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**An Ethnic Polarization Measure With An Application
To Ivory Coast Data¹**

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Abstract

In this paper, we suggest a framework for the analysis of ethnic polarization. This framework allows for the measurement of ethnic or religious polarization. We apply our measure to Ivory Coast and find a surprising result as the ethnic polarization decreased in years preceding the conflict in the country. However, further decomposition of the ethnic polarization index allows us to understand better how the variation in polarization may have induced this conflict.

Keywords: Ethnic polarization, Conflict, Ivory Coast

JEL Codes : D63, I30

Résumé

Dans cet article, nous proposons un cadre d'analyse de la polarisation ethnique. Ce cadre analytique permet d'analyser la polarisation ethnique et religieuse. Nous appliquons ce cadre à des données de la Côte d'Ivoire et constatons que la polarisation ethnique a diminué durant les années précédant le conflit. Par contre, une décomposition plus fine de notre indice de polarisation ethnique nous permet de mieux comprendre comment les variations de polarisation ont pu induire le conflit.

Mots-clé: Polarisation ethnique, Conflit, Côte d'Ivoire

Classification JEL: D63, I30

1. Introduction

In the last three decades, a large body of the literature tackled the comparison between living standards' distributions. Most of the research focused on the measurement of inequality, social welfare and poverty. These comparisons are, however, missing a potentially important aspect of the distribution of living standards; namely polarization⁵. Recently there has been a growing body of research on polarization measurement: Esteban and Ray (1994), Foster and Wolfson (1994), Wolfson (1994 and 1997), Wang and Tsui (2000), D'Ambrosio (2001), Duclos, Esteban and Ray (2004) and Esteban, Gradin and Ray (2007). This polarization has often been associated with social unrest. In fact, Esteban and Ray (1999) show, in their theoretical model, that an increase of polarization may be the source of social conflict. All the measures mentioned above focused on income polarization, nevertheless, the world in the post-Cold War period has witnessed an eclipse of social class conflicts and the emergence of ethnic conflicts (Brubaker and Laitin, 1998). These conflicts are however not exclusively ethnic. Robinson (2001), Esteban and Ray (2005) and Caselli and Coleman (2006) pointed out that ethnicity may be a marker for economic grabbing.

The objective of this paper is to develop an index of ethnic polarization that is based simultaneously on income and ethnicity. These two dimensions of polarization may be potential determinants of ethnic conflict. To illustrate, we apply this index using Ivorian data. Results show that the decline of economic power of the Akan group may be the source of the emergence of the ethnic conflict that has marked the country in the end of the 90s.

The remaining of the paper is organized as follow. In section two we present our ethnic polarization index. Section three applies this index to the *Enquête prioritaire en Côte d'Ivoire* (EPCI) for 1993 and 1998 in order to explain the emergence of the ethnic conflict in this country. Finally, in the last section, we briefly conclude.

⁵ To illustrate the focus of the last decades, note for instance that the concept of polarization is not even mentioned in the important *Handbook on Income Distribution* edited by Atkinson and Bourguignon (2000).

2. A measure of ethnic polarization

In this section, we build on Esteban and Ray (1994) and Duclos, Esteban and Ray (2004) and construct an ethnic polarization index. In general, polarization is determined by alienation and identification. The more identified the individual is with an alienated group, the more important is the antagonism with individual of other groups. To have a better grasp of how these two factors can influence polarization, it is important to present an overview Esteban and Ray's (1994) and Duclos, Esteban et Ray's (2004) framework. These latter derive their income polarization index using an axiomatic approach that can be intuitively described as follows:

- 1) Polarization does not increase if there is only one pole in the distribution and if the mode of this distribution increases.
- 2) Polarization does not decrease if there are three poles in a distribution and if the modes of the extreme poles increase in the same fashion.
- 3) Polarization increases if two symmetric poles move away from each other.
- 4) Polarization is not affected by the population size.

Esteban and Ray's (1994) polarization index satisfies the above mentioned conditions and can be formally written as follows:

$$(1) \quad P_{\alpha}^{ER}(\pi, y) = K \sum_{i=1}^n \sum_{j=1}^n \pi_i^{1+\alpha} \pi_j |y_i - y_j|,$$

where π_i represents the number of persons who belong to group i 's, y_i , group i 's natural logarithm of income⁶ and α , the degree of aversion to polarization. For a value of $\alpha = 0$, this index correspond to the Gini index of inequality. The higher α , the larger is the difference between this index and the concept of inequality.

