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**No. 16**

DECEMBER 2018

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# Poverty and Inequality in Francophone Africa, 1960s-2010s

by

SÉDI-ANNE BOUKAKA, GIULIA MANCINI,

AND GIOVANNI VECCHI

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*Please cite this paper as:*

Boukaka, S., Mancini, G. and Vecchi, G. (2018). 'Poverty and Inequality in Francophone Africa, 1960s-2010s', *HHB Working Paper Series*, No. 16, December 2018, Rome.

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HHB Project  
Via Columbia, 2  
00133 Rome  
Italy  
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# Poverty and Inequality in Francophone Africa, 1960s-2010s

Sédi-Anne Boukaka

University of Rome “Tor Vergata”, Dept. of Economics and Finance  
[sedianne.boukaka@outlook.com](mailto:sedianne.boukaka@outlook.com)

Giulia Mancini

University of Rome “Tor Vergata”, Dept. of Economics and Finance

Giovanni Vecchi

University of Rome “Tor Vergata”, Dept. of Economics and Finance

December 2018

## Abstract

The paper provides first generation estimates of poverty and inequality rates for three countries in francophone Africa – Cameroon, Côte d’Ivoire and Gabon – in the aftermath of independence. Sources – a large collection of historical household budgets – are new, as is the method that allows to connect historical sources to modern household budget surveys, and to deliver nationally representative estimates. The second part of the paper identifies the trend of poverty and inequality in Côte d’Ivoire for the years 1965-2015; we find that mean income growth failed to reduce poverty during the fifteen years of economic boom post-independence (1965-1979) because of increasing inequality. Conversely, in the following period (1979-2015) poverty changes are mostly guided by the evolution of growth.

**Keywords:** poverty; inequality; grouped data; living standards; economic well-being; household budgets; Cameroon; Cote-d’Ivoire; Gabon.

**JEL classification:** C13, I32, O12, N37.

We thank Stefano Fenoaltea, Nicola Amendola, Gianluigi Nico and Francesco Olivanti whose comments have helped us substantially improve the paper. We are indebted to Laurence Goury (IRD, Institut de Recherche pour le Développement) and Françoise Gubry (CEPED, Centre Population et Développement) for their dedication in preserving the archival items, part of which were used in this paper. We are grateful to the participants of the 7th EH/Tune Workshop (Tuscany University Network in Economic History), the 2018 ICID–SITES –IFAD Conference on International Development, the 13th AEHN meeting (African Economic History Network), the Groningen FRESH Meeting 2018 and the December 2018 Eternal City Economic History Workshop. We take responsibility for all errors.

## 1 Introduction

Sub-Saharan Africa is home to the majority of the world's poor. In international rankings of GDP per capita, life expectancy, infant mortality, educational attainment, African countries often end up at the bottom of the chart (World Bank WDI 2017). Evidence on the path that has led to this situation is limited and stands on shaky ground: historical statistics of both national accounts and other dimensions of wellbeing in the African continent is still incomplete, and often inconclusive – even if we restrict our attention to the fifty or sixty years following most countries' independence from colonial rule.

Influential works like [Acemoglu et al. \(2001\)](#) and [Nunn \(2008\)](#), which sparked a resurgence of African economic history after a period of relative obscurity, have sought to explain differences in income per capita across countries today, and Africa's setbacks in particular, by using features of the distant past, such as the institutional legacy of European settlers, the consequences of slave trade. This approach has drawn some criticism among economic historians of Africa, who perceived it as ahistorical and reductionist ([Austin and Broadberry, 2014](#)), and as incorrectly implying a long-run stagnation of growth and living standards in Africa. Other “myths” about African development have been pointed out by other scholars: that Africa had been a victim of a “chronic failure of economic growth” ([Jerven, 2013](#)), that poverty in Africa had been a historically persistent phenomenon ([Frankema and van Waijenburg, 2012](#)) – misconceptions that do not hold up to recent empirical evidence and that lead to an inaccurate understanding of the continent's present situation.

With this renewed interest in the economic history of Africa in general, and in wellbeing indicators in particular, the work of reconstructing the history of African living standards is underway. An influential strand of the literature has focused on macroeconomic *monetary* indicators. Building on Maddison (1982, 1995 and 2003), [Bolt et al. \(2014, 2018\)](#) have revised and completed the long-run series of GDP for most African countries. The World Bank has invested heavily in its World Development Indicators database, which covers all African countries since 1960. Similarly, the Penn World Tables, the standard source of data on PPP-adjusted GDP across countries ([Feenstra et al., 2015](#)), goes back to 1950. The availability of newly constructed time series on *non-monetary* indicators has further widened the scope of the research, and stimulated the study of multiple dimensions of the living standards in the long run. Jan Luiten Van Zanden

coordinated a large-scale project that represents an extension and a complement of the GDP-based Maddison Project, making available a variety of internationally comparable long-run historical statistics ([Van Zanden et al., 2014](#)).

Finally, the use of composite indices, as a way of combining monetary and non-monetary dimension of economic development, has become a popular line of investigation – from [Sanders \(1983\)](#), who constructed Morris’s Physical Quality of Life index for the Republic of the Congo since 1950, to [Leandro Prados de la Escosura \(2010, 2015\)](#) with his Historical Index of Human Development (HIHD). The use of composite indices, however, has been criticized by economists ([Fleurbaey, 2009](#)) and economic historians ([Amendola et al., 2017, 2018](#)), and adds little, if anything, to the stories told by the elementary time series.

The single most revolutionary trait of the last couple of decades is probably the use of historical *microdata*. In a recent review article, [Fourie \(2016\)](#) has hailed the beginning of a “data revolution” in African economic history: new data, often painstakingly assembled from a variety of lesser-known sources of individual- or household-level information, allow analysts to uncover a number of new dimensions of long-run living standards and economic development in the African continent. The study of human heights is one of the most established uses of historical microdata: from [Eltis \(1982, 1990\)](#) to [Cogneau \(2011\)](#) or [Austin, Baten, and Van Leeuwen \(2012\)](#), a mountain of height-based evidence has piled up and helped shedding new light on the many facets of economic development in Africa. Thanks to data on heights, scholars have stretched their research agenda further, bringing in topics that had remained at the margins of the literature. One is economic inequality ([Baten and Moradi, 2005](#)). The fact that living standard inequality can be proxied by biological inequality is not uncontroversial (see [Deaton, 2008](#), and [A’Hearn and Vecchi, 2016](#)): nevertheless, among the merits of this line of research is its contribution to making the point that an economic history of Africa silent on the long-term changes in the distribution of income would be an incomplete one.

The research avenue of historical microdata has been even more fruitful in recent years. Adopting [Allen’s \(2001\)](#) methodology, [Frankema and van Waijenburg \(2012\)](#) used real wages to challenge the traditional view of Africa as a “stagnant continent”. [Frankema \(2012\)](#) used colonial blue books to study the impact of British educational policies on enrolment rates in British Africa. [Meier zu Selhausen and Weisdorf \(2016\)](#) exploited

marriage registers in Kampala to investigate how different facets of gender inequality changed as a result of European colonization. More and more scholars are busy constructing a variety of other datasets based on microdata ([Manning 2012](#), [Frankema and Jerven 2014](#)).

Despite all these efforts, three major limitations stand out, and motivate our initial statements on the need for more complete and detailed evidence on long-run living standards in the African continent. Firstly, available indicators and measures of living standards display a lack of consistency. Secondly, we know little, if anything, on the long-run dynamics of the incidence and depth of (absolute) poverty, and on the distributional aspects of wellbeing. Thirdly, geographic coverage: while the past of many countries in Africa has been thoroughly investigated, others remain obscure.

Our first argument, consistency, has to do with the fact that different sources and data deliver different stories. [Deaton and Heston \(2010\)](#) have contributed to our understanding of the differences between GDP measures by focusing on the role of the PPPs. [Jerven \(2013, 2018\)](#) has written extensively on the deficiencies of primary data and methods, with a special focus on GDP in African economies. Overall, these studies suggest to double check the empirical foundations of many “facts” that provide the basis of our knowledge on the historical growth pattern of most African countries.

Regarding poverty and inequality, the lack of long-run estimates for most African countries qualifies as a major gap in the literature. The former chief economist of the World Bank, Francois Bourguignon, explained that any account of the evolution of living standards should include the dynamics of both economic growth and inequality and poverty. He coined the term “growth-inequality-poverty triangle”, to indicate how interlinked these three dimensions are in the definition of a development strategy ([Bourguignon, 2004, 2015](#)). In addition to that, most historical statistics currently available – from heights to real wages – would be considered a second-best solution by any modern welfare analyst. [Deaton \(1997\)](#) and [Ravallion \(2016\)](#), among others, explain why living standards are currently assessed on the basis of household income and expenditure collected through modern complex-design probabilistic surveys. [A’Hearn et al. \(2016\)](#) have elaborated more on this arguing that household budgets are also a viable solution for economic historians. [Amendola and Vecchi \(2017\)](#) completed such an enterprise for the case of Italy, covering more than one and half centuries of history.

Finally, geographic coverage. Take the case of the ex-French colonies: for most countries in this region, research based on microdata is in its infancy ([Gervais and Marcoux, 1993](#)). [Alfani and Tadei \(2017: 3\)](#) have recently reiterated the point “it is clear that most of our knowledge of inequality during colonial rule comes from information on British colonies in Eastern and Southern Africa. West African colonies and territories subjected to other colonial powers are much less well known”.

In this paper, we contribute to the literature by addressing each of these three limitations. We focus on Cameroon, Côte d’Ivoire, and Gabon, and provide new estimates of growth, inequality and poverty for the mid 1960s. We do this by using a new dataset constructed by harmonizing data from a number of historical household budget surveys (HBS). Section 2 outlines the economic context for the rest of the paper. We conclude that available statistics fail to provide a consistent ranking of the three countries. Section 3 deals with the sources used in our analysis. Section 4 illustrates the statistical methods that lead to the inequality and poverty estimates discussed in Sections 5 and 6. Section 7 concludes.

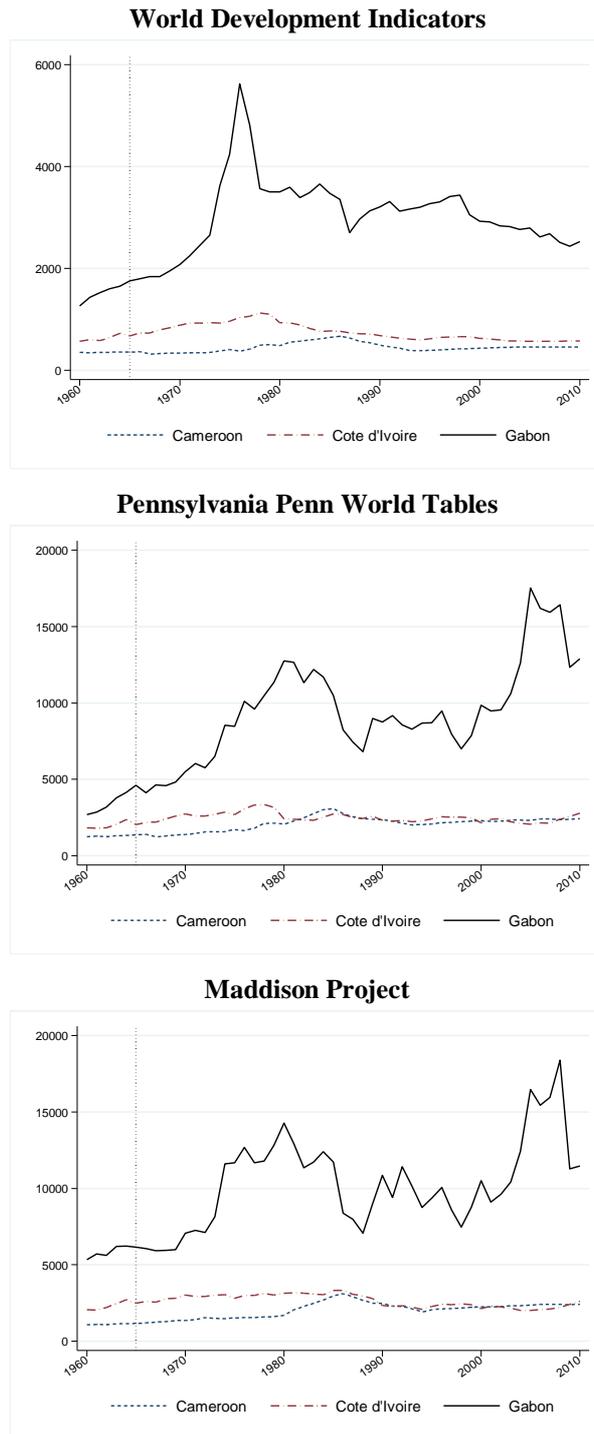
## **2 Living standards in Cameroon, Côte d’Ivoire and Gabon: what we think we know**

When it comes to checking our knowledge of the long-run evolution of living standards in any of the countries here studied, it is easy to realize that we think we know more than we actually do. The list of available indicators reviewed in this section is short, and they often conflict with each other: different indicators tell different stories, and so do different sources for the same indicator. While it is natural for different dimensions of wellbeing to evolve in different ways and at different paces over time, contradictions such as those illustrated in this section generate a sense of confusion, and possibly raise concerns related to data quality.

To illustrate, take the Gross Domestic Product (GDP). Estimates come from three sources: the World Bank World Development Indicators (WDI), the University of Pennsylvania Penn World Tables (PWT), and the dataset maintained by the Maddison Project. Development economists tend to use WDI, macroeconomists the PWT, while

economic historians and a growing group of economists seem to prefer Maddison's estimates.

**Figure 1 – GDP per capita, Cameroon, Côte d'Ivoire and Gabon, 1960-2000s**



Sources: WDI: Data Worldbank, GDP per capita (constant LCU) – PWT: penn tables Expenditure-side real GDP at chained PPPs (in mil. 2011US\$) per capita – Maddison: Maddison project GDP per capita (1990 Int. GK\$). All data are as available for download at May 15, 2018.

Figure 1 shows that in terms of levels of GDP per capita, the ranking of the countries is consistent throughout the period 1960-present day: Gabon is well above Côte d'Ivoire and Cameroon. On the other hand, Côte d'Ivoire and Cameroon remain pretty close to each other during the whole period. However, when we move away from levels and examine the dynamics of GDP for each country, the picture blurs.

