insignificant.

The purpose of this section is to analyze the effect of different dimension of ethnic diversity on economic development and to compare the empirical performance of fractionalization indices versus polarization. An increasing body of economic literature identifies a high degree of ethnic heterogeneity as a negative factor on growth. When there are social cleavages, there are frictions among social groups. When the society is divided by religious, ethnolinguistic, or race differences, tensions emerge along these divisions. Rent-seeking models show that the resources spent by the groups in order to obtain political influence (time, labor, etc.) can be considered as a social cost with a negative effect on economic growth because it implies a nonproductive use of these inputs. This clearly would reduce investment in the productive sector. Secondly, because religious and ethnic differences are important social cleavages, the social response to this heterogeneity could generate violence and civil war. In addition, even if this heterogeneity creates only the potential for conflict, it can affect growth negatively because instability and uncertainty also reduce investment. Moreover, the government will increase government consumption in order to mitigate potential conflict, which also has a negative effect on growth. As we argued before, the social cost generated by the rent-seeking behavior is maximum under a bimodal distribution. Mauro (1995) points out that ethnolinguistic fractionalization is a proxy for ethnic conflict and argues that this conflict may lead to political instability and, in extreme cases, to civil war. We believe that this effect cannot be captured by the index

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[31] They argue that color fractionalization in U.S. cities, metropolitan areas, and urban counties reduces expenditure in productive public services and increases rent-seeking expenditures.

of fractionalization and that it should be empirically calculated using the index of polarization Q. In order to support this claim, we should show that the polarization index explains better than the fractionalization index the effect of ethnic (religious) heterogeneity on investment, public consumption, and the likelihood of violent conflicts and civil wars.

For all the empirical exercises, we consider a sample of 138 countries and data from 1960 to 1989 organized in 5-year intervals.[32] To analyze the direct effect of religious and ethnic diversity on growth, we adopt the standard specification (Barro 1991)

$$GROWTH_{it} = \alpha + \beta LNGDP0_{it} + \sum \gamma_j X_{jit} + \delta_1 CW_{it} + \delta_2 POL_i + \delta_3 FRAC_i + u_{it} \tag{2}$$

where GROWTH is the growth rate of GDP per capita and LNGDP0 is the log of gross domestic product per capita in the initial year of each subperiod. The set of X values includes the ratio of real government consumption to real GDP (GOV), the number of revolutions (REVOLT) or coups (COUP) per year, the proportion of assassinations per million population (ASSASS), the absolute deviation of the PPP value of the investment deflator from the sample mean (PPDEV), the ratio of real domestic investment to GDP (INV), secondary-school enrollment rate (SEC) and primary-school enrollment (PRI). The sample covers the 138 countries in Barro-Lee (1994). They are organized in 5-year intervals from 1960 to 1989.

We add three variables to the basic growth regression: civil wars (CW), ethnic (religious) fractionalization (FRAC) and ethnic (religious) polarization (POL). Civil wars (CW) are traumatic episodes with a long-lasting effect on growth. Data on civil wars come from Doyle and Sambanis (2000). Doyle and Sambanis (2000) define civil war as an armed conflict with the following characteristics: "(a) it caused more than one thousand deaths; (b) it challenged the sovereignty of an internationally recognized state; (c) it occurred within the recognized boundary of that state; (d) it involves the state as a principal combatant; (e) it included rebels with the ability to mount organized armed opposition to the state; and (f) the parties were concerned with the prospects of living together in the same political unit after the end of the war".

Additionally, we include in the regression different variables to measure religious and/or ethnic diversity using fractionalization (FRAC) and polarization (POL) indices. In all the empirical exercises, we use the Barro and Lee (1994) dataset for the standard variables and our data for the ethnic and religious heterogeneity indices.

We also consider three indirect channels: the effect of ethnic/religious heterogeneity on investment, public consumption, and the incidence of civil wars. In order to avoid "variables fishing", we adopt the most common specifications in the literature for each of these variables.[33] The investment equation is specified as in Barro (1991) including civil wars (CW) among the political instability variables. The specification for government consumption follows Persson and Tabellini (1999) and includes the log of GDP per capita and ethnic diversity variables. The regression could also include the proportion of

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[32] There are many recent examples of estimation of growth regressions that consider each period as a different equation in a SURE. See for instance Barro (1997a,b). Easterly and Levine (1997) and Alesina et al. (2003) pool three decades and use also the SUR estimator.