As mentioned above, polarization is based on an identification/alienation framework. It depends on how much individuals identify with their own group. This identification exacerbates the alienation experienced when an individual compares his income to that of individuals from other groups. This alienation between two individuals, of whom one is member of group i and the other is member of group j is captured by the difference in their income, $|y_i - y_j|$. Identification of individuals to their own group i is captured through π_i^{α} . In this context,

⁶ The use of the natural logarithm implies that the absolute difference in the equation may be interpreted has relative differences.

$\pi_i^\alpha |y_i - y_j|$ may be interpreted as the antagonism between an individual of group i and another individual of j .

A major problem arises when we try to implement empirically Esteban and Ray's (1994) index of polarization. In fact, we have to redistribute all observed income, which can be seen as drawn from a continuous distribution, into a finite set of income group. This implies that we can consider every observed income as assigned to a group for which the continuous support interval has been defined arbitrarily. In this context, two incomes that are almost equal may be assigned to two different income groups if they lie on different sides of a limit between those groups. To address this problem, Duclos, Esteban and Ray (2004) develop another polarization index. This index is based on kernel estimation of income density; it therefore avoids the problem of defining arbitrarily the frontiers between income groups. The interpretation of the axioms underlying the index is similar to the ones in Esteban and Ray (1994).

Duclos, Esteban and Ray (2004) show that a polarization index respects those axioms if and only if it is proportional to:

$$(2) \quad P_\alpha(F) = \int_y f(y)^\alpha a(y) dF(y),$$

where

$$(3) \quad a(y) \equiv \mu + y(2F(y) - 1) - 2 \int_{-\infty}^y x dF(x).$$

Note that if we multiply the index $P_\alpha(F)$ by $\mu^{\alpha-1}$, we obtain an index which is homogeneous of degree zero. Also note that $\alpha \in [0.25, 1]$.

This index may be decomposed into an alienation and identification components. Average identification is given by

$$(4) \quad \bar{t}_\alpha \equiv \int f(y)^\alpha dF(y) = \int f(y)^{1+\alpha} dy,$$

and individual alienation by

$$(5) \quad a(y) = \int |y - x| dF(x).$$

In this context, average alienation is given by

$$(6) \quad \bar{a} = \int a(y) dF(y) = \int \int |y - x| dF(x) dF(y).$$

The normalized covariance between identification and alienation is given by

$$(7) \quad \rho \equiv \frac{\text{COV}_{t_\alpha, a}}{\bar{t}_\alpha \bar{a}} = \frac{1}{\bar{t}_\alpha \bar{a}} \int [t_\alpha(y) - \bar{t}_\alpha][a(y) - \bar{a}]f(y)dy$$

$$= \frac{1}{\bar{t}_\alpha \bar{a}} \left[\int f(y)^{1+\alpha} a(y)dy - \bar{a} \bar{t}_\alpha \right] = \frac{P_\alpha^{DER}(f)}{\bar{t}_\alpha \bar{a}} - 1.$$

The index P^{DER} may be expressed as the product of identification, alienation and their normalized covariance:

$$(8) \quad P_\alpha^{DER}(f) = \bar{t}_\alpha \bar{a} (1 + \rho).$$

In this paper, we are interested in measuring ethnic or religious polarization. Therefore, we must modify the above mentioned indices which have been developed in the context of pure income polarization. We assume that ethnic or religious polarization is an increasing function of income polarization between ethnic or religious groups. It is also an increasing function of individuals' identification to their ethnic or religious group. We assume that we have n ethnic groups and that the population size is normalized to 1. In this context, we have:

$$(9) \quad \sum_{i=1}^n \pi_i = 1$$

where π_i represents the population share of group i .