Figure 1 shows the yearly series of GDP for the period 1960 onwards. The upshot here is that the intertemporal pattern of growth rates varies widely according to sources: during the five decades considered in the figure, Gabon's average yearly growth rate is slightly positive according to WDI (+0.8%), and remarkably fast according to Maddison and PWT (+2.6% and +3%). Similarly, growth rates vary widely across sources for both Cameroon and Côte d'Ivoire. The differences in the growth patterns in Figure 1 support our initial claim: the state of confusion is high, even when it comes to examining an indicator as fundamental and as closely monitored as GDP. Unless an agreement is reached on the reliability of the three sources, any historical account of the long-term performance of these countries would ultimately be driven by a judgment call.

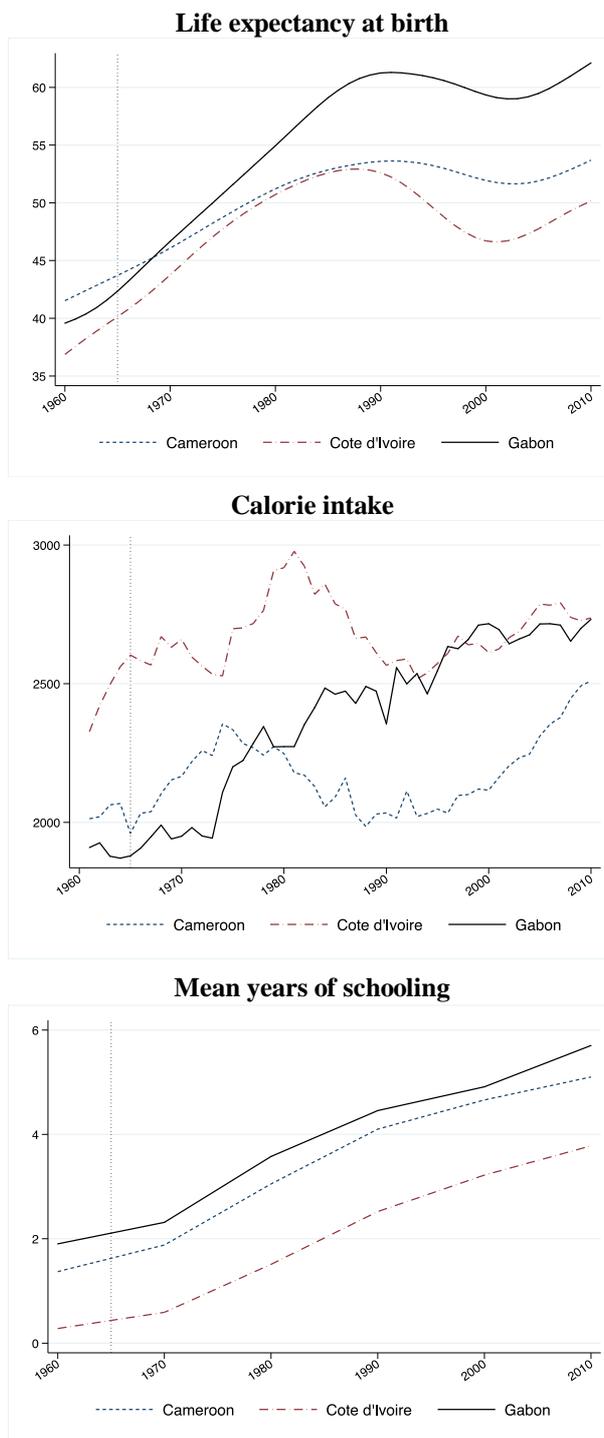
Other indicators of wellbeing can be called into question to resolve inconsistencies among GDP estimates, and to mitigate the limitations of a merely monetary proxy of living standards. As anticipated, piecing together different facets of human development – from health to human capital – does not yield a coherent picture, both in terms of levels and dynamics. Figure 2 shows the time series for life expectancy at birth (top panel), calorie intake (middle panel), and mean years of schooling (bottom panel). Three main messages emerge.

First, according to non-monetary indicators, the three countries are much closer than they are according to the GDP metric, and Gabon's primacy is not as overwhelming. Second, the dynamics of the three series tell widely different stories. While all series display a positive trend over the period considered, we observe divergence in the series of life expectancy<sup>1</sup>, convergence in the series of calorie intake, and constant distances among the three countries in the series of years of schooling. Third, the correlation between GDP

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<sup>1</sup> What we see in Figure 2 for life expectancy, also applies to other health indicators, including infant mortality (Baten and Blum, 2015).

**Figure 2 – Selected welfare indicators, Cameroon, Côte d’Ivoire, Gabon, 1960-2000s**



Sources: Life expectancy at birth: Data Worldbank, Life expectancy at birth, total (years) <https://data.worldbank.org/> - Calorie intake: FAO stat, Food supply (kcal/capita/day) <http://www.fao.org/faostat/> – Mean years of schooling: Leeuwen, Bas van and Jieli van Leeuwen-Li (2015). Average Years of Education via the Clio Infra database <https://www.clio-infra.eu/>

and other non-monetary indicators tends to be quite low (the correlation between of GDP and life expectancy for Cameroon surpasses 0.6, that between calorie intake and

the PWT measure of GDP for Gabon reaches 0.8, while all other cross-correlations are lower than 0.4).

A number of other indicators are available, even if they do not always cover the entire period. An interesting, if in some way tricky indicator is human height. According to the Clio Infra database, average height in 1960 and 1970 was largest in Cameroon, and lowest in Gabon: the richer the country, according to a ranking based on GDP, the shorter its people.

The conclusion to be drawn from these comparisons is that our knowledge of the developments of living standards in the three countries under examination over recent decades is inconclusive at best. This blurry picture, together with the need to shade light on the growth-inequality-poverty nexus motivate our search for new evidence based on a modern, state-of-the-art welfare indicator derived from historical household budgets.

### **3 Household budget surveys in Francophone Africa**

After World War II, the French Colonial regime was reshaped into a new political entity (*Union Française*) intended to replace the old colonial system. [Racine \(2017\)](#) argues that, in the mid-1950s, the French government was heavily pressured by international opinion to reconsider its relations with its overseas territories, in the midst of the turmoil of the Algerian war. In parallel, the future economic orientation of the Union was being elaborated under the *Troisième plan quadriennale de modernisation et d'équipement*, that planned a number of actions and set objectives for the years 1958-1961. In particular, it reiterated the government's commitment to participate in the improvement of the living standards of indigenous populations in the former colonies, while also tying the development of these territories to the "largest and most direct participation of its interested individuals". To this end, scientific research overseas was explicitly mentioned: "No field is more urgently called for than a policy of research. This will be organized in such a way as to be able to call on all the national research resources and to move towards the technical assistance of the *metropole* to its associated overseas countries. The overseas scientific and technological infrastructure will continue to be developed by the O.R.S.T.O.M. (Office de la Recherche Scientifique et Technique Outre-

Mer)” (p. 206).<sup>2</sup> All these factors contributed, after the mid 1950s, to the implementation of an increasing number of household budget surveys ([Hallu et al. 1970](#), [Gendreau 1987](#), [Binet 1962](#)).

After independence, the collaboration of the newly sovereign territories with the French experts continued and expanded, and new players, such as international super-national agencies, stepped in and greatly promoted the use of household budgets surveys. Ivory Coast, for instance, has been the object of one of the first LSMS ever conducted by the World Bank, from 1985 to 1988. As soon as data became available, scholars extensively exploited them ([Newman 1988](#), [Deaton 1988](#), [Glewwe 1988](#), [Grootaert et al. 1990](#), [Kakwani 1990](#), and [Grimm 2001](#), among the others). Later on, in parallel with surveys becoming regularly administered, medium- and long-term welfare analyses became possible. [Cogneau et al. \(2011\)](#) used LSMS and DHS data on height to retrieve the living standards of cohorts born between 1925 and 1960. [Cogneau et al. \(2014\)](#) used five household surveys, covering the years 1988-2008, to recount the “descent to hell from the stand point of poverty and living standards” in Ivory Coast.

Overall, it is difficult to overestimate the importance of household budgets in the welfare economics narrative. Given this premise, the time travel in the 1950s, 1960s and 1970s illustrated in the remaining sections is hopefully a significant contribution to our understanding of inequality and poverty trends in Côte d’Ivoire, Cameroon and Gabon.<sup>3</sup>

### 3.1 Côte d’Ivoire

Household budget surveys carried out in Côte d’Ivoire in the early 1950s were a continuation of the demographic studies of local urban areas first conducted in Senegal by the *Direction des Services de la Statistique Générale de l’AOF* (Diourbel and Ziguinchor in 1951, Thiès in 1953, St-Louis in 1954, Dakar in 1955). The same agency then conducted enquiries in Côte d’Ivoire’s Bongouanou (1955) and Abidjan (1956). With a sample of 560 families, the latter household survey is described by its author as “the first of its kind to have been carried out in French Africa” for both its significance

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<sup>2</sup> The O.R.S.T.O.M. played a central role in perpetuating France’s post-colonial domination on its ex possessions ([Bamba, 2016](#)). Most surveys gathered in this paper from the mid 1950s to the mid 1960s come from studies conducted by the O.R.S.T.O.M., see sections 3.1-3.3.

<sup>3</sup> For Côte d’Ivoire, inequality estimates based on the French *Annuaire Statistiques* (old-fashioned colonial national accounts) are produced by [Alfani and Tadei \(2017\)](#) from the late 1930s.

and its methods (probabilistic sampling, use of specially trained indigenous investigators and implementation of objective measures) ([Lonchamp, 1958 p.9](#)).

Indeed, apart from the earlier work of [Mersadier \(1955, 1957\)](#) in Dakar, Thies and St-Louis, on 136 families, we are aware of no other examples of urban family budget studies of a similar scale in French West Africa (AOF) before the 1960s. Instead, the study follows the already significant tradition of urban surveys conducted in the British colonies of Ghana (Accra 1953, Kumasi 1955, Sekondi Takoradi 1955), Nigeria (urban consumers 1953-1955) and Sierra Leone (Freetown 1951). As for its British pioneering counterparts ([Serra 2014](#)), the survey's implementation was met with difficulties: respondents' mistrust of interviewers, household composition mutations, and arduous traceability of women's barter transactions. These problems did not, however, severely impact the quality of the survey, as they were mitigated by the typology of population considered (wage workers) and the sound survey design (probabilistic sampling based on a freshly completed demographic study, replacement households carefully chosen, guests and lodgers consumption defined upfront and accounted for). A pilot survey previously carried out also emphasized the risk of underreporting of income, which was then stressed during the training of enumerators. In the final report, a wide set of variables and expenditure categories were contemplated and reported across eight spending brackets. In the four decades following its publication, the study was exploited extensively by authors who focused on various topics, including the analysis of food expenditure patterns ([Kaneda and Johnston, 1961](#)), dietary intake ([Dubresson, 1989](#)), processed food marketing ([Bosteen, 1993](#)), income elasticities at low income levels for different commodities ([Clark and Haswell, 1970](#)), or tax impact analysis ([Heian and Monson, 1987](#)).

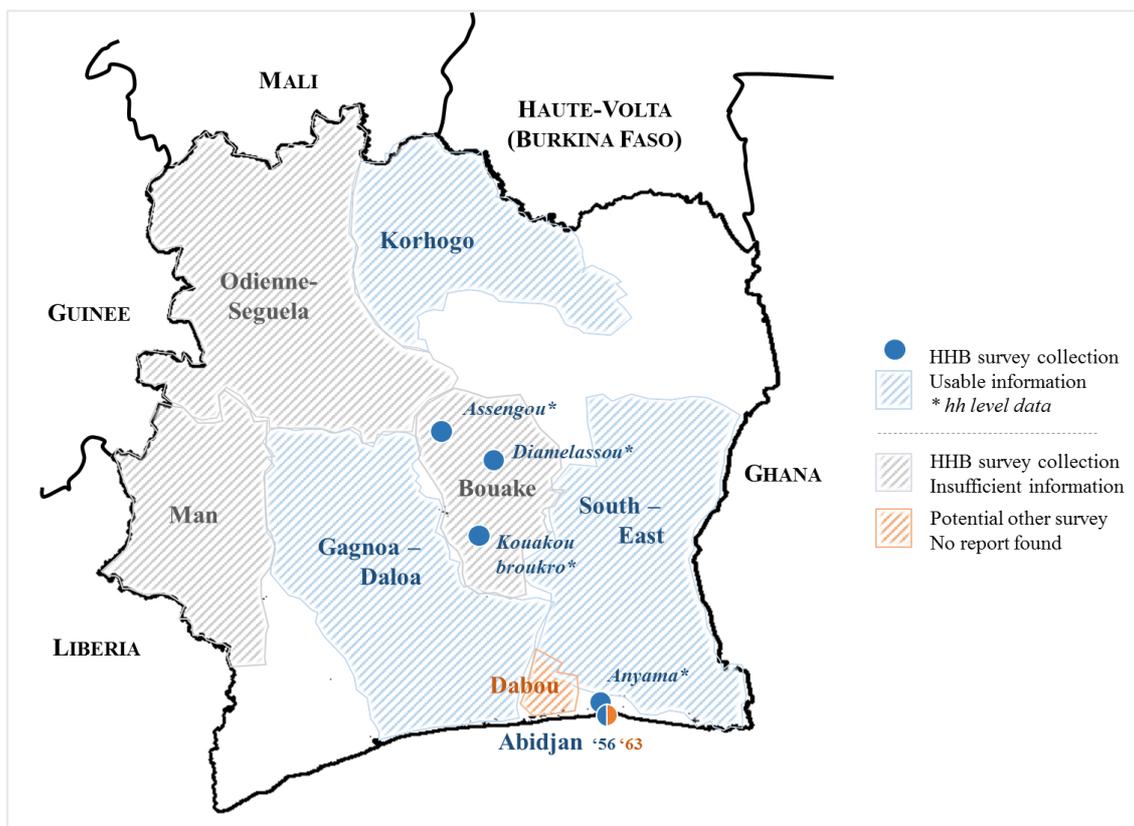
After independence in 1960, the *Ministère du Plan* launched a large program of regional studies. Côte d'Ivoire, as most of the newly independent colonies, aimed at gathering information about national economic resources and the standards of living of the population, to help design its economic policy. This effort was linked to the survival in power of the recent government ([Aubertin 1983](#)). In addition, many French institutions were commissioned in the ex-French overseas territories to work alongside the freshly created national statistical offices on those operations.<sup>4</sup> Therefore, demographic, housing,

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<sup>4</sup> The list includes, among others, the Institut national de la statistique et des études économiques (INSEE), the Office de la recherche scientifique et technique outre-mer (ORSTOM), the Société d'Etude pour le

agricultural, time use and household budget surveys were administered in several waves in Côte d'Ivoire's regions between 1962 and 1965.