[33] This was also the reason for choosing Barro's specification for the growth regression.

population over 65, openness or some measures related with the electoral system (Milesi-Ferretti et al., 2002). Because these variables are only available for a limited set of countries, we decided to avoid a large reduction in the sample size and use the level of democracy (DEMP3).[34]

Finally, to analyze the effect of ethnic diversity on civil wars, we adopt a specification that contains the set of common variables in recent studies on the causes of civil war (Collier and Hoeffler 1998; Montalvo and Reynal-Querol 2002; Fearon and Laitin, 2003). Following this criterion, the explanatory variables in the civil war equation include the initial log of GDP per capita, the log of population (LNPOP), an index of ethnic (religious) heterogeneity and the index of democracy (DEMP3). The inclusion of real GDP per capita captures the opportunity cost of rebellion. The population is interpreted as a measure of taxable capacity and a proxy for the cost of coordination. In addition, the common specification for civil wars includes ethnic heterogeneity as a measure of coordination problems. We argue that what matters for civil wars is ethnolinguisticc (religious) polarization and not fractionalization[35]. More diversity (fractionalization) could decrease the probability of conflict while polarization should increase it because coordination problems are smaller than with many groups. In fact, Collier and Hoeffler (1998) acknowledge that "the coordination cost would be at their lowest when the population is polarized between an ethnic group identified as the government and a second similarly sized ethnic group, identified with the rebels". However, they use as a proxy for ethnic heterogeneity the index of fractionalization instead of an index of polarization.

The estimation procedure for the direct channel (growth equation) and the indirect channels (investment, government consumption over GDP and civil wars) is the seemingly unrelated regression estimator (SURE)[36] common in recent empirical research on growth[37]. There is at least one issue that can potentially affect the estimation of the standard deviation of the parameters. The specification of civil wars follows a linear probability model which implies that at least the residuals from that regression will be heteroskedastic[38]. In order to deal with the issue of heteroskedasticity we calculate the standard errors using the sandwich formula instead of the usual estimator of the asymptotic variance of the seemingly unrelated regression estimates.

Table 3 shows the comparison of the effect of religious polarization (RELPOL) and religious fractionalization (RELFRAC) on growth, investment, the probability of civil

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[34] See Appendix I for a definition of this variable and the source.

[35] Montalvo and Reynal-Querol (2002) show that the effect of polarization on civil wars is robust to the inclusion of fractionalization and its square as well as the inclusion of a variable for ethnic dominance (the largest group larger than 45% and smaller than 90%).

[36] Notice that not instrumenting the endogenous variables in the estimation of the growth regression could generate inconsistent estimates. However, as pointed out by one referee, the SURE procedure is potentially less sensitive to specification mistakes than the three stages least-squares estimator, which we used in the working paper version of this article.

[37] See, for instance, Easterly and Levine (1997).

[38] The possibility that the predicted values of the variable civil war lie outside the unit interval is of less concern if we are interested in hypothesis testing. Heckman and MaCurdy (1985) propose a simultaneous equation linear probability model. They argue that, although it is possible to impose the constraint that predicted probabilities always lie in the unit interval, the procedure is unattractive in practice and only important if the final objective is forecasting. See also Heckman and Snyder (1997).

Table 3
The effect of religious heterogeneity SUR estimation for 5-year periods

Variables	Growth	INV	CW	GOV
C	0.70 (7.89)	0.14 (4.25)	0.48 (2.39)	0.23 (6.54)
LNGDP0	−0.066 (5.06)	0.04 (10.1)	−0.10 (4.31)	−0.01 (3.81)
INV	0.46 (3.60)			
SEC	0.00 (0.99)	0.00 (0.92)		
PRI	0.00 (0.82)	0.00 (3.05)		
GOV	−0.55 (4.32)	0.01 (0.18)		
REVOLT	−0.00 (0.43)	−0.00 (0.93)		0.00 (0.02)
ASSASS	−0.00 (1.67)	−0.00 (1.31)		−0.00 (0.44)
COUP	−0.01 (1.03)	−0.00 (0.20)		0.00 (1.30)
PISH		−0.05 (5.78)		
PPDEV	−0.02 (0.95)	0.01 (1.15)		
LNPOP			0.04 (3.49)	
DEMP3			0.07 (1.72)	−0.01 (2.28)
CW	−0.07 (2.74)	−0.03 (3.43)		−0.01 (0.73)
RELPOL	0.14 (0.95)	−0.08 (2.34)	0.63 (2.92)	0.19 (3.94)
RELFRAC	−0.22 (1.34)	0.14 (3.09)	−0.91 (2.72)	−0.24 (3.08)
Reg. Dum.	Yes		Yes	
R^2	0.31	0.53	0.13	0.28
OBS	448	448	448	448

Absolute t-statistics between parenthesis using a heteroskedasticity robust asymptotic variance estimator.
Reg. Dum.: Regional dummies (Safrica, Laam and Asiae). REL: religious. FRAC: fractionalization. POL: Polarization. Growth: growth rate of real GDP per capita. INV: ratio of real domestic investment to GDP. CW: civil war=1. GOV: ratio of real government consumption to GDP.

wars and government consumption. As already documented by some authors like Alesina et al. (2003), the null hypothesis of no direct effect of the index of religious fractionalization on growth cannot be rejected. We find that the index of religious polarization does not have a statistically significant direct effect on growth either. The rest of the variables have the expected sign on growth, including the coefficient of the regional dummy variables that we do not show for the sake of clarity[39].

However, religious polarization has the expected effect on the indirect channels: it decreases investment and increases the proportion of public consumption over GDP and the likelihood of a civil war[40] while the effect of religious fractionalization is the opposite to the expected. This means that, given a particular degree of polarization, more diversity increases the investment rate and decreases the ratio of government consumption over GDP and the probability of a civil war. In principle, an increase in fractionalization implies more difficulties of coordination and, conditional on polarization, it may imply a lower probability of civil wars.