A first method of measuring ethnic polarization that may come to our mind consists of using Esteban and Ray's (1994) index while assigning to each individual the average income of his own ethnic group. In this context, we have:

$$(10) \quad P_\alpha^\gamma = P_\alpha^{ER} \text{ with } K = 1/\mu.$$

Nevertheless, this measure is independent of the individuals' identification to their own ethnic group. We assume that identification is inversely related to income polarization within a given ethnic group and measure polarization inside each ethnic group using Duclos, Esteban and Ray's (2004) index $P_{\alpha,i}^{DER}$:

$$(11) \quad P_\alpha^\phi = \sum_{i=1}^n \pi_i P_{\alpha,i}^{DER}.$$

Combining (10) and (11), we can measure ethnic polarization as an increasing function of polarization between groups and identification of individuals to their group. As identification is an inverse function of polarization, a straight forward measure of ethnic polarization is given by:

$$(12) \quad P_{\alpha}^e = P_{\alpha}^{\gamma} / P_{\alpha}^{\phi} .$$

3. An application to Ivory Coast

3.1 Data

Our empirical application uses the data from the *Enquête prioritaire en Côte d'Ivoire* (EPCI) for 1993 and 1998. These surveys focused on the social dimensions of structural adjustment and were conducted with the assistance of the World Bank. In 1993, 9600 were surveyed and 4200 in 1998. In our analysis, we use expenditure figures as they seem to be a better proxy for household welfare than the declared incomes.⁷ Both surveys provide detailed information on the ethnicities which allows us to perform our ethnic polarization analysis.

Table 3.1
Descriptive statistics of the surveys

Years	Number of households	Number of individuals	Real Average income
1993	9 600	56 700	159 070
1998	4 200	24 128	494 263

The average income of this table was used in normalizing household income between the surveys.

3.2 Polarization index

We first compute our polarization index P^{DER} , for the two periods of interest. We then decompose it into three components; namely alienation, identification and normalized covariance between the two other components.

⁷ We will make reference to household income even if we use expenditure as a proxy for simplicity.

Table 3.2
Polarization index

Year	Polarization	Alienation	Identification	Normalized covariance
1993	0,1951	0,3950	0,6458	-0,2353
1998	0,1896	0,3782	0,6710	-0,2528
$\Delta\%$	-2,81%	-4,26%	3,90%	7,45%

Looking at table 3.2, we notice that the overall variation in polarization does not have the expected sign; it decreases by 2.81%. Normally, we would have expected an increase in the polarization index given the reduction in redistribution programs during the period we are considering. Turning our attention to the three components, we notice that they do not all exhibit that same trend. Alienation decreases but by a larger magnitude (-4.26%) whereas identification increases by 3.9%. The normalized covariance is the one that changes the most at 7.45%.

These figures give an overall picture of the evolution of income distribution between the two periods. Since we are interested in understanding the source of the ethnic conflict, we move to the estimation of ethnic polarization.

3.3 Ethnic polarization index

We assume that an increasing ethnic polarization can be at the source of ethnic conflicts. For the period we are considering, we observe a decrease in ethnic polarization. As we have mentioned earlier, programs that previously contributed to the redistribution in Ivory Coast were significantly reduced. The “ivoirité” concept is an illustration that redistribution across ethnic groups was no longer in the plans of the government. Given these circumstances we should normally expect an increase in ethnic polarization; nevertheless we observe a significant decrease.

Table 3.3.1
Ethnic polarization index

Year	Ethnic Polarization	Inter-group Alienation	Intra-group Alienation
1993	0,3906	0,0692	0,1771
1998	0,1456	0,0283	0,1945
$\Delta\%$	-62,73%	-59,07%	9,80%

As we have mentioned, we can decompose our index into an inter-group and an intra-group alienation. A reduction in redistributive programs is expected to increase the inter-group alienation. In fact we observe the opposite; the intra-group alienation component increased. This increase accentuates the decrease in total ethnic polarization for the period at hand. To get a better understanding of this counterintuitive result, it is necessary to look at the evolution of the polarization index for each ethnic group. To do so, further decomposition of our index is required⁸.

Looking at table 3.3.2, we note that the Krou and Akan comprise more than half our sample size. Polarization indices range from 0.16 to 0.23 with the exception of the Malians who exhibit the highest index at 0.44. This discrepancy is due to the high level of identification prevailing among the Malians compared to other groups. Given that the Malians' group size is relatively small; their contribution to overall polarization will be relatively modest. At this point it is important to note that the average income of the Akans, the group that is favoured by government policies, is below the national average. Moreover, the average income of immigrants is above the national average.

⁸ As Ivory Coast is host to over 60 ethnic groups, we used families of ethnic groups.