**Figure 3 – Household budget in Côte d'Ivoire, 1955-1967**



Source: our elaboration.

A first set of these post-independence surveys covered in particular the Korhogo area<sup>5</sup> (Figure 3). The study focuses on the rural population, and features a whole volume reporting the results of a household budget survey covering 60 households ([Roussel et al., 1964](#)). This study is an essential part of our corpus of 1960s Ivorian surveys, being the one source representing the northern (and poorest) part of the country ([Aubertin, 1983](#);

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Développement Economique et Social (SEDES), the Société d'économie et de mathématiques appliquées (SEMA), the Compagnie d'Etudes Economiques et de Gestion Industrielle (CEGI), the Bureau pour le Développement de la Production Agricole (BDPA) and the Institut pour le développement économique et technique-Commission générale d'organisation scientifique (IDET-CEGOS)

<sup>5</sup> Bouaké and Man were also surveyed. In Bouaké, results are mainly presented under the form of averages for the whole sample. This level of aggregation precludes the use of the Bouaké survey for our current purposes. In Man, to the best of our knowledge, the specific results of the “budget-consommation” survey were never published.

[Bamba, 2016](#)). Tabulations provided in the final report are detailed enough, as we shall see in section 5, to be of use for welfare analysis.

A second wave of surveys, carried out between 1963 and 1964, covered the South-east ([Pescay 1967](#)), Daloa-Gagnoa ([République de Côte d'Ivoire SEC and OBM, 1966](#)) and Odienné-Seguela ([République de Côte d'Ivoire and IDET-CEGOS, 1968](#)) areas (Figure 3). Unlike the North, the South in general and the South-eastern region in particular featured a prosperous rural economy based on production and export of cash crops (coffee, cocoa, bananas, palm oil). The specifics of data processing and the level of detail of published information allow for the determination of consumption aggregates for two out of the three studies (South-East and Daloa-Gagnoa)<sup>6</sup>, comprising around 400 households each. While the first survey covered both the rural and urban population, the second focused on the rural households of Daloa-Gagnoa. In both regions, the rural economy was driven by cocoa and coffee production, and fieldwork took place between August 1963 and July 1964 – this allowed for two waves of visits, during the harvesting period and in leaner times.<sup>7,8</sup>

In parallel to the regional operations, local studies in about twenty towns and villages were also implemented, and resulted in as many publications including household- and individual-level data. In particular, data were identified for Assengou ([Michotte 1967](#)), Anyama ([Verniere 1966](#)), Kouakou-broukro ([Fride and al. 1966](#)) and Diamelassou ([Etienne and al. 1966](#)). In Assengou, where cotton production was steadily growing, the objective of the collection and study of household budgets was the analysis of the consequences of rural development on peasants' income and consumption patterns. The remaining three studies are brief and localized monographs. Table 1 outlines the essential features of these inquiries.

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<sup>6</sup> The final report of the Odienné-Seguela survey contains detailed breakdowns of income and expenditure by income sources and typology of products consumed for the whole sample, but information is averaged at the region level, thus precluding any distributional analysis.

<sup>7</sup> Households in the urban localities of Abengourou and Bongouanou, in the South-East area, were surveyed only once, for a period of one month.

<sup>8</sup> A last set of surveys, carried out between 1963 and 1965, comprised the urban and sub-urban areas of the capital city of Abidjan ([République de Côte d'Ivoire et al., 1962](#)) and the Dabou region. We were not able to recover the associated reports. Regarding Dabou, references to a demographic ([République de Côte d'Ivoire et al., 1966](#)) and a urban planning ([République de Côte d'Ivoire et al., 1965](#)) study were found, but we failed to trace any household budget survey associated with them.

**Table 1 – Household budgets in Côte d’Ivoire, 1956-today**

year	Area	Urban/ Rural	No of hh	No of indiv.	Pop. (000)	% total pop.	type of data
1956	Abidjan	U	560	2,507	350	8.8%	G
1962	Korhogo	R	60	923	125	3.1%	G
1963	South East	R+U	403	2,930	726	18.2%	G
1963	Daloa G.	R	376	2389	567	14.2%	G
1966	Anyama	SU	20	150	-	-	H
1967	Assengou	R	25	191	-	-	H
1962	Kouakou-B.	R	3	23	-	-	H
1962	Diamelassou	R	3	25	-	-	H
<b>Total 1960s</b>			<b>1,450</b>	<b>9,138</b>	<b>4,000</b>	<b>44.3%</b>	
1979	EBC	N	1,930	13,300	7,934	-	G
1985/88	EPAM (LSMS)	N	1,600	13,200	10,223	-	H
1993	DSA	U/R	9,600	56,600	13,623	-	H
1995	ENV	N	1,200	6,800	14,541	-	H
1998	ENV	N	4,200	24,500	15,885	-	H
2002	ENV	N	10,800	57,900	17,367	-	H
2008	ENV	N	12,600	59,400	19,498	-	H
2015	ENV	N	12,900	n/a	23,108	-	H

Notes and sources: col. 1 refers to the survey year; col. 2, LSMS stands for “Living Standards Measurement Study”, EPAM for “Enquête Permanente Auprès des Ménages” and ENV is for “Enquête Niveau de Vie”; col. 3: U denotes “urban”, R is for “rural”, SU for “sub-urban” and N for “National”; col. 6: “Total 1960s” refers to the population in 1965 according to the results of the regional studies synthesis operated in 1965, while data for the remaining years come from the “Population, total” indicator of the World Bank development indicator <https://data.worldbank.org/>; col. 8: G denotes “grouped data”, and H stands for “household level data”.

The dozens of surveys conducted in Côte d’Ivoire in the decade starting from 1955 defy much of the “uneven statistical topography” critique lobbed by Serra at household budget surveys in African ex-colonies, such as Ghana in the 1950s (Serra, 2014). The patchworked surface that they represent leaves very few areas of the country uncovered (Figure 3), thus diminishing the concern for representativeness. Serra also calls attention to the heterogeneity of published income-expenditure tables, due to the loose definition of the concept of “household budget”, often pegged to a specific government political agenda. In Côte d’Ivoire, while the various studies might have lacked coordination, they were carried out following a structured statistical plan, guidelines and shared objectives enclosed in the “Elaboration d’un programme d’études régionales en Côte-d’Ivoire” (Marciniak, 1962). Concepts, survey design and implementation, data collection and

processing remain heterogeneous between waves, as they were incrementally improved over time, or adapted to the population studied. However, in assessing the overall outcomes of the data collection effort in Sub-Saharan Africa from 1945 to 1966, [Gendreau \(1987\)](#) concluded that “the quality of the results yielded by these operations may be open to discussion, but demographically speaking, they are of considerable historical interest, as they are the first results obtained through scientific procedures for a key period in African history.” (p. 43).

In 1979, almost 20 years after independence, the Ivorian government launched a large scale survey on household budget and consumption (“Enquête Budget Consommation” EBC). With the help of the traditional French institutions SEDES and INSEE and the further expertise of the FAO and the World Bank, the survey was administered to a sample of 1,930 households divided into five major strata covering the entire country. Results were only published in 1984, seemingly due to the lack of available staff and the lengthy processing software training at the time ([Odounfa 1984](#)). In 1985, the LSMS replaced its predecessor, and set a new standard, in terms of statistical methodology, one that became a worldwide standard for developing countries. That said, the 1979 EBC is particularly worthy of our attention as it occurred precisely at the apex of the *Ivorian miracle*, in a period when scholars suggested that the country “was well on its way toward self-sustained development” ([Bamba 2016](#): 40).

### **3.2 Gabon**

The first large-scale statistical operation carried out in Gabon dates back to just after independence, when the 1960-1961 national population census was carried out ([République Gabonaise, 1965](#)). In fact, just like Ivory Coast, the Gabonese Government, helped by the *Ministère français de la Coopération*, elaborated in 1959 an ambitious statistical plan to evaluate the socio-economic status of the country and its development opportunities. The *Service national de la statistique*, then *Direction générale des statistiques* in 1976, was created to that end, and managed the pioneering statistical plan. While the first component of the program involved a population census, as well as demographic and agricultural studies at the national level, the second component consisted in measuring living standards both in the capital city of Libreville (1961) and in rural areas (1963). Both studies could count on an updated and relatively accurate, by

the standards of the time, sampling frame (one of the advantages of the new population census).

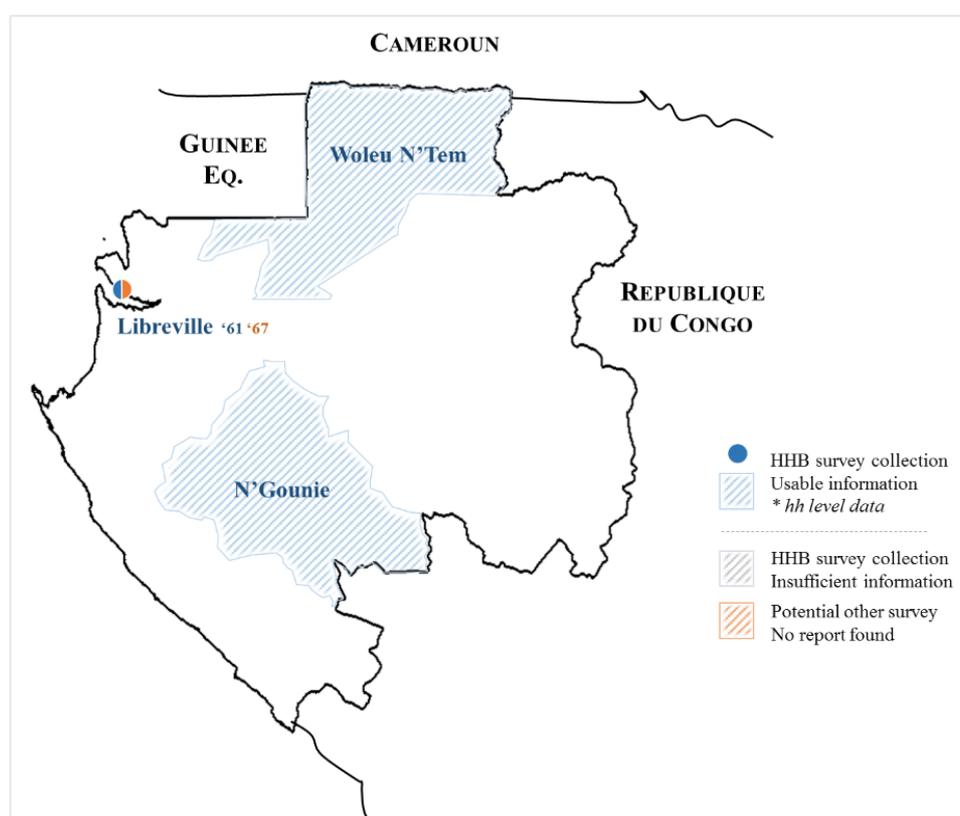
The study of Libreville aimed at analyzing household budgets, with a focus on income and expenditure ([Bascou-Brescane, 1969](#)). The field work spanned from July 1961 until March 1962 and involved 304 households. Most of them were headed by a salaried worker – employees from the public and private sector, skilled, unskilled, domestic workers and servants. Data capturing was carried out with a 1 month recall. The final results were published only in tabular format, by multiple criteria (socio-professional categories, ethnicity, household size, period in which the household settled in Libreville etc.), but with plenty of details on the structure of incomes and expenditures.

To make allowance for rural areas, two studies were also carried out in 1963 in the regions of NGounie and Woleu Ntem (Figure 4), which were claimed to give a fair representation of rural Gabon given their population size (both regions added up to 35% of the country's total population) and economic conditions. The inquiries, largely focused on nutrition, included distinct dietary surveys and were run by the Gabonese national statistical office in cooperation with the French INSEE. While the Woleu Ntem economy was heavily based on cocoa production (and coffee to a lesser extent), NGounie's economic drivers were forestry and wood industries, gold mining, coffee, groundnuts and trade.

In south Gabon, the study of Ngounie ([Verneuil, 1970](#)) was administered on the field from December 1962 until December 1963, and recorded the monetary budgets of 239 households, and the total budget of 143 of them (the whole region less the Fogamou district). Income and expenditure were surveyed for 28 days in each household, and presented in tabular format by district, ethnicity, occupational activity, household size and eight expenditure brackets.

In Woleu Ntem ([Tissier, 1970](#)), the northernmost region of the country, 230 households were interviewed throughout a year. Once again, the recall period for each household was of 28 days. Concerning income, another questionnaire was administered, to retrospectively reconstruct family revenues for the whole year, in order to correct for the seasonality of cocoa and coffee production. In any case, income and expenditure were reported on a monthly basis. Food auto-consumption was analyzed for 4 families out of 5 during a single week, and imputed to the rest of the sample at the end of the study, using a matching methodology. Table 2 summarizes the main features of household budget surveys in Gabon since 1961 to the present day.

**Figure 4 – Household budget Surveyed areas in Gabon**



Source: our elaboration.

**Table 2 – Household budgets in Gabon, 1961-today**

year	Area	Urban/ Rural	Nb of hh	Nb of indiv.	Pop. (000)	% total pop.	Grouped vs. hh level
1961	Libreville	U	304	1.181	31	7%	G
1963	Woleu Ntem	R	230	970	78	17.6%	G
1963	Ngounie	R	239	880	79	17.8%	G
<b>Total 1960s</b>			<b>773</b>	<b>3,031</b>	<b>444</b>	<b>42.3%</b>	
1994	EBC	U	-	-	1,059	-	H
2003	EDM	U	1,008	-	1,328	-	H
2005	EGEP I	N	7,913	37,600	1,403	-	H
2017	EGEP II	N	In progress		1,978	-	H

Note: col. 1 refers to the survey year; col. 2, EBC stands for “Enquête Budget Consommation” EDM for “Enquête Dépenses des Ménages” and EGEP is for “Enquête Gabonaise pour l’Evaluation et le Suivi de la Pauvreté”; col. 3, U denotes “urban”, R is for “rural”, and N for “National”; col. 8, G denotes “grouped data” meaning tabular data and H stands for “household level data”. col. 6: “Total 1960s” refers to the population according to the 1960/61 census. The data for the remaining years come from the “Population, total” indicator of the World Bank development indicator <https://data.worldbank.org/>. Data for 2017 refer to the population in 2016 (End date of the current revision).