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[39] In particular, column (3) shows, as reported in all the studies on civil wars, that the initial level of income per capita has a negative effect on the probability of civil wars while population has a positive effect. We also run all the regressions with a full set of time dummies in the regressions that pool data from the five-year periods. The basic results do not change.

[40] Notice that the estimation of the probability of civil wars is somewhat imperfect because we are using a linear probability model.

However, the results in Table 3 are difficult to interpret since the high degree of correlation between religious fractionalization and polarization (0.95) may create a problem of multicolinearity. In Table 4, we consider separately the effect of religious polarization, columns (1) to (4), and fractionalization, columns (5) to (8). The direct effect of religious heterogeneity on growth is again statistically insignificant. However, religious polarization has a negative effect on investment and a positive effect on government consumption and the likelihood of civil wars. By contrast,

Table 4
The effect of religious heterogeneity SUR estimation for 5-year periods

Variables	(1) Growth	(2) INV	(3) CW	(4) GOV	(5) Growth	(6) INV	(7) CW	(8) GOV
C	0.70	−0.11	0.40	0.21	0.70	−0.11	0.47	0.26
	(10.1)	(2.49)	(1.78)	(6.28)	(5.97)	(2.82)	(2.07)	(7.46)
LNGDP0	−0.06	0.04	−0.10	−0.01	−0.06	0.04	−0.11	−0.01
	(5.09)	(10.0)	(3.89)	(2.46)	(5.10)	(9.95)	(4.01)	(3.70)
INV	0.49				0.49			
	(3.69)				(3.77)			
SEC	0.00	0.00			0.00	0.00		
	(1.07)	(0.61)			(1.09)	(0.58)		
PRI	0.00	0.00			0.00	0.00		
	(0.80)	(3.02)			(0.73)	(3.03)		
GOV	−0.52	0.07			−0.52	0.06		
	(3.24)	(0.25)			(3.22)	(0.29)		
REVOLT	−0.00	−0.00		0.00	−0.00	−0.00		0.00
	(0.43)	(0.46)		(0.17)	(0.45)	(0.48)		(0.24)
ASSASS	−0.00	−0.00		−0.00	−0.00	−0.00		−0.00
	(1.56)	(0.94)		(0.46)	(1.60)	(0.96)		(0.64)
COUP	−0.01	−0.00		0.00	−0.01	−0.00		0.00
	(0.98)	(0.34)		(1.19)	(0.96)	(0.60)		(1.27)
PISH		−0.05				−0.05		
		(5.09)				(5.10)		
PPDEV	−0.02	0.02			−0.02	0.02		
	(0.90)	(1.16)			(0.87)	(1.18)		
LNPOP			0.04				0.04	
			(3.39)				(3.47)	
DEMP3			0.08	−0.01			0.08	−0.01
			(2.14)	(1.33)			(2.29)	(1.11)
CW	−0.07	−0.04		−0.005	−0.07	−0.04		−0.004
	(2.59)	(4.21)		(0.85)	(2.58)	(4.22)		(0.98)
RELPOL	0.005	−0.03	0.15	0.05				
	(0.38)	(2.02)	(2.25)	(4.37)				
RELFRAC					−0.01	−0.04	0.13	0.05
					(0.17)	(1.12)	(0.33)	(2.54)
Reg. Dum.	Yes		Yes		Yes		Yes	
R^2	0.31	0.53	0.13	0.26	0.31	0.52	0.11	0.23
OBS	448	448	448	448	448	448	448	448

Absolute *t*-statistics between parenthesis using a heteroskedasticity robust asymptotic variance estimator.
Reg. Dum.: Regional dummies (Safrica, Laam and Asiae). REL: religious. FRAC: fractionalization. POL: Polarization. Growth: growth rate of real GDP per capita. INV: ratio of real domestic investment to GDP. CW: civil war=1. GOV: ratio of real government consumption to GDP.

Table 5
The effect of ethnolinguistic heterogeneity SUR estimation for 5-year periods

Variables	Growth	INV	CW	GOV
C	0.76 (7.54)	−0.09 (2.23)	0.58 (2.43)	0.34 (11.37)
LNGDP0	−0.08 (6.74)	0.04 (9.90)	−0.12 (4.65)	−0.02 (6.54)
INV	0.55 (4.67)			
SEC	0.00 (1.14)	0.00 (0.53)		
PRI	0.00 (0.30)	0.00 (3.31)		
GOV	−0.56 (3.53)	−0.13 (0.14)		
REVOLT	−0.00 (0.33)	−0.00 (1.52)		0.00 (0.30)
ASSASS	−0.00 (1.82)	−0.00 (1.50)		−0.00 (0.38)
COUP	−0.01 (0.83)	−0.00 (0.52)		0.01 (1.40)
PISH		−0.05 (5.82)		
PPDEV	−0.02 (0.97)	0.01 (1.54)		
LNPOP			0.04 (3.42)	
DEMP3			0.07 (1.80)	−0.01 (1.67)
CW	−0.05 (2.38)	−0.03 (3.37)		−0.00 (0.81)
ETHPOL	0.06 (1.07)	−0.05 (3.95)	0.16 (2.12)	0.02 (2.05)
ETHFRAC	−0.11 (3.03)	0.00 (0.53)	−0.03 (0.42)	−0.01 (1.10)
Reg. Dum.	Yes		Yes	
R^2	0.32	0.51	0.12	0.16
OBS	448	448	448	448