Table 3.3.2
Group polarization index (1993)

Ethnic group	Proportion	Polarization	Alienation	Identification	Normalized covariance	Normalized average income
Akan Family	0,2946	0,1637	0,2952	0,6836	-0,189	0,6949
Krou Family	0,2187	0,1687	0,306	0,6775	-0,1863	0,648
North Mande Family	0,0503	0,183	0,3641	0,6191	-0,1883	0,6892
South Mande Family	0,1047	0,1842	0,3585	0,652	-0,2121	1,8561
Voltaïque Family	0,0698	0,2035	0,3634	0,7321	-0,235	1,7564
Burkinabé Family	0,0401	0,1791	0,3372	0,653	-0,1867	1,1557
Malian Family	0,0022	0,4363	0,3913	1,3293	-0,1613	1,9889
Ghanaian Family	0,1374	0,1828	0,3586	0,6503	-0,2161	1,1611
Other Africans	0,0117	0,2324	0,3138	0,9101	-0,186	1,2213
Naturalized Ivorians	0,0706	0,1895	0,3602	0,6585	-0,2012	1,0987

In 1998 (table 3.3.3), the situation changed significantly. First, the Akan and Krou families saw their proportion decrease while the Malians increased their share of total population. The polarization of the Malians is now in the same range as other groups. Second, the naturalized Ivorians have now the highest polarization (90 percent above the national average). Both, changes in alienation and identification contribute for this large change in polarization. Once again, it is important to highlight the fact that this group represents less than one percent of the total population. Consequently, its contribution to the change in the total ethnic polarization index is very small. In 1998, the average income of the Akan and Krou families is higher than the national average.

Table 3.3.3
Group polarization index (1998)

Ethnic group	Proportion	Polarization	Alienation	Identification	Normalized covariance	Normalized average income
Akan Family	0,3046	0,1903	0,3792	0,6837	-0,2658	1,1756
Krou Family	0,1497	0,1935	0,3616	0,6949	-0,2299	1,0284
North Mande Family	0,1827	0,2017	0,3851	0,7074	-0,2598	0,8453
South Mande Family	0,0931	0,1825	0,2995	0,7479	-0,1852	0,9174
Voltaïque Family	0,09	0,2019	0,4037	0,6919	-0,2772	0,9896
Burkinabé Family	0,0905	0,1923	0,3464	0,7301	-0,2397	0,8534
Malian Family	0,0331	0,1819	0,3485	0,6891	-0,2424	0,7698
Ghanaian Family	0,0089	0,206	0,3342	0,6953	-0,1137	0,8205
Other Africans	0,0445	0,2067	0,4039	0,6817	-0,2494	1,0123
Naturalized Ivorians	0,003	0,368	0,5584	0,8471	-0,222	1,3598

Focusing our attention on the evolution between the two periods allows us to shed light on the role of changing ethnic polarization as a source of the conflict in Ivory Coast. Before analyzing our results, it is important to mention an important caveat. Our two survey samples (9600 in 1993 and 4200 in 1998) sizes imply that our sub-group samples can become relatively small. For example, the Malian and Ghanaian are represented by 139 and 37 households respectively in the 1998 survey. The sampling process did not consider ethnicity as a criterion for designing the sampling plan. This induces important variation in the weight of different groups between the samples. The robustness of our results for these groups with small weights has to be considered relatively weak. Hence, we will focus on the analysis of groups with stronger weights in the samples.

Table 3.3.4
Variation of polarization indices between 1993-98

Ethnic group	Polarization	Alienation	Identification	Normalized covariance	Normalized average income
Akan Family	16,30%	28,45%	0,01%	40,66%	69,18%
Krou Family	14,72%	18,19%	2,57%	23,43%	58,71%
North Mandé Family	10,21%	5,76%	14,27%	37,96%	22,64%
South Mandé Family	-0,93%	-16,48%	14,70%	-12,67%	-50,57%
Voltaïque Family	-0,81%	11,09%	-5,50%	17,99%	-43,66%
Burkinabé Family	7,36%	2,72%	11,80%	28,36%	-26,16%
Malian Family	-58,30%	-10,94%	-48,16%	50,31%	-61,30%
Ghanaian Family	12,68%	-6,80%	6,92%	-47,41%	-29,34%
Other Africans	-11,08%	28,74%	-25,10%	34,12%	-17,11%
Naturalized Ivorians	94,22%	55,01%	28,64%	10,31%	23,77%