### 3.3 Cameroon

The earliest household budget surveys identified in the country date back from the mid-1950s, and have a remarkably comprehensive coverage. The surviving documents, however, lack pieces of information that are key for inequality and poverty analysis, and were not used in this paper.<sup>9</sup>

Following independence in 1960, amidst the (French-guided) creation of new offices for the implementation of modern statistical operations, a series of studies were programmed throughout the country, until 1965. These operations involved the evaluation of living conditions in three main Cameroonian regions, whose economic drivers can be roughly identified, from North to South, with cotton production, cattle breeding and cocoa production.<sup>10</sup>

[Winter \(1966\)](#) reports a most important survey carried out in rural Adamaoua and the town of Ngaoundere in 1963-1964. [Clark \(1970\)](#) made use of the information regarding the daily working hours of men and women as a benchmark for other similar results available for central Africa. The survey in Adamaoua was directed in collaboration with O.R.S.T.O.M., and involved 124 households visited in 3 waves of 28 days each. Along with the diary surveys, a recall questionnaire related to income, expenditure and production was administered with a 1 year reference period at the first visit, and a 3 month reference period for the successive 2 visits.

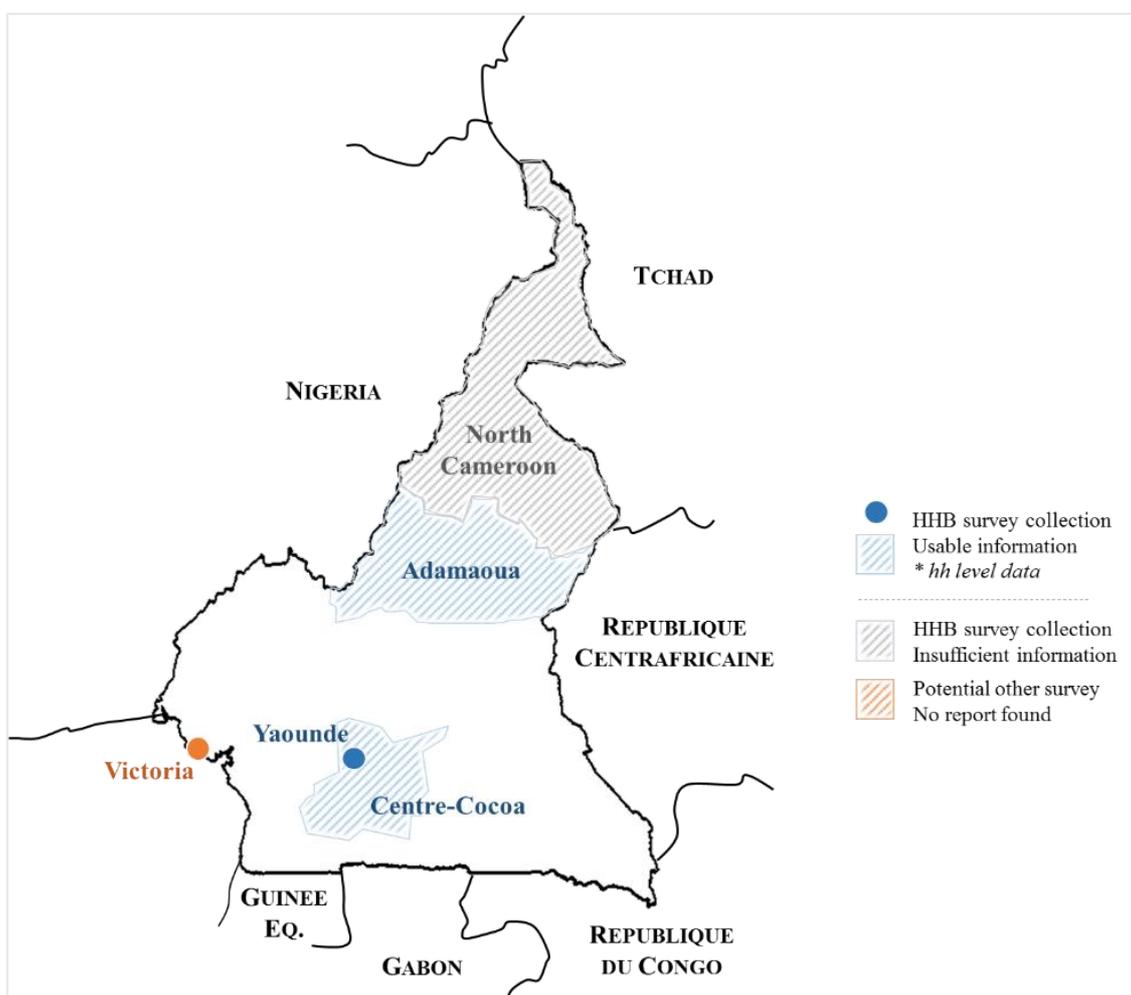
The cocoa area surrounding the capital city of Yaoundé, part of the vast plateau of South Cameroon (Figure 5), was the last macro-region studied, from August 1964 until July 1965. The study included both a household and a dietary survey ([Turlot, 1966](#)). The design, methodology and dissemination was very similar to those of the above-mentioned Adamaoua survey: each of the 90 interviewed families was visited 3 times during the year (21 days of observation for each visit) and the resulting yearly household budget was the product of the various recall and diary modules.

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<sup>9</sup> [Pauvert and Lancrey-Javalle \(1957\)](#) studied 43 families in Evodoula in 1954. From 1954 to 1956, Jacques Binet, research director at the ORSTOM, was entrusted with the implementation of two household budget surveys in the Southern cocoa area and the North of Cameroon, with much larger samples, reaching 500 families.

<sup>10</sup> The first survey in 1960-1961 ([République Fédérale du Cameroun, 1965](#)) focused on the northern Cameroon. Unfortunately, we did not manage to recover the raw data related to this survey.

**Figure 5 – Household budget Surveyed areas in Cameroon**



Source: our elaboration.

The first detailed analysis of household budgets in urban areas for the post-colonial period in Cameroon was conducted in the Capital city of Yaoundé in 1965 ([Rathery and al., 1967](#)). The 851 households sampled were visited twice for a period of 30 days. Recall questionnaires were also used in this case. The level of auto-consumption (around 4% of total expenditure on average) was also assessed and taken into account. The fourth chapter of the final report analyzes expenditure with respect to 18 income levels.

It is worth noting that most Cameroonian studies report detailed lists of common good and food item prices, often used for the evaluation of auto-consumption in rural areas. This information is precious for modern analysis, in that it has the potential to help fine-tune the imputation of auto-consumption, to serve as the basis for the computation of spatial deflators, and to support the construction of a poverty line.

**Table 3 – Household budgets in Cameroon, 1963-today**

year	area	Urban/ Rural	Nb. of hh	Nb. of Indiv.	Pop. (000)	% total pop.	Grouped vs. hh level
1963	Adamaoua	R	124	501	154	3%	G
1964	Center- Cocoa	U	90	408	532	10.3%	G
1965	Yaoundé	U	851	2,476	90	1.75%	G
<b>Total 1960s</b>			<b>1,065</b>	<b>3,385</b>	<b>5,150</b>	<b>15.1%</b>	
1983	EBC	Nat	5,500	31,000	9,445	-	H
1996	ECAM 1	Nat	1,731	10,300	13,812	-	H
2000	EDM	U	1,884	10,400	15,274	-	H
2001/02	ECAM 2	Nat	10,992	56,400	15,672	-	H
2007	ECAM 3	Nat	11,390	51,800	18,395	-	H
2014	ECAM 4	Nat	12,847	n/a	22,240	-	H

Note: col. 1 refers to the survey year; col. 2, EBC stands for “Enquête Budget Consommation” EDM is for “Enquête sur les Dépenses des Ménages” and ECAM is for “Enquête Camerounaise Auprès des Ménages”; col. 3, U denotes “urban”, R is for “rural”, and Nat for “National”; col. 8: “G” denotes grouped data, “H” stands for “household level data”. col. 6: “Total 1960s” refers to the population in 1965 according to the regional studies of 1961-1964 that were summarized in a “Tableau de la population du Cameroun” by the Institut de recherche scientifique du Cameroun (IRCAM) in 1965. The data for the remaining years come from the Population, total indicator of the Data World Bank <https://data.worldbank.org/>.

Table 3 shows that the overall population coverage of the sources for Cameroon is lower than in Côte d’Ivoire and Gabon (15% vs. 42% in Gabon, 44% in Côte d’Ivoire). The three studies nonetheless provide an overview of both rural and urban realities, including the capital city. The inventory could potentially be incremented were the results of the North Cameroon study be recovered. Furthermore, another budget-consumption study conducted in 1966 in the city of Victoria (now Limbe) is also mentioned by [Fotso \(1986\)](#). Indeed, when it comes to African historical data, it appears that many sources are yet to be uncovered.

#### 4 Methodology

Most of the 1960s sources we rely on for our analysis only report summary statistics and frequency tables summarizing the expenditure distribution, rather than actual individual-level records, which, in all likelihood, have not survived. The problem we are faced with – extracting information on poverty and inequality from grouped data – is by no means a new one. Many methods have been developed to solve it, starting from the 1970s. In fact,

one might argue that the portfolio of alternative approaches has grown so rapidly that the main challenge has become to pick the “best” method out of the many available. This includes the many different functional forms that have been proposed as parametric approximations of the empirical distribution of incomes, from the Pareto distribution, which appeared in 1895, all the way to the generalized beta of the first and second kinds, which were shown to be not only very successful in fitting income data, but also to subsume many of the distributions proposed up to then as special or limiting cases ([McDonald 1984](#), [Jenkins 2009](#), [2017](#)).

A common situation is when data are presented as a set of income intervals, together with the mean income and the number of individuals in each interval. Figure 6 illustrates how data look like in a typical source that reports data in grouped form, for a survey carried out in 1963-64 Cameroon. Under this circumstance, analysts have often relied on simple *interpolation methods* or on methods based on parametrized Lorenz curves ([Datt 1998](#)). [Cowell and Mehta \(1982\)](#) and [Cowell \(2000\)](#) illustrate the general problem and provide an illustration of these approaches. The recent interest in social tables and the possibility of pushing the analysis further back in the past that comes with it, has greatly revived the interest for fitting curves, and more and more refinements on existing techniques are being experimented with ([Milanovic 2011](#), [Modalsli 2013](#)).<sup>11</sup>

In this paper, we explore a different approach, first proposed by [Shorrocks and Wan \(2008\)](#). The peculiarity of the method is that it produces a *synthetic sample* of observations from a set of Lorenz coordinates, effectively recreating microdata that “match” the available aggregate information (details are discussed in the methodological appendix). The need to go beyond interpolation methods is threefold: first, we would like to be able to combine more than one source with grouped data – this would allow us to take full advantage of the many sources that are available, as we have seen in section 3, for the same country in the same period of time. Secondly, dealing with microdata gives the advantage of exploiting the analytical tools commonly used today, but that require microdata: this is the case of stochastic dominance analysis ([Atkinson 1970](#)), as well as of most dynamic decomposition techniques ([Datt and Ravallion 1992](#)). Thirdly, the

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<sup>11</sup> The World Bank has developed a software (POVCAL) that automates the interpolation of tabular data and facilitates the estimation of inequality ([Datt 1998](#)). [Minoiu and Reddy \(2009\)](#) provide a critical assessment of this tool.

availability of microdata, even if synthetic, for the surveys belonging to the past, makes it possible to splice historical datasets with modern data. Ungrouping grouped data *à la Shorrocks and Wan (2008)* makes all this doable.

**Figure 6 – Example of grouped household expenditures**

Tableau 42						
REVENUS MONETAIRES, DEPENSES, STRUCTURES DES DEPENSES + DES MENAGES DE L'ADAMAOUA SELON LA TRANCHE DE REVENUS MONETAIRES (FCFA)						
TRANCHES DE REVENUS PAR MENAGE	- 10.000	10.000 à 19.999	20.000 à 29.999	30.000 à 49.999	50.000 et +	BROUSSE
Taille de l'échantillon (nombre de ménages)	35	24	27	22	16	124
% après pondération	281	185	210	180	144	1.000
Nb. moy. de pers. par ménage (1)	3,02	3,42	4,22	4,61	6,12	4,12
" " d'U.C. " "	2,28	2,49	2,94	3,20	4,05	2,91
" " d'actifs " " (2)	2,34	2,42	2,67	2,96	3,45	2,77
(1)	1,29	1,41	1,58	1,56	1,77	1,49
(2)						
<b>REVENUS MONETAIRES</b>						
- Par ménage	6.030	15.100	24.280	37.940	83.290	28.660
(par an. FCFA) - Par personne	2.000	4.420	5.750	8.230	13.610	6.960
- Par actif	2.580	6.240	9.090	10.720	24.140	10.350
<b>DEPENSES +</b>						
- Par ménage	6.430	15.330	22.260	31.740	74.330	26.030
(par an. FCFA) - Par personne	2.130	4.480	5.270	6.890	12.150	6.320
- Par U.C.	2.820	6.150	7.570	9.920	18.350	8.950

Note: data are expenditures (FCFA) in Adamaoua, Cameroon for 1963-64. Source: Winter (1966).

Once the grouped-to-synthetic data transformation has taken place, the analyst can pool together ungrouped samples from any number of sources available. This is what we do in section 5 for Côte d'Ivoire, Cameroon and Gabon. Ideally, we would like to be able to produce datasets that approach nationally representative samples as closely as possible, and to do so, we have to account for the relative size of each of the constituting parts of the pooled dataset (that is, the regions for which we possess grouped data) in the true

population. This can be accomplished by post-stratification, that is, by creating a set of expansion factors that adjust the weight of the observations in each stratum, so as to match the true proportion of each stratum in the national population ([Holt and Smith, 1979](#)). This use of post-stratification was implemented, for instance, by [Rossi et al. \(2001\)](#), [A'Hearn et al. \(2016\)](#), and [Vecchi \(2017\)](#).

One final adjustment is made to the ungrouped, post-stratified datasets for each of the three target countries. Local imperfections are expected to characterize any empirical CDF, especially in the presence of an uneven distribution of the observations across the strata: one will be faced with spikes and troughs that originate from limitations of the method, certainly not a feature of the real data. To gain protection against such defects, and obtain robust estimates, we fit a Generalized Beta of the second kind to the data, using maximum likelihood methods, and conduct the rest of the analysis based on the synthetic observations generated by the model instead of the “raw” post-stratified synthetic data. As argued by [Jenkins \(2009\)](#), this four-parameter distribution “provides an excellent description income distributions” (p. 392).