Absolute t-statistics between parenthesis using a heteroskedasticity robust asymptotic variance estimator.
Reg. Dum.: Regional dummies (Safrica, Laam and Asiae). ETH: ethnolinguistic. FRAC: fractionalization. POL: Polarization. Growth: growth rate of real GDP per capita. INV: ratio of real domestic investment to GDP. CW: civil war=1. GOV: ratio of real government consumption to GDP.

religious fractionalization has only a statistically significant effect on government consumption[41].

Taken into account that public consumption and civil wars have a negative effect on growth and that the rate of investment has a positive impact, the total effect of increasing religious polarization from 0 to 1 is a reduction in the average annual growth rate of output per capita of 1% point. This implies that reducing the level of religious polarization of Nigeria[42] (0.95) to the average level of polarization (0.43) will increase the average annual growth rate of per capita output in 0.53% points. Alternatively, a reduction in one standard deviation of the index of polarization implies an increase of 10.2 percent of a standard deviations in per capita growth across countries.

Table 5 shows the results of using as regressors ethnolinguistic polarization (ETHPOL) and ethnolinguistic fractionalization (ETHFRAC). With respect to the direct effect, we observe that ethnolinguistic fractionalization, as reported by many other authors, has a negative and significant effect on growth, while ethnolinguistic polarization has no statistically significant direct effect. On the other hand, the

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[41] Notice also that the R^2 for the regression of government consumption is clearly higher when using religious polarization instead of religious fractionalization.
[42] For instance, redrawing the borders of the country.

Table 6
The effect of ethnolinguistic heterogeneity SUR estimation for 5-year periods

Variables	(1) Growth	(2) INV	(3) CW	(4) GOV	(5) Growth	(6) INV	(7) CW	(8) GOV
C	0.69	−0.09	0.57	0.33	0.74	−0.09	0.60	0.35
	(7.10)	(2.69)	(2.41)	(10.3)	(7.45)	(2.61)	(2.51)	(11.6)
LNGDP0	−0.07	0.04	−0.12	−0.02	−0.07	0.04	−0.11	−0.02
	(6.31)	(10.1)	(4.51)	(4.53)	(6.54)	(9.52)	(4.36)	(6.36)
INV	0.53				0.54			
	(4.47)				(4.49)			
SEC	0.00	0.00			0.00	0.00		
	(1.03)	(0.53)			(1.15)	(0.67)		
PRI	0.00	0.00			0.00	0.00		
	(0.67)	(3.36)			(0.20)	(3.04)		
GOV	−0.51	−0.01			−0.54	−0.03		
	(3.21)	(0.17)			(3.35)	(0.38)		
REVOLT	−0.00	−0.00		0.00	−0.00	−0.00		0.00
	(0.52)	(1.48)		(0.24)	(0.51)	(1.27)		(0.23)
ASSASS	−0.00	−0.00		−0.00	−0.00	−0.00		−0.00
	(1.86)	(1.52)		(0.35)	(1.91)	(1.45)		(0.39)
COUP	−0.01	−0.00		0.01	−0.01	−0.00		0.01
	(0.90)	(0.50)		(1.36)	(0.89)	(0.32)		(1.31)
PISH		−0.05				−0.05		
		(5.92)				(6.27)		
PPDEV	−0.02	0.01			−0.02	0.01		
	(1.03)	(1.60)			(0.88)	(1.54)		
LNPOP			0.04				0.04	
			(3.51)				(3.02)	
DEMP3			0.07	−0.01			0.07	−0.01
			(1.78)	(1.78)			(1.80)	(1.70)
CW	−0.07	−0.03		−0.00	−0.05	−0.03		−0.00
	(2.55)	(3.34)		(0.76)	(2.31)	(3.52)		(0.88)
ETHPOL	0.002	−0.05	0.14	0.02				
	(0.05)	(4.30)	(2.31)	(1.71)				
ETHFRAC					−0.06	−0.02	0.07	−0.00
					(2.69)	(1.69)	(1.14)	(0.15)
Reg. Dum.	Yes		Yes		Yes		Yes	
R^2	0.30	0.51	0.12	0.16	0.31	0.49	0.10	0.15
OBS	448	448	448	448	448	448	448	448

Absolute *t*-statistics between parenthesis using a heteroskedasticity robust asymptotic variance estimator.
Reg. Dum.: Regional dummies (Safrica, Laam and Asiae). ETH: ethnolinguistic. FRAC: fractionalization. POL: Polarization. Growth: growth rate of real GDP per capita. INV: ratio of real domestic investment to GDP. CW: civil war=1. GOV: ratio of real government consumption to GDP.

level of ethnolinguistic polarization has the expected impact on investment, government consumption and the incidence of a civil war, while ethnolinguistic fractionalization has no effect on those indirect channels. Therefore, there seems to be no empirical justification to argue that the negative effect of ethnic fractionalization on growth is due to its impact on the indirect channels above mentioned.