Excluding two of the small groups (Malian and Naturalized Ivorian) the changes are within reasonable range. During the period of analysis, redistributive programs were strongly contracted. This was a consequence of the drop in prices of cocoa and coffee which put enormous pressure on government revenues. The reduction of transfer programs and the rise of “ivoirité” should have concentrated direct and indirect transfers to the groups that are closer to political power (namely the Akan and Krou groups). While we expected to observe an increase in polarization in ethnic groups that are away from political power, we observe the opposite. It is the Akan (+16,3%) and Krou (+14,7%) who are most negatively affected in the period. Polarization at the national level decreases after the reduction in distribution programs. This is an

interesting result that could explain part of the increasing tension between the politically dominant groups and other groups among which non ivorians. In fact, the Akan and Krou were likely the biggest winners from the transfers programs. Their elimination might have contributed to the improvement of the situation of other groups relative to the Akan and Krou groups. This is reflected by the reduction in polarization for four groups (South Mande, Voltaic, Malian and Other African) and relatively weak increases in polarization for the Burkinabe and North Mande groups.

In light of our results and contrary to our initial anticipation, it is not an increase in overall polarization that has led to the conflict. Disadvantaged groups improved their situation in terms of polarization whereas the politically dominant groups experienced the strongest increase in their indices. This strong movement could have contributed to the eruption of the conflict in 1999. Consequently, looking uniquely at an aggregate polarization index would have led us to conclude a reduction in polarization and that the change in income distribution was not one of the determinants of the conflict in Ivory Coast. Our ethnic polarization framework allows us to isolate the movement of polarization in different groups. It also allows us to argue that the strong and quick change in income distribution between and within groups can be one of the determinants of the political conflict that started at the end of 1999.

3.4 Religious polarization

As the religious dichotomy in Ivory Coast is often cited to be at the origin of the conflict, it is therefore interesting to investigate how our index evolves based on this decomposition. Moreover, it is interesting to compare this decomposition with the one presented in the previous section. Our data distinguished two main religious groups (Catholics and Muslims) and other religions.

Results are presented in Table 3.4.1. As for ethnic polarization, religious polarization also decreased during the period. Our results show that inter-group alienation is lower for the 1998 data. On the other hand, intra-group polarization has barely changed between the two periods. As no distributive programs were targeted to religious groups, it is not surprising that the removal of these programs did not contribute to increasing polarization.

Table 3.4.1
Religious polarization index

Year	Religious Polarization	Intergroup Alienation	Intragroup Alienation
1993	0,3028	0,0579	0,1912
1998	0,2535	0,0476	0,1879
$\Delta\%$	-16,27%	-17,68%	-1,69%

We also present in the appendix a decomposition of the P^{DER} index for each group as well as the elements required for computation of the religious polarization index.

4. Conclusion

In this paper, we have presented a heuristic derivation of an ethnic polarization index. Using this index, we have tried to explain how ethnic polarization may have played a role in the emergence of the ethnic conflict in Côte d'Ivoire. In future research, two paths may be followed. First, on a theoretical level, it may be interesting to develop an index of ethnic polarization based on an axiomatic approach. Second, on an empirical level it may be worth to examine the dynamics of ethnic polarization during the end of Houphouët-Boigny's reign using data from the 80's as the movement in polarization during this period may explain the political unrest of the 90's.

Appendix

Table A.1
Polarization index (1993)

Religious Group	Proportion	Polarization	Alienation	Identification	Normalized Covariance	Normalized Mean Income
Musulman	0,3942	0,1945	0,3839	0,6618	-0,2343	0,9323
Chrétien	0,3162	0,1982	0,4065	0,6285	-0,2243	1,2397
Autre	0,2896	0,1789	0,3588	0,6357	-0,2158	0,8304
	1,0000					

Table A.2
Polarization index (1998)

Religious Group	Proportion	Polarization	Alienation	Identification	Normalized Covariance	Normalized Mean Income
Musulman	0,3987	0,1856	0,3613	0,6788	-0,2430	0,8676
Chrétien	0,3490	0,1977	0,3933	0,6869	-0,2681	1,1617
Autre	0,2522	0,1780	0,3426	0,6682	-0,2225	0,9855
	1,0000					

Table A.3
Variation of the polarization index

Religious Group	Proportion	Polarization	Alienation	Identification	Normalized Covariance	Normalized Mean Income
Musulman	1,13%	-4,57%	-5,89%	2,56%	3,70%	-6,94%
Chrétien	10,40%	-0,25%	-3,25%	9,28%	19,56%	-6,30%
Autre	-12,89%	-0,48%	-4,51%	5,11%	3,08%	18,67%

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