**Figure 7 – Ungrouping, pooling and re-weighting**

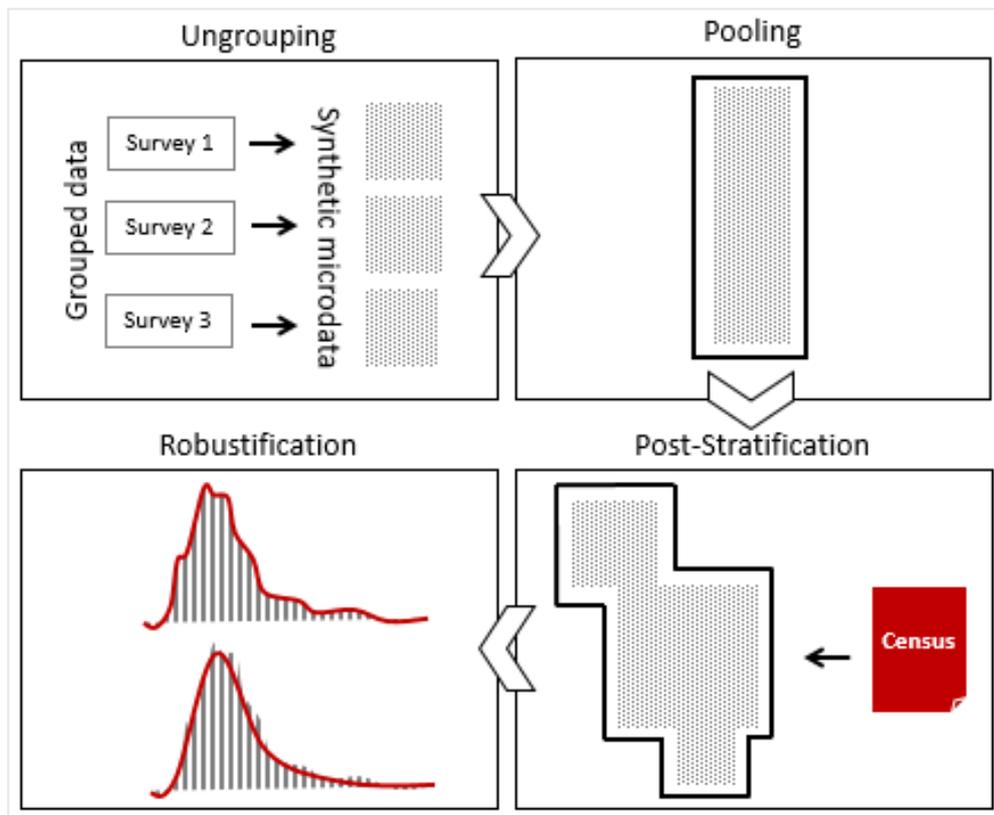


Figure 7 summarizes the sequence of steps that we have described in this section with the aim to produce nationally representative estimates of the empirical PDF starting from a collection of heterogeneous and un-coordinated historical surveys.

## 5 Poverty and Inequality Estimated: The 1960s

The methodology outlined in section 4 can be used to construct the empirical cumulative distribution functions (ECDFs) for each of the three countries under examination. The ECDF is arguably the curve that best summarizes the distribution of income or expenditure in a country, and is the main analytical tool used in the rest of the paper. The procedure requires three steps: we need to *i*) ungroup data that are only available in tabular grouped form (as is the case for most of the sources described in section 3), *ii*) transform the expenditures of each survey into a common constant-price currency, and *iii*) create expansion factors (weights) to be associated with both synthetic and genuine household-level observations.

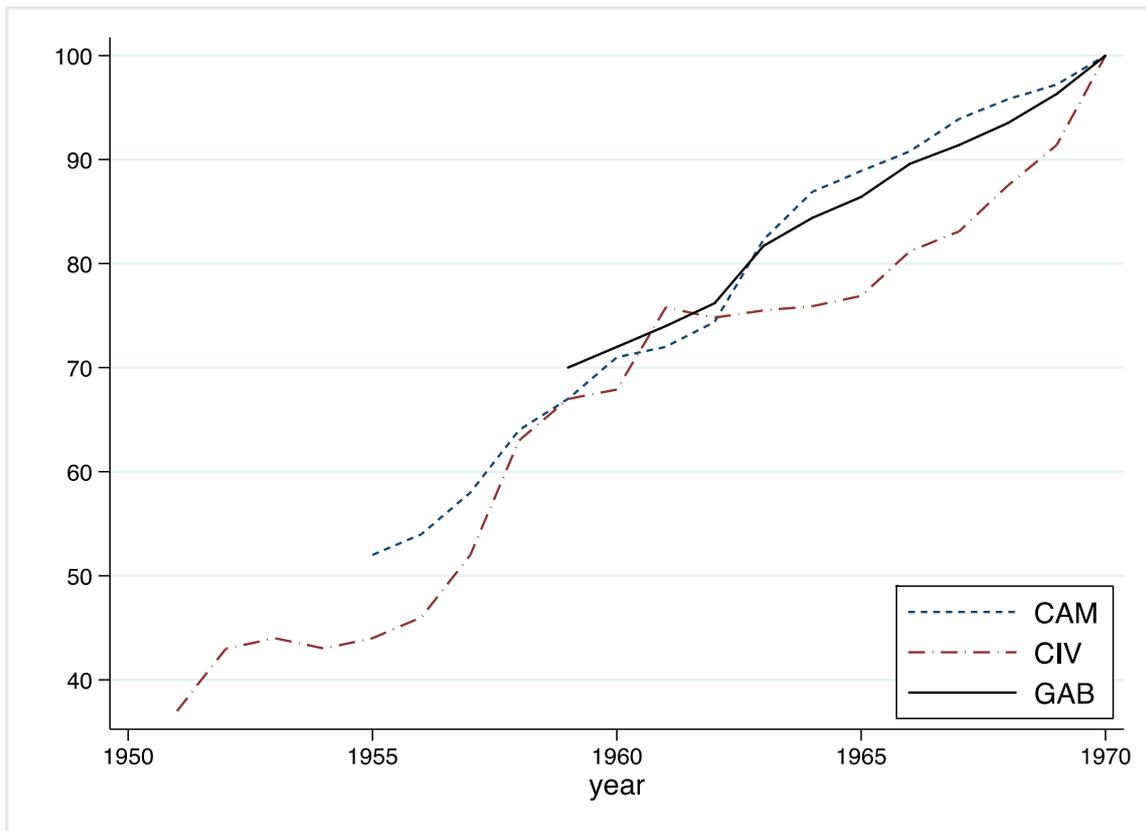
The first step, ungrouping tabular data for the three target countries, implies the choice of a specific functional form – this is required to initialize the [Shorrocks and Wan \(2008\)](#) algorithm. Our strategy is to use the simplest solution, the lognormal distribution, and to carry out sensitivity analysis to ensure that results are robust to this choice.

The second step consists in arranging the data *as if* all surveys had been carried out in the same year. While Section 3 makes clear that this is not the case – our sources span the years between the late 1950s and the mid 1960s – we proceed by collapsing all data into a single year, using a consumer price index to adjust all monetary variables for inflation. In particular, we choose 1965 as a benchmark year, and use the CPI series from [Mitchell \(2013\)](#).<sup>12</sup> Figure 8 shows a visual summary of the CPI trends in Cameroon, Côte d’Ivoire and Gabon during the years 1956-1970. Overall, the series trend together, with no breaks in the time period under examination. We proceed to relate all expenditures to 1965, using the appropriate indices for each country.

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<sup>12</sup> Mitchell (2013) is a useful compendium, but other sources are available. We have explored other sources, but found no significant differences with Mitchell’s series,

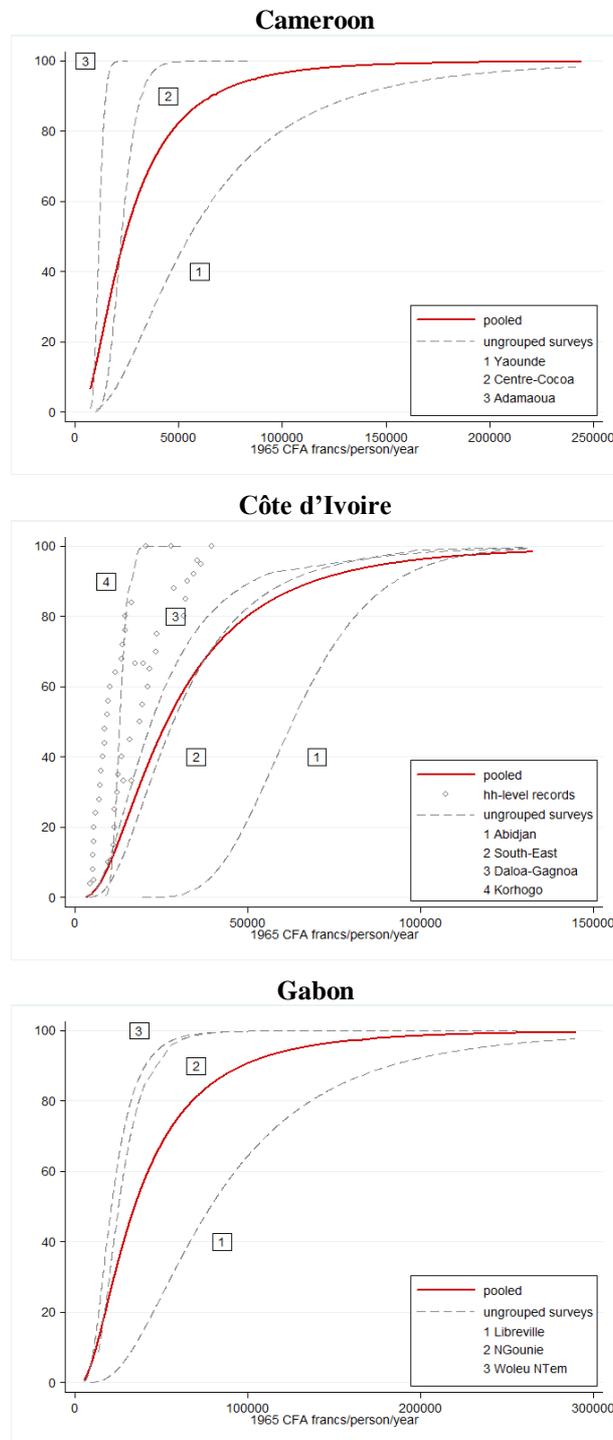
**Figure 8 – Consumer Price Indices for Cameroon, Côte d’Ivoire and Gabon (1956-1970)**



Source: Mitchell (2013).

Once expenditures have been transformed into 1965 CFA Francs, synthetic observations can be pooled together and added to other household-level observations. Figure 9 shows the results of steps one and two, and highlights how, for each of the three countries under consideration, the distributions of per capita expenditures obtained from each individual ungrouping procedure (as well as the genuine household-level observations) are consolidated into a country-level pooled distribution (red lines). We shall refer to these curves as “unweighted ECDFs”. Why unweighted? The reason lies the fact that the ECDFs in Figure 9 offer no guarantee to be representative of the population. Despite the efforts to cover all segments of the population, a collection of independent historical sources cannot meet the standard of modern probabilistic surveys, certainly not in terms of statistical representativeness. This is why we need to take a third step, which involves the post-stratification of the pooled data ([Holt and Smith, 1979](#)).

**Figure 9 – Unweighted Cumulative Distribution Functions, 1965**



Source: our estimates.

Note: distributions are trimmed (at the 99th percentile) to facilitate the reading of the graph.

Table 4 shows selected summary statistics for each survey, for each country. Two issues are worthy of a comment. First, the coverage of our dataset before post-stratification given at the bottom of each panel. It is slightly below 50 percent for Côte d'Ivoire and

Gabon, but is as low as 15 per cent for Cameroon. This suggests that our historical household budgets are likely to produce preliminary and use-at-your-own-risk estimates for the latter country, while we are entitled to higher optimism for Côte d'Ivoire and Gabon.

A second comment relates to the effect of post-stratification on the means and the medians of the national distributions (columns 1 and 2). All countries become “poorer” on average after post-stratification, because the weight of synthetic observations from the richer and smaller capital cities is reduced, with respect to that of poorer and more populous rural areas. Post-stratification has the smallest effect on mean per capita expenditures of Côte d'Ivoire, while median per capita expenditures are least affected in Cameroon.

Overall, the effect of posts-stratification is driven by the interplay of several factors (how dispersed expenditures are across regions within a country, how far unweighted population sizes are from actual population sizes given by the census), which determine the final shape of the post-stratified distributions and their distance from the unweighted ones. Distributions for the three countries recede quite significantly, as expected from the composition of underlying sources (see figure A2 in the appendix). This does not amount to say that the larger the distance, the poorer the coverage of the data, but it certainly makes the analyst aware of the fact that population-census based weights play an important role in the analysis, as they offset data coverage deficiencies.

The end result of the process is a set of three expenditure ECDFs for Cameroon, Côte d'Ivoire and Gabon in the year 1965 (Figure 10). For the reasons outlined above, estimates for Cameroon should be handled with more care than those for the remaining countries. In fact, given the low geographic coverage, we prefer to stay on the safe side, and focus our comments on Côte d'Ivoire and Gabon.