Table 7
The effect of ethnolinguistic and religious heterogeneity SUR estimation for 5-year periods

Variables	Growth	INV	CW	GOV
C	0.79 (6.52)	−0.13 (1.91)	0.51 (1.90)	0.26 (8.49)
LNGDP0	−0.07 (5.44)	0.04 (10.2)	−0.10 (3.84)	−0.01 (2.16)
INV	0.51 (3.48)			
SEC	0.00 (1.04)	0.00 (0.50)		
PRI	0.00 (0.24)	0.00 (2.99)		
GOV	−0.63 (3.78)	0.00 (0.84)		
REVOLT	−0.00 (0.24)	−0.00 (0.67)		0.00 (0.07)
ASSASS	−0.00 (1.61)	−0.00 (1.04)		−0.00 (0.48)
COUP	−0.01 (1.05)	−0.00 (0.90)		0.00 (1.35)
PISH		−0.04 (4.88)		
PPDEV	−0.02 (0.92)	0.01 (1.31)		
LNPOP			0.04 (3.28)	
DEMP3			0.07 (1.81)	−0.01 (2.16)
CW	−0.06 (2.63)	−0.02 (3.79)		−0.00 (0.79)
RELPOL	0.17 (0.10)	−0.03 (0.78)	0.58 (3.13)	0.22 (3.65)
RELFRAC	−0.22 (1.38)	0.09 (1.73)	−0.84 (2.73)	−0.25 (2.83)
ETHPOL	0.05 (1.35)	−0.05 (4.04)	0.08 (0.91)	−0.00 (0.60)
ETHFRAC	−0.13 (3.31)	−0.00 (0.40)	−0.04 (0.41)	−0.04 (1.57)
Reg. Dum.	Yes		Yes	
R^2	0.33	0.52	0.14	0.30
OBS	448	448	448	448

Absolute *t*-statistics between parenthesis using a heteroskedasticity robust asymptotic variance estimator.
Reg. Dum.: Regional dummies (Safrica, Laam and Asiae). REL: religious. ETH: ethnolinguistic. FRAC: fractionalization. POL: Polarization. Growth: growth rate of real GDP per capita. INV: ratio of real domestic investment to GDP. CW: civil war=1. GOV: ratio of real government consumption to GDP.

Table 6 presents the estimations separating the impact of ethnic polarization and fractionalization. The results are identical to the ones obtained in Table 5[43]. Using the estimates of Table 6, we can conclude that a reduction of the level of ethnolinguistic fractionalization of Uganda (0.93) to the average level of ethnic fractionalization (0.42) would increase its annual growth rate of output per capita in 0.6% points. Alternatively, it implies that a one-standard-deviation decrease in ethnic fractionalization is associated with an increase in per capita growth of 8.9% of a standard deviation in per capita growth across countries. If we compute the total effect of ethnolinguistic polarization, we find that reducing the level of ethnic polarization from 1 (total polarization) to zero (complete homogeneity) is associated with an increase in average annual growth per capita of 0.91% points. The effects of the rest of the variables are similar to the ones obtained in Table 3.

Table 7 compares the effect of the indicators of ethnolinguistic and religious heterogeneity in the same specification. The results confirm the findings in previous tables. Only ethnic fractionalization has a statistically significant direct effect on growth. A

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[43] Notice that in this case the correlation between ethnic fractionalization and polarization is much lower (0.62) than in the case of religious diversity.

Table 8
The effect of ethnolinguistic and religious heterogeneity SUR estimation for 5-year periods

Variables	(1) Growth	(2) INV	(3) CW	(4) GOV	(5) Growth	(6) INV	(7) CW	(8) GOV
C	0.75	−0.11	0.52	0.27	0.69	−0.12	0.47	0.21
	(7.52)	(1.58)	(1.96)	(8.14)	(5.98)	(1.58)	(2.38)	(6.20)
LNGDP0	−0.07	0.04	−0.11	−0.01	−0.07	0.04	−0.11	−0.01
	(5.35)	(9.52)	(3.96)	(4.08)	(5.01)	(10.7)	(4.45)	(2.39)
INV	0.48				0.47			
	(3.63)				(3.64)			
SEC	0.00	0.00			0.00	0.00		
	(1.20)	(0.59)			(1.08)	(0.56)		
PRI	0.00	0.00			0.00	0.00		
	(0.24)	(2.55)			(0.80)	(3.15)		
GOV	−0.56	−0.05			−0.53	−0.04		
	(3.46)	(0.48)			(3.24)	(0.47)		
REVOLT	−0.00	−0.00		0.00	−0.00	−0.00		0.00
	(0.41)	(0.85)		(0.33)	(0.44)	(0.61)		(0.16)
ASSASS	−0.00	−0.00		−0.00	−0.00	−0.00		−0.00
	(1.54)	(1.11)		(0.69)	(1.56)	(0.98)		(0.46)
COUP	−0.01	−0.00		0.00	−0.02	−0.00		0.00
	(1.00)	(0.54)		(1.30)	(0.99)	(0.80)		(1.15)
PISH		−0.05				−0.05		
		(5.27)				(4.88)		
PPDEV	−0.02	0.02			−0.02	0.02		
	(0.75)	(1.37)			(0.89)	(1.29)		
LNPOP			0.04				0.04	
			(3.06)				(3.44)	
DEMP3			0.08	−0.00			0.08	−0.00
			(2.14)	(0.90)			(1.73)	(0.92)
CW	−0.06	−0.03		−0.00	−0.07	−0.03		−0.00
	(2.37)	(3.81)		(1.13)	(2.59)	(3.69)		(1.28)
RELPOL	0.01	0.03	0.07	0.05				
	(0.40)	(1.03)	(0.34)	(4.11)				
ETHPOL	0.00	−0.06	0.09	−0.00				
	(0.16)	(4.87)	(2.22)	(0.90)				
RELFRAC					0.03	0.04	0.02	0.06
					(0.55)	(0.34)	(0.17)	(1.36)
ETHFRAC					−0.09	−0.04	0.04	−0.02
					(2.98)	(2.54)	(0.69)	(1.78)
Reg. Dum.	Yes		Yes		Yes		Yes	
R^2	0.31	0.52	0.13	0.26	0.32	0.50	0.11	0.24
OBS	448	448	448	448	448	448	448	448