If we are to believe to Figure 10, Gabon and Côte d'Ivoire look very similar in 1965. The two ECDFs are very close to each other, implying that not only mean and median PCE are not far apart (which we saw in Table 4), but also that all other distributional statistics are close. One of the advantages of the method used in this paper is exactly that the distributions can be interrogated in many of the same ways as any distribution obtained from modern household budget surveys. For instance, this allows us to investigate both

inequality and poverty. Regarding the former, Table 5 reports a wide selection of inequality measures.<sup>13</sup>

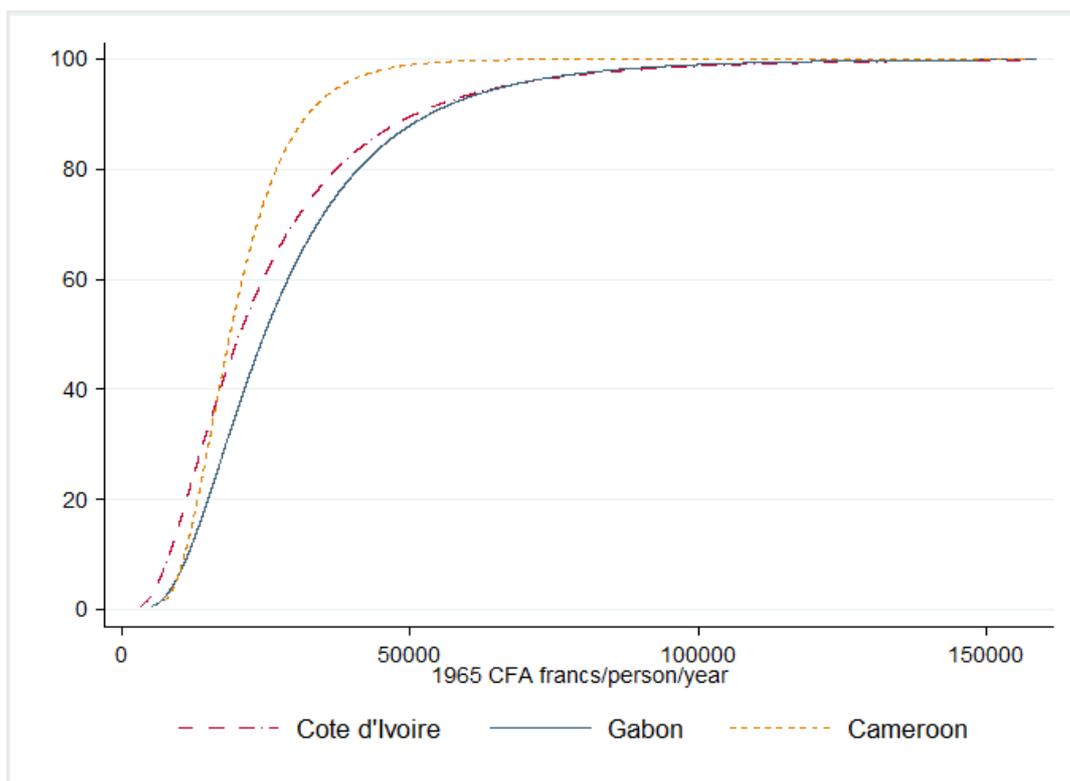
**Table 4 – Summary statistics before and after post-stratification, 1965**

	mean PCE	median PCE	population size	% national population
	(1)	(2)	(3)	(4)
<b>Côte d’Ivoire</b>				
Abidjan & urban periphery	60,486	56,457	411,000	10
East Forest	35,085	26,102	867,210	21.1
West Forest	28,051	21,236	1,249,440	30.4
Savannah	13,064	12,790	986,400	24
Centre	14,371	11,712	595,950	14.5
<i>CIV 1965 (post-stratified)</i>	<i>27,198</i>	<i>18,025</i>	<i>4,110,000</i>	<i>100</i>
<i>CIV 1965 (unweighted)</i>	<i>35,395</i>	<i>23,801</i>	<i>1,783,740</i>	<i>43.4</i>
<b>Gabon</b>				
Libreville	97,769	82,099	31,098	7
North	29,029	24,954	177,706	40
South	23,921	20,762	235,460	53
<i>GAB (post-stratified)</i>	<i>31,134</i>	<i>23,057</i>	<i>444,264</i>	<i>100</i>
<i>GAB (unweighted)</i>	<i>50,240</i>	<i>28,206</i>	<i>187,922</i>	<i>42.3</i>
<b>Cameroun</b>				
Yaoundé	71,668	56,674	87,550	1.7
North	11,753	11,195	1,483,200	28.8
South	23,294	21,598	3,574,100	69.4
<i>CAM (post-stratified)</i>	<i>20,790</i>	<i>19,760</i>	<i>5,144,850</i>	<i>99.9</i>
<i>CAM (unweighted)</i>	<i>35,572</i>	<i>21,156</i>	<i>772,500</i>	<i>15</i>

Notes: PCE stands for “per capita expenditure” (1965 CFAF/person/year). Source: columns 2-3, our estimates based on the sources discussed in section 3; col. 4 national population censuses.

<sup>13</sup> Bootstrapped standard errors are omitted here, not to clutter the Table, but are available from the Authors upon request.

**Figure 10 – CDFs of per capita expenditure in Cameroon, Côte d’Ivoire and Gabon, 1965**



Source: our estimates.

Note: distributions are trimmed (at the 99<sup>th</sup> percentile) to facilitate the reading of the graph.

Quantile ratios are straightforward indicators. The 90/10 ratio is the ratio between the 90<sup>th</sup> percentile and the 10<sup>th</sup> percentile. For Côte d’Ivoire, the 90/10 ratio is equal to 5.3, which means that the poorest person of the richest 10 percent of the population consumes 5.3 times as much as the richest person of the poorest 10 percent.<sup>14</sup> This is significantly higher than the 90/10 ratio in Gabon. Quantile ratios are rough inequality measures, totally insensitive to what happens in other parts of the distribution. If we use other indicators, we still find that the distribution of living standards in Côte d’Ivoire is significantly more concentrated than in Gabon. This ranking is robust to the choice of the inequality measure\_ with the exception of the half coefficient of variation squared\_ , that is, it holds true no matter whether we use the class of generalized entropy indices ([Shorrocks, 1980](#)), or the Gini Index. For most of the indices listed in the bottom panel of Table 5 we find that inequality is significantly higher in Côte d’Ivoire than in Gabon.

<sup>14</sup> Note that the 90/10 ratio can be decomposed as the product of the 90/50 ratio times the 50/10 ratio, and the decomposition tells us to what extent the 90/10 ratio is driven by inequality in the top of the distribution versus inequality at the bottom end.

**Table 5 – Descriptive statistics of PCE (1965 CFA/person/year)**

	<b>CIV</b>	<b>GAB</b>	<b>CAM</b>
<b>Selected percentiles</b>			
10th	9,686	12,769	10,377
25th	12,246	16,886	13,672
50th	18,025	23,057	19,760
75th	35,082	31,161	22,867
90th	51,436	49,477	27,910
<b>Quantile ratios</b>			
p90/p10	5.3	3.9	2.7
p90/p50	2.9	2.1	1.4
p10/p50	0.5	0.6	0.5
p75/p25	2.9	1.8	1.7
<b>Generalized Entropy Indices</b>			
Mean Log Deviation	28.8	23.2	10.5
Theil	32.0	29.5	12.7
Half squared CV	49.0	54.2	21.8
Gini index	41.9	37.5	24.4

Source: our estimates.

A final remark on poverty. Even in the absence of a poverty line, Figure 10 gives some clear-cut results. If we trust the estimated ECDF for Cameroon, then we would conclude that poverty is always higher in Cameroon than in Gabon at least. What we observe is that the Cameroon first-order-stochastically dominates Gabon ([Atkinson, 1987](#)), that is no matter where one draws the poverty line, the headcount ratio (as well as any other member Foster-Greer-Thorbecke poverty class measures) would always be higher in Cameroon than in Gabon. This is a first, very robust result that we obtain from Figure 10. A second remark refers to the comparison of poverty between Côte d’Ivoire and Gabon. Here we observe no FOD, nor do we find higher-order stochastic dominance, meaning that in terms of poverty rates, the distance between Gabon and Côte d’Ivoire is small. This is in line with a number of indicators examined in section 2, and gives support to the thesis that the two countries – contrary to what GDP-based indicators would suggest – enjoy similar living standards. Caution is still in order, because Figure 10 makes no allowance for other factors that should be considered, such as differences in prices between the countries, differences in the demographic structure, lifestyles and others ([Ravallion, 2016](#)).

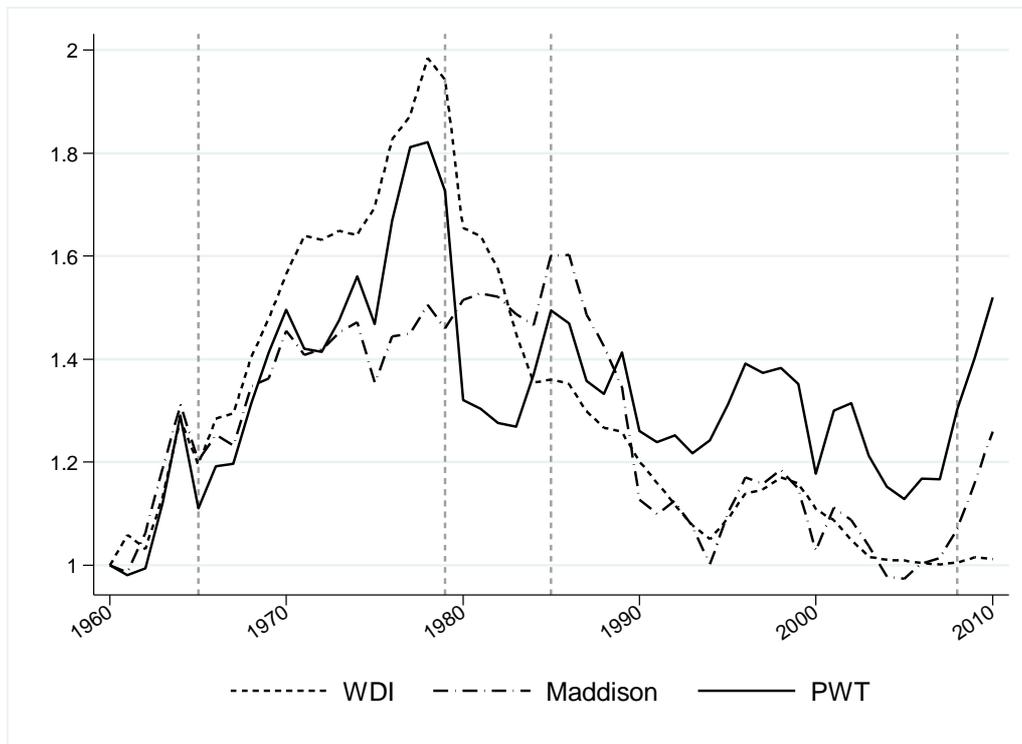
## 6 Côte d'Ivoire, 1965-2015

In this section we focus on Côte d'Ivoire, with the aim of identifying inequality and poverty trends during the last 50 years. Côte d'Ivoire has attracted the interest of several scholars in the field of poverty and inequality analysis (for instance, [Glewwe, 1988](#); [Grootaert, 1995](#); [Grootaert and Kanbur, 1995](#)), in part because of its peculiar post-independence development history – one of growth followed by decline. The use of survey-based estimates for 1965 and 1979, allowed by our collection of ungrouped household budget data, is a novel addition to this literature, which has focused on the period following the 1980s.

At independence, in 1960, the economic structure of Côte d'Ivoire was similar to many countries at the early stages of economic development: agriculture accounted for more than 50 percent of GDP, and about 90 percent of the population depended on agriculture for their income. At the same time, Côte d'Ivoire was believed to be the richest country among all the French colonies in Africa ([O'Connor, 1972](#)). In the aftermath of independence, economic growth was fast. Unsurprisingly, estimates on the yearly average growth rates during the first two decades are not in agreement, but Côte d'Ivoire clearly stands out as a frontrunner in the region. Stability, both economic and political, seems to have played a key role in promoting living standards in the country from 1960 to, roughly, the end of the 1970s. By the end of the 1970s, the country's buoyant economic growth came to a halt. Economic recession, locally denominated "la conjuncture", set in. Figure 11 shows that, according to WDI and PWT estimates, there are two distinct periods in the per capita GDP series: a "boom" period, from 1960 to (about) 1979, and a period of economic decline, from 1980 to the 2000s.

With the beginning of the 1980s, concerns about the stability of the Ivorian government began to spread: President Houphouët-Boigny's advancing age and the lack of a designated successor stoked the fear that the state would scale down its role in preserving political and macroeconomic stability ([Mingst, 1988](#)). The 1980s were characterized by the effort to implement reforms and adjustment programs of the kind usually associated with the World Bank and the IMF. During these years "the Ivorian authorities have been mainly concerned with growth issues and structural reforms, considering the problems of income distribution and poverty as secondary" ([Grimm et al. 2001](#): 4).

**Figure 11 – GDP per capita (1960 = 100), in Côte d’Ivoire, 1960-today**



Note: vertical bars denote the years where household budget surveys used in this section were carried out.

Whether the effects of such reforms have been detrimental to the poor is not uncontroversial. For the case of Côte d’Ivoire, [Demery and Squire \(1996: 55-6\)](#) argued that “Cote d’Ivoire was seriously fettered in its adjustment because of its obligations to maintain nominal exchange rate parity. Unable to follow an expenditure-switching policy and unwilling to introduce needed market liberalization to make its internal adjustment strategy work, the country experienced negative growth and increasing poverty. If there is any message coming from the Ivorian experience, it is that delays in adjustment make matters much worse for the poor.”

Regardless of any assessments of the effects of structural reforms, survey data paint a far more dramatic picture of the *fall of the elephant* from the late 1980s ([Cogneau et al. 2014](#)) with respect to macroeconomic data: “Between 1988 and 1993, according to national accounts, GDP per capita [again] fell by US\$100 and final private consumption per capita was reduced by 16 per cent. Our survey data indicates an even more dramatic collapse of household consumption per capita, from US\$2.92 to US\$2.02 per capita and per day respectively (constant 2005 international dollars), i.e. a 30 per cent reduction.”

From a methodological standpoint, the comparison of inequality and poverty over time requires that two issues be addressed. First, the consistency of the definition of the living standards indicator, that is, the extent to which the variable “per capita expenditure” has been constructed consistently across surveys. Secondly, the estimation of the absolute poverty lines and the mechanism used to update their value over time.

How consistent is each survey with the others? [Beegle et al. \(2012\)](#) show that small changes in survey design can have a large impact on both inequality or poverty trends. The “details” related to the method of data capture (e.g., diary versus recall), the analytical units (e.g., individuals versus households), the reference periods for which consumption is reported (whether on weekly, fortnightly, or monthly basis), and the degree of commodity detail greatly matter. There is little that can be done to improve the consistency of the data that we will be using in this section. But little is likely in need to be done. All surveys define a welfare indicator based on total expenditure, and all transform total household expenditure in per capita terms. The definition of per capita expenditures includes both monetary and in-kind consumption expenditures. Table 6 shows summary statistics of per capita expenditure for years in which surveys are available.