Absolute *t*-statistics between parenthesis using a heteroskedasticity robust asymptotic variance estimator.
Reg. Dum.: Regional dummies (Safrica, Laam and Asiae). REL: religious. ETH: ethnolinguistic. FRAC: fractionalization. POL: Polarization. Growth: growth rate of real GDP per capita. INV: ratio of real domestic investment to GDP. CW: civil war=1. GOV: ratio of real government consumption to GDP.

high level of religious polarization increases the likelihood of a civil conflict and the share of government consumption on GDP while religious fractionalization has the opposite effect, similar to what we find in Table 3. Finally, ethnic polarization has a negative effect on investment.

Table 8 presents the results when polarization and fractionalization are included in the system separately[44]. Ethnic fractionalization continues having an important direct effect on growth. Ethnic polarization has a negative effect on investment, column (2), and a positive effect on the likelihood of a civil war, column (3), while religious polarization has a positive effect on government consumption, column (4). Using the estimates in Table 8, columns (1) to (4), we can calculate the total effect of polarization on growth. Reducing the degree of polarization (ethnic and religious) from 1 to 0 implies an increase of 1.20% points in the average growth rate of GDP per capita. In addition, a one-standard-deviation decrease in ethnic and religious polarization is associated with an increase in per capita growth of 12.5% of a standard deviation in per capita growth across countries. Columns (5) shows the negative direct effect of ethnic fractionalization on growth. The size of that coefficient implies that reducing the degree of ethnolinguistic fractionalization of Uganda (0.93) to the average (0.42) would increase the average growth of Uganda's GDP per capita in 0.93% points. The only significant effect of fractionalization on the indirect channels is the negative impact of ethnic fractionalization on investment. However, we already showed that, if we do not include religious fractionalization in the specification[45], ethnic fractionalization has no significant effect on investment. In addition, the R^2 of the investment regression is significantly higher if we use ethnic polarization instead of ethnic fractionalization.

5. Conclusions

This paper presents a measurement of religious and ethnic diversity and their effects on economic development. The first part of the paper discusses the construction of a database of religious and ethnic diversity for a large sample of countries. We consider the impact of different data sources and indicators on the measurement of heterogeneity. We also analyze the effect of alternative synthetic indices for religious and ethnic diversity. We argue that the index of polarization is better suited to capture the potential for conflict in a society than the traditional index of fractionalization. We show that polarization and fractionalization indices have positive and close relationship in homogeneous countries. However, for high levels of heterogeneity, the correlation between fractionalization and polarization indices is close to zero or even negative.

The second part of the paper analyzes the effect of religious and ethnic diversity on economic development. Several papers have documented the negative effect of ethnic fractionalization on economic development. Many authors argue that the reason for that negative effect is that a high degree of ethnic fractionalization the increase potential conflict, which has negative effects on investment and increases rent seeking activities. Our results confirm that ethnolinguistic fractionalization has a direct negative effect on growth. However, we find no strong empirical justification to argue that the negative effect of fractionalization on growth is due to its impact on the indirect channels above

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[44] As we see in Table 7, including religious polarization and fractionalization in the same specification leads again to signs of multicollinearity.

[45] Which in any case it is statistically insignificant.

mentioned. By contrast, our results suggest that an increase in social polarization has a negative effect on growth because it reduces the rate of investment and increases public consumption and the incidence of civil wars.

Acknowledgement

Appendix A. Definition of the variables

GROWTH Growth rate of real GDP per capita of the period (Summers and Heston).

INV   Average of the ration of real domestic investment for the period (private plus public) to real GDP. SH.

LNGD0   Log of real GDP per capita of the initial period (1985 international prices) from SH v.5.5.

SEC   Percentage of secondary school attained in the total population. Taken at the beginning of the period. Source: Barro and Lee.