**Table 6 – Per capita expenditure (2008 CFA Francs/person/year) by decile, 1965-2015**

	1965	1979	1985	2008	2015
Deciles	(1)	(2)	(3)	(4)	(5)
1(poorest)	111,868	130,198	131,927	74,428	77,359
2	169,816	171,307	219,177	121,528	128,578
3	188,765	186,934	284,312	156,154	164,951
4	205,877	210,088	351,528	189,178	198,049
5	237,996	238,889	428,418	226,375	232,596
6	306,992	267,571	519,217	270,345	276,522
7	385,707	338,588	631,599	327,177	333,025
8	533,711	556,338	790,632	401,495	406,322
9	698,541	898,609	1,022,118	537,785	533,758
10	1,333,095	2,247,041	1,902,246	1,123,646	1,056,566
Average	416,909	524,556	627,301	342,730	340,645

Sources: col. 1-4, own elaborations (data sources described in Section 3.3); col. 5 from INS (2015).

First, a caveat is in order. Data for 1979 stand out in the series: the distribution of per capita consumption per decile displays seemingly irregular features for most deciles when compared to the surrounding surveys. For this reason, results for the year 1979 are to be considered as preliminary at this stage.

When we compare the dynamics of the remaining survey-based estimates with the dynamics of national account aggregates (GDP and private consumption), we find that for the period 1965-1979, survey-based estimates match very well with the Maddison estimates for GDP: the former yield an annual growth rate of 1.6%, while the latter imply an annual growth rate of 1.7%. The Maddison estimates is the most pessimist among GDP series pointing at a clearly downsized “miracle”. In contrast, in 1979-1985 survey-based estimates indicate a strong annual growth rate of 3%, in contradiction with the negative GDP –growth estimates for all the macroeconomic series. The argument in [Deaton \(2005\)](#) applies.

## 6.1 Inequality and poverty trends

In this section, we focus on identifying the inequality trend in Côte d’Ivoire during the last half a century. Table 7 gives inequality indices for the five years under consideration. According to most indices, inequality today (2015) is at the same level as fifty years ago and never gave sight of inflection. On the contrary it peaked in 1979 at the height of the country’s macroeconomic boom.

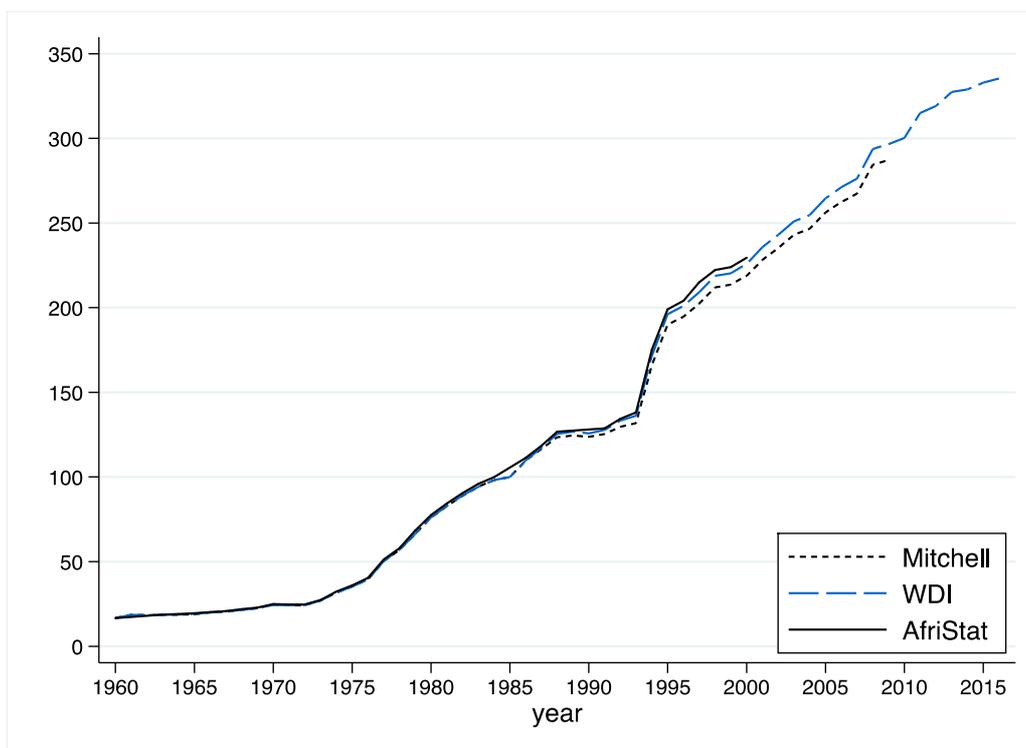
**Table 7 – Selected inequality indices, Côte d’Ivoire 1965-2015**

	1965	1979	1985	2008	2015
Gini	41.9	51.8	40.7	42.1	40.5
MLD	28.8	44.5	28.6	30.2	27.4
Theil	32.0	53.5	28.7	33.6	29.3
CV squared	49.0	99.1	38.3	58.1	45.6
Atkinson					
$\varepsilon = 0.5$	14.1	22.0	13.3	14.6	-
$\varepsilon = 1$	25.1	35.9	24.9	26.0	-
$\varepsilon = 2$	40.1	50.2	44.1	43.3	-

Source: for 1965-2008, our elaboration.

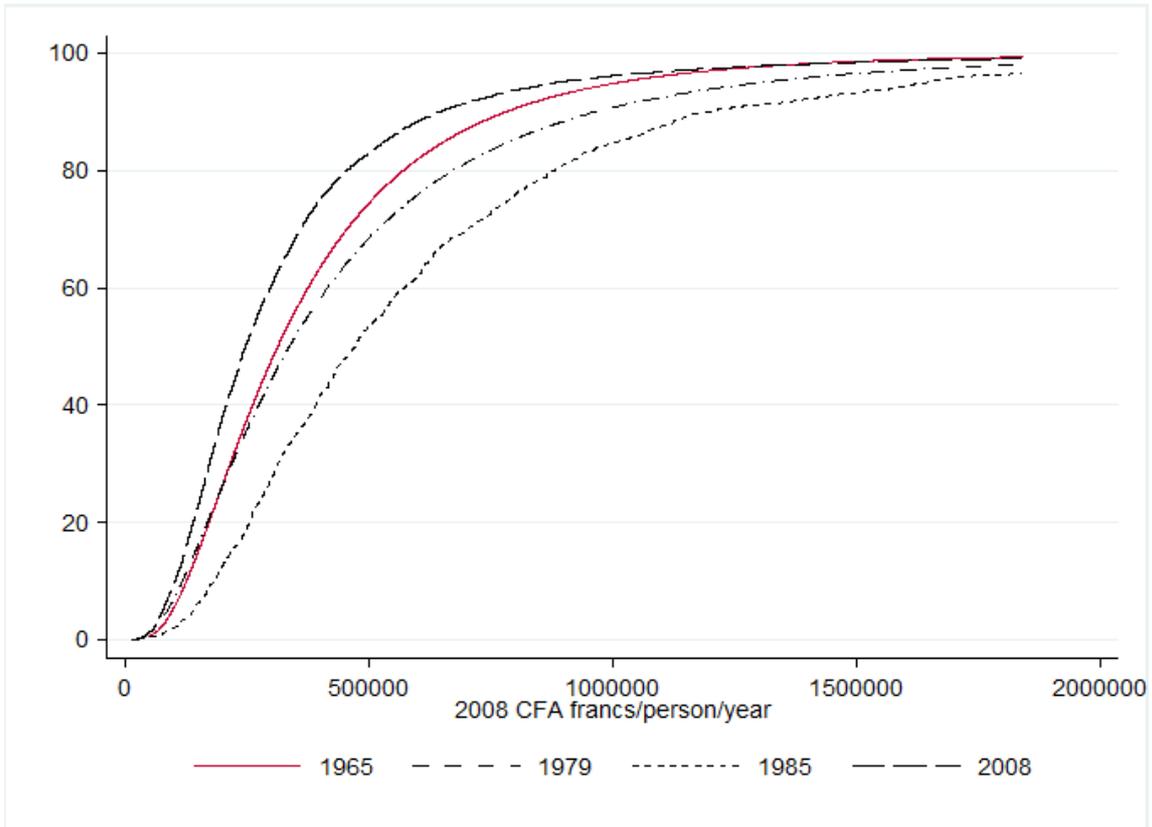
The dynamic analysis of the distribution of expenditures is potentially affected by the way in which one adjusts for inflation. Figure 12 compares the consumer price indices (CPI) available from three different sources, showing that the series are, overall, in agreement. In the rest of the analysis we use the WDI series, as available in the World Bank web repository.

**Figure 12 – Consumer Price Indices, 1960-2015**



The use of the CPI allows us to adjust the PCE for each survey year, so that all welfare indicators are expressed in 2008 CFA Francs per person per year. The corresponding constant-price CDF are shown in Figure 13. This Figure contains the key result for this section. Part of the story, for the years that run from 1985 to 2008, is already known: no matter how the poverty line is chosen, the incidence of poverty *increases* significantly over the period. Technically, the CDF for 1985 displays first order stochastic dominance (FOD) over the CDF for 2008. The novel piece of information found in Figure 13 concerns the period between 1965 and 1985: although 1979 is supposed to be at the apex of the country's aggregate economic growth we observe a short distance between the CDF for 1965 and the CDF for 1979. Moreover, the incidence of poverty was lower in 1985 than in 1979 (there is FOD of the 1985 CDF over the 1979 CDF).

**Figure 13 – Cumulative distribution functions, 1965, 1979, 1985 and 2008**



Source: our elaboration.

Note: distributions are trimmed (at the 99<sup>th</sup> percentile) to facilitate the reading of the graph.

To step beyond relative considerations, and attempt an estimation of the absolute levels of poverty over 50 years, we face one last challenge: the estimation of an absolute poverty line. Different strategies are available. Côte d’Ivoire’s Institut National de la Statistique (INS) has estimated a poverty line for 2008, using the cost-of-basic-needs method ([Ravallion, 1994](#)). Poverty lines for 1985 and 1965 can be obtained by deflating the 2008 line via CPIs. An official poverty line is also available for 1985, but it is termed an “extreme poverty line”, and is identified simply as the 10<sup>th</sup> percentile of the distribution of per capita expenditures in that year: therefore, it cannot be interpreted as an absolute poverty line, not in the usual sense.

Another route is to estimate an absolute poverty line for 1965, using the “bare bones” and “respectability” bundles developed by Allen (various years). This approach solves the obvious issue posed by back-projecting modern poverty lines in the past, which implies the imposition of a minimum living standard based on anachronistic consumption patterns.

Table 8 displays our estimates of a selection of Allen-type absolute poverty lines. The leftmost panel reproduces the [Allen's \(2013\)](#) historical baskets for Europe. The right panel displays a “regional adaptation” of the left panel, both in terms of diet composition and quantities. This version of the poverty line is obtained using the linear programming method introduced (or rather revamped) by [Allen \(2017\)](#).<sup>15</sup>

If we use CPIs to update the cost of the respectability basket from the right panel of Table 8 (13,485 CFA Francs/person/year) and express it in 2008 prices, we obtain an amount equal to 206,707 CFA Francs/person/year. This is not that far from the official INS poverty line of the same year, which is 241,145 CFA Francs/person/year. Such a result is reassuring in terms of the reasonableness of the basket we obtain. In the remainder of this section, the poverty lines used correspond to the Côte d’Ivoire respectability basket with regional adaptations for 1965 and 1979; for 1985 we back-cast the official 2008 INS poverty line<sup>16</sup>. Table 9 shows the resulting poverty estimates.

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<sup>15</sup> Regarding prices, the data is based on the retail food prices reported in Abidjan, Boungouanou, Bouake, Daloa-Gagnoa, Korhogo, Man, Odienné Seguela and South East region in 1965 prices.

<sup>16</sup> As reported in : “République de Côte d’Ivoire, Ministère du plan et du développement, Institut National de la statistique. *Enquête sur le niveau de vie des ménages (ENV 2008), rapport définitif version 1* (Octobre 2008) ”

**Table 8 - Subsistence and respectability baskets for Côte d'Ivoire (1965)**

Quantities per person per year	Europe (Allen 2013)			Cote d'Ivoire 1965 with regional adaptations						
	unit	Subs.	Resp.	unit	Subsistence			Respectability		
		qty	qty		qty	cost	cal/day	qty	cost	cal/day
Grain	kg	155		kg	49	1,555	489	72	2,650	561
Tuber & Plantain				kg	175	1,953	798	158	2,106	682
Bread	kg		182	kg				1	71	9
Beans	kg		40	kg						
Nuts & Seeds				kg	42	1,075	691	42	1,075	691
Meat & Fish	kg	5	26	kg	16	4,259	121	19	4,452	117
Vegetables				kg				4	192	4
Dairy	kg		5.2	kg						
Eggs	p.		52	kg						
Oils an Fats	kg	3	5.2	l				1	132	27
Fruits				kg				1	12	1
Alcoholic beverages	l		182	kg				8	233	8
Soap	kg	1.3	2.6	kg	1	140		3	281	
Linen/cotton	m	3	5	m	3	384		5	640	
firewood	kg	1.3	2.6	kg	150	255		300	510	
Lamp oil	l	1.3	2.6	l	2	82		4	164	
Fuel	M.BTU	2	5							
Water				m3	9	183		16	325	
Rent				%	5	494		5	642	
<b>Total cost (grams of silver)</b>		<b>213</b>	<b>559</b>	<b>Total (FCFA)</b>	<b>10,381</b>			<b>13,485</b>		
<b>Calories/day</b>		<b>2099</b>	<b>2103</b>		<b>2100</b>			<b>2100</b>		

\*This diet supposes that grains were rice and corn, tubers correspond to cassava, yam and taro, nuts and seeds are groundnuts and palm nuts. Oils and fats coincide with butter in Allen (2012) and palm oil in this context.

\*\*Regarding the non-food items, we considered firewoods instead of candles (for cooking purposes). Linen and cotton was substituted with wrapper (pagne) fabric.

**Table 9 - Poverty Lines and poverty measures for Côte d'Ivoire**

	1965	1979	1985	2008	2015
Poverty Line ( <i>current CFA francs/person/year</i> )	13,485	46,724	82,125	241,145	269,075
H	35.4	33.8	17.7	48.9	46.3
PG	7.5	6.5	5.5	18.2	16.3
PG2	2.8	1.9	2.5	9.1	8

Source: our elaboration. H stand for “Headcount ratio”, PG for “Poverty Gap Index”, PG2 for “Poverty Gap Squared Index”.