PRI   Percentage of "Primary school attained" in the total population. Taken at the beginning of the period. Source: Barro and Lee.

GOV   Average period of the ratio of real government "consumption" expenditure net of spending on defense and on education to real GDP.

REVOLT Number of revolutions per year, averaged over the period (Banks).

ASSAS   Number of assassination per million population per year, average period. Source: Banks.

COUP   Number of coups per year, average period.

PISH   Price level of investment (PPP I/Xrate relative to U.S.) at the beginning of the period. (U.S.=1.0). Source: SH v.5.5.

PPDEV   Magnitude of the absolute deviation of PISH from the sample mean.

LNPOP   Log of the population al the beginning of the period.

DEMP3   Democracy score: general openness of the political institutions (0=low; 10=high). Source: Polity III data set. (http://www.colorado.edu/IBS/GAD/spacetime/data/Polity.html). We transform the score in a dummy variable that takes value 1 if the

score is higher or equal to 4. This variable is very correlated with the variable Freedom of the Freedom House.

CW   A dummy hat takes value 1 if there is a civil war during the period and zero otherwise. The data comes from Doyle and Sambanis (2000), (DS).

Regional dummies:
Safrica   Dummy for Sub-Saharan African countries.
Laam   Dummy for Latin-American countries.
Asiae   Dummy for East-Asian countries.

APPENDIX: Data on ethnic and religious fractionalization and polarization.
ETHPOL: ethnic polarization; ETHFRAG: ethnic fractionalization.
RELPOL: religious polarization; RELFRAG: religious fractionalization.

COUNTRY	Barrolee code	ETHPOL	ETHFRAG	RELPOL	RELFRAG
Algeria	1	0.514	0.299	0.032	0.016
Angola	2	0.572	0.805	0.906	0.453
Benin	3	0.436	0.868	0.820	0.552
Botswana	4	0.650	0.485	1.000	0.500
Burkina Faso	5	.	.	0.918	0.598
Burundi	6	0.512	0.286	0.948	0.488
Cameroon	7	0.576	0.817	0.893	0.647
Cape Verde	8	0.822	0.435	0.004	0.002
Cent.Afri.Rep	9	0.578	0.787	0.901	0.546
Chad	10	0.665	0.768	0.900	0.626
Comoros	11	0.127	0.061	0.012	0.006
Congo	12	0.674	0.721	0.656	0.355
Egypt	13	0.427	0.247	0.360	0.180
Ethiopia	14	0.778	0.695	0.906	0.615
Gabon	15	0.519	0.834	0.530	0.271
Gambia	16	0.689	0.728	0.485	0.268
Ghana	17	0.661	0.731	0.880	0.582
Guinea	18	0.843	0.649	0.839	0.436
Guinea-Biss	19	0.532	0.829	0.914	0.578
Cote d'Ivoire	20	0.432	0.874	0.886	0.647
Kenya	21	0.381	0.890	0.832	0.482
Lesotho	22	0.343	0.185	0.640	0.320
Liberia	23	0.390	0.890	0.888	0.643
Madagascar	24	0.017	0.050	0.979	0.519
Malawi	25	0.736	0.684	0.818	0.547
Mali	26	0.420	0.862	0.620	0.327
Mauritania	27	0.536	0.334	0.020	0.010
Mauritius	28	0.803	0.482	0.888	0.628
Morocco	29	0.897	0.475	0.078	0.039
Mozambique	30	0.499	0.838	0.833	0.559
Niger	31	0.698	0.718	0.423	0.214
Nigeria	32	0.404	0.885	0.836	0.498

Appendix (*continued*)

COUNTRY	Barrolee code	ETHPOL	ETHFRAG	RELPOL	RELFRAG
Rwanda	33	0.401	0.221	0.711	0.427
Senegal	34	0.560	0.809	0.317	0.169
Seychelles	35	0.160	0.084	0.048	0.024
Sierra Leone	36	0.600	0.793	0.920	0.571
Somalia	37	0.679	0.385	0.005	0.003
South Africa	38	0.718	0.469	0.790	0.442
Sudan	39	0.699	0.711	0.711	0.427
Swaziland	40	0.318	0.178	0.685	0.363
Tanzania	41	0.271	0.959	0.882	0.648
Togo	42	0.673	0.732	0.897	0.624
Tunisia	43	0.167	0.087	0.039	0.020
Uganda	44	0.279	0.932	0.846	0.524
Zaire	45	0.586	0.799	0.843	0.434
Zambia	46	0.606	0.787	0.894	0.451
Zimbabwe	47	0.698	0.534	0.958	0.497
The, Baham	48	0.705	0.441	0.060	0.030
Barbados	49	0.366	0.199	0.374	0.206
Canada	50	0.672	0.767	0.156	0.082
Costa Rica	51	0.420	0.241	0.078	0.039
Dominica	52	0.370	0.202	0.008	0.004
Dominic.Rep	53	0.725	0.460	0.999	0.500
El Salvador	54	0.279	0.145	0.138	0.070
Grenada	55	0.945	0.542	0.035	0.018
Guatemala	56	0.955	0.520	0.759	0.382
Haiti	57	0.207	0.104	0.747	0.380
Honduras	58	0.430	0.254	0.272	0.143
Jamaica	59	0.600	0.354	0.293	0.150
Mexico	60	0.654	0.576	0.156	0.079
Nicaragua	61	0.681	0.496	0.270	0.143
Panama	62	0.586	0.048	0.516	0.298
St. Lucia	63	0.958	0.540	0.093	0.047
St. Vice and Gre	64	0.773	0.527	0.123	0.063
Trini and Tobago	65	0.842	0.662	0.805	0.518
United State	66	0.691	0.583	0.468	0.263
Argentina	67	0.579	0.408	0.182	0.096
Bolivia	68	0.767	0.708	0.918	0.513
Brazil	69	0.773	0.644	0.622	0.332
Chile	70	0.723	0.432	0.271	0.146
Colombia	71	0.789	0.675	0.315	0.170
Ecuador	72	0.837	0.657	0.605	0.311
Guyana	73	0.813	0.634	0.871	0.594
Paraguay	74	0.310	0.174	0.122	0.062
Peru	75	0.817	0.658	0.890	0.460
Suriname	76	0.734	0.729	0.746	0.720
Uruguay	77	0.426	0.260	0.166	0.086
Venezuela	78	0.758	0.539	0.227	0.119
Afghanistan	79	0.786	0.603	0.958	0.492
Bahrain	80	0.569	0.383	0.934	0.536
Bangladesh	81	0.132	0.068	0.503	0.261
Myanmar	82	0.650	0.474	0.364	0.204
China	83	0.661	0.599	0.819	0.671

Appendix (*continued*)

COUNTRY	Barrolee code	ETHPOL	ETHFRAG	RELPOL	RELFRAG
Hong Kong	84	0.066	0.034	0.741	0.702
India	85	0.348	0.901	0.564	0.345
Indonesia	86	0.529	0.793	0.823	0.660
Iran, I.R of	87	0.598	0.756	0.352	0.185
Iraq	88	0.665	0.390	0.947	0.552
Israel	89	0.548	0.286	0.543	0.296
Japan	90	0.067	0.034	0.808	0.568
Jordan	91	0.982	0.515	0.347	0.169
Korea	92	0.028	0.014	0.669	0.782
Kuwait	93	0.980	0.513	0.784	0.446
Malaysia	94	0.762	0.695	0.740	0.676
Nepal	95	0.652	0.682	0.342	0.185
Oman	96	0.408	0.239	0.292	0.149
Pakistan	97	0.698	0.608	0.710	0.397
Philippines	98	0.497	0.843	0.212	0.108
Saudi Arabia	99	0.114	0.059	0.113	0.058
Singapore	100	0.666	0.421	0.738	0.623
Sri Lanka	101	0.749	0.452	0.727	0.500
Syria	102	0.373	0.207	0.410	0.220
Taiwan	103	0.685	0.363	0.919	0.591
Thailand	104	0.582	0.361	0.266	0.143
Uni. Arab. Em	105	0.640	0.320	0.839	0.507
Yemen, N. Ar	106	0.063	0.032	0.975	0.507
Austria	107	0.240	0.128	0.051	0.026
Belgium	108	0.871	0.544	0.067	0.034
Cyprus	109	0.652	0.357	0.616	0.309
Denmark	110	0.097	0.049	0.014	0.007
Finland	111	0.294	0.148	0.006	0.003
France	112	0.294	0.147	0.193	0.100
Germany, W	113	0.227	0.123	0.118	0.059
Greece	114	0.186	0.099	0.061	0.031
Hungary	115	0.308	0.167	0.043	0.022
Iceland	116	0.055	0.028	0.026	0.013
Ireland	117	0.141	0.072	0.005	0.003
Italy	118	0.154	0.080	0.010	0.005
Luxembourg	119	0.596	0.298	0.029	0.015
Malta	120	0.167	0.083	0.002	0.001
The Netherlands	121	0.214	0.113	0.094	0.048
Norway	122	0.090	0.045	0.006	0.003
Poland	123	0.099	0.051	0.003	0.001
Portugal	124	0.020	0.010	0.001	0.001
Spain	125	0.693	0.436	0.002	0.001
Sweden	126	0.337	0.189	0.018	0.009
Switzerland	127	0.724	0.560	0.032	0.016
Turkey	128	0.342	0.185	0.022	0.011
United Kingdom	129	0.571	0.373	0.137	0.071
Yugoslavia	130	0.599	0.782	0.438	0.219
Australia	131	0.492	0.315	0.044	0.022
Fiji	132	0.930	0.559	0.929	0.569
New Zealand	133	0.366	0.196	0.040	0.020

Appendix (*continued*)

COUNTRY	Barrolee code	ETHPOL	ETHFRAG	RELPOL	RELFRAG
Pap New Gui	134	0.669	0.354	0.126	0.064
Solom Icelan	135	0.258	0.139	0.167	0.084
Tonga	136	0.066	0.034	0.056	0.028
Vanuatu	137	0.285	0.155	0.638	0.321
West Samoa	138	0.388	0.199	0.067	0.033

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