The series of the headcount ratios reinforces and deepens our understanding of Côte d'Ivoire's post-colonial history. The “conjuncture” started in the late 1970s separates two different worlds: poverty increased more than two and a half times from 1985 to 2008, reaching almost 50%, and showing weak signs of recovery in recent years. However, the most novel takeaway from Table 9 is perhaps the poverty trend between 1965 and 1985. Absolute poverty remained almost unchanged during the country's “boom” years between 1965 and 1979, decreasing by only 1,6 percentage points over 14 years. Living standards of the poor experienced a dramatic transformation afterwards as absolute poverty fell from 34% in 1979 to 18% in 1985.

The change in poverty shown in Table 9 is the result of the joint impact of two forces at work: one is the change in mean income (with inequality held constant), the second force is the change in inequality (with mean income held constant). Table 10 shows the decomposition of the total change in poverty into these two constituent parts: this provides a way of assessing the respective roles of growth and redistribution in reducing poverty ([Datt and Ravallion 1992](#)).

The second column of Table 10 reveals that the stall of poverty rates despite mean income growth between 1965 and 1979 is attributable to the powerful contrasting effect of redistribution that left the poorest segments of the population behind in prosperous time. On the contrary, the sharp decrease in poverty rates between 1979 and 1985 is due to the virtuous dual-effect of growth of mean incomes for the most part and inequality reduction to a lesser extent: people in need benefited from the enlargement of the cake and did get a slightly bigger slice of it. This successive experience of vicious and virtuous growth illustrates how crucial redistribution is in the poverty debate.

**Table 10– What drives changes in poverty? Côte d’Ivoire, Growth and Inequality  
Poverty decomposition<sup>17</sup>**

	<b>1965-85</b>	<b>1965-79</b>	<b>1979-85</b>	<b>1985-08</b>
	<b>(1)</b>	<b>(2)</b>	<b>(3)</b>	<b>(4)</b>
poverty rate (base year 1)	35.4	35.4	33.8	17.7
poverty rate (base year 2)	17.7	33.8	17.7	48.9
change	-17.7	-1.7	-16.0	31.2
growth component	-22.8	-20.5	-12.9	30.3
redistribution component	5.2	18.8	-3.2	0.9

Source: our elaboration

Finally, Figure 14 shows the growth incidence curves (GICs) for the three sub-periods, 1965-1979 (top right panel), 1979-1985 (bottom left panel) and 1985-2008 (bottom right panel), as well as for the entire period 1965-2008 (top left panel).

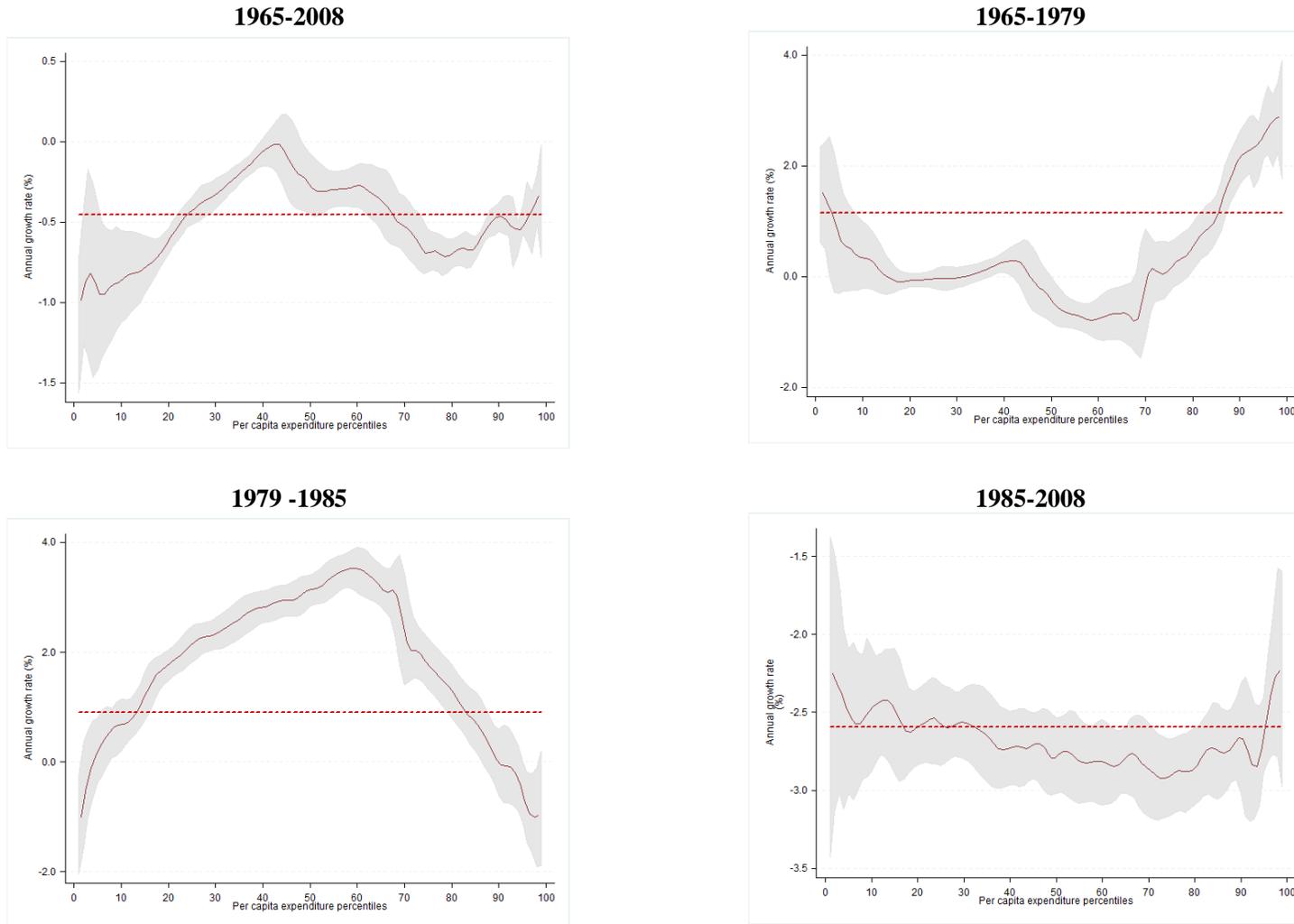
The findings emerging from Table 10 are confirmed and refined: while growth between 1965 and 1979 benefited an elite at the top 20 deciles of the distribution, the winner in the first half of the 1980s is the median Ivoirian. The GICs however, do not highlight any clear pro-poor (that is, downward-sloping) redistribution pattern over the history of the country.

## 7 Conclusion

Compendia of historical international statistics are of tremendous help for scholars engaging in long-run evidence-based analysis. One can probably even argue that their impact on how new methods and new ideas evolve and spread in the community is significant. With no exceptions that we are aware of, the thematic coverage is limited to demographic and socio-economic *macro*-indicators. Topics such as inequality and poverty have proved more elusive for economic historians interested in comparative and long-run analysis, particularly in certain regions of the world. In this paper, we have explored the use of a new source, historical household budget surveys, and of a frontier statistical method, which allows to take advantage of information on household incomes and expenditures available in the form of “grouped data”. Armed with such tools, we have explored ways to fill a gap in the literature. In particular, we have estimated both the level

<sup>17</sup> “Redistribution” is intended as “the change in poverty due to a change in the Lorenz curve while keeping the mean income constant” ([Datt and Ravallion, 1992: 277](#)).

**Figure 14 – Growth Incidence Curves, 1965-2008**



Source: our elaboration

and the distribution of living standards for a set of countries (Cameroon, Côte d’Ivoire and Gabon) for which little or nothing is known, covering the last five decades.

The results of our research are rich, at times remarkably so, and can be summarized as follows. First, with regard to the countries under examination, we manage to combine historical household surveys with population censuses and to obtain estimates of the entire distribution of per capita expenditure – our proxy for measuring the wellbeing of their population – for 1965, immediately after independence. According to our estimates, Gabon and Côte d’Ivoire are similarly well-off, while Cameroon is behind. This evidence suggests that some existing rankings based on per capita GDP might not provide a true picture of the standard living enjoyed by the population back in 1965. Household budgets provide support to the ranking that emerges from other non-monetary indicators such as infant mortality and life expectancy at birth (section 2). While we do not construct absolute poverty lines for comparing the three countries, such an exercise is feasible (PPP exchange rates are needed) and would lead to first-generation nationally representative estimates of absolute poverty in the region. Regarding Cameroon, results are also clear-cut, but caution suggests to wait for new surveys to be dug out of the archives and included in the analysis to improve the current coverage of our dataset.

Second, we focus on Côte d’Ivoire and deal with the task of estimating both poverty and inequality over the past five decades. This is a complex exercise, due to the lack of household-level data for the period immediately following independence. By combining synthetic households obtained via “ungrouping” with modern household-level records, we identify the trend of inequality and poverty for the years 1965-2015. According to our estimates during the period 1965-1979 poverty stalled between 34 and 35 percent while it strongly decreased to 18 percent, over the following six years. By decomposing poverty change we find that during the “miraculous years”, from 1960 to roughly 1980, growing inequality constitutes a clear brake on poverty reduction for the country. In the following period until 1985, the central segment of the distribution stands out as the real beneficiary of economic growth. This is the lesson that we learn from the growth incidence curves constructed in section 6. It also suggests that the strong poverty reduction experienced by the country between 1979 and 1985 involved to a greater extent the share of the poor closer to the poverty line, rather than those living in extreme poverty.

A third result is of relevance for future work. Arguably, the empirical playground chosen by the present paper – micro-data in Africa in the aftermath of independence – is a challenging one. We believe that the sources and the method employed should encourage economic historians to consider using historical surveys, no matter if not nationally representative, as they are far more numerous and widespread than generally supposed. The Historical Household Budget (HHB) Project provides a useful infrastructure that greatly facilitates their use.

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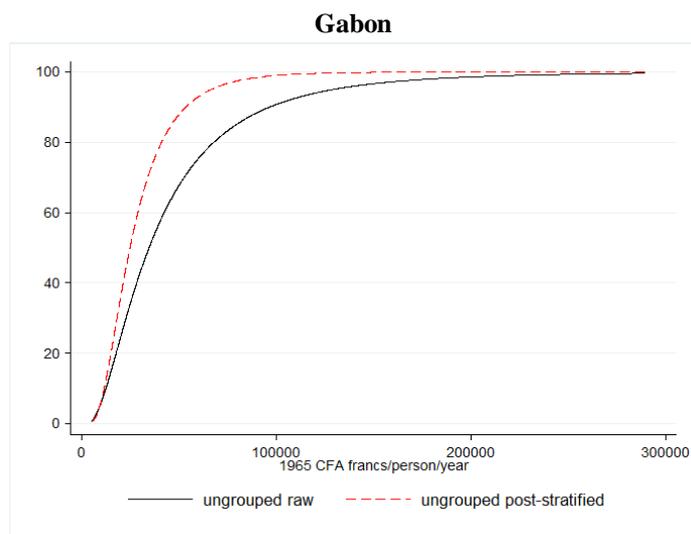
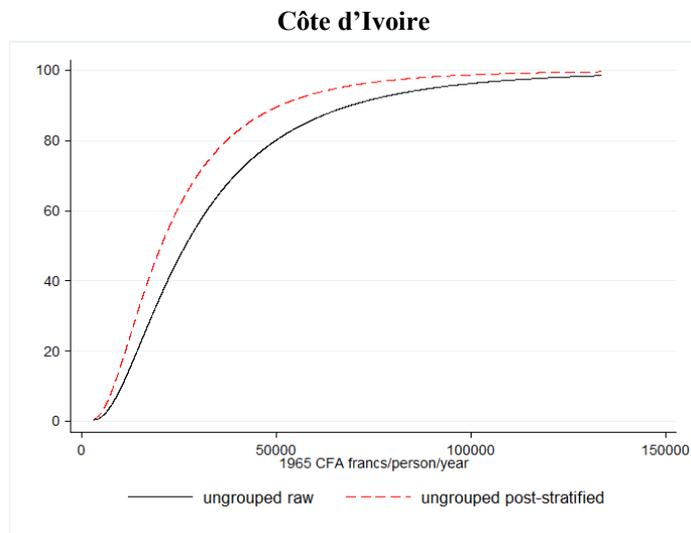
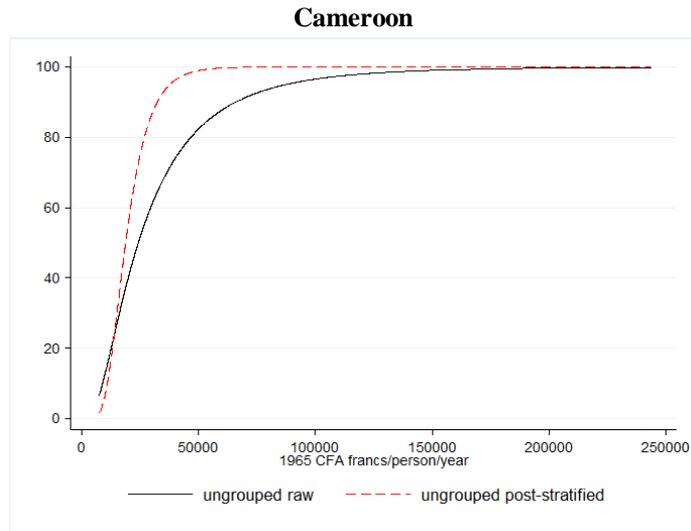
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## Appendix

**Figure A2 – Unweighted vs. post-stratified CDFs, 1965**



Source: our estimates.

Note: distributions are trimmed (at the 99<sup>th</sup> percentile) to facilitate the reading of the graph.

## Methodological Appendix

This appendix summarizes the algorithm proposed by Shorrocks and Wan (2008). The first step of the algorithm entails generating a rough initial synthetic sample, a first approximation of the final product, by fitting a parametric distribution to the grouped data. Any of the functional forms that are routinely used to model income distributions can potentially be used at this stage: the lognormal (LN), General Quadratic (GQ), Beta, Generalized Beta (GB) and Singh-Maddala (SM) forms are those used and compared by the authors.

In practice, the information supplied by whatever type of grouped data is available to the analyst is converted into a set of  $m + 1$  Lorenz coordinates  $(p_k^*, L_k^*)$ , where  $(k = 1, \dots, m)$ ,  $p_k^*$  is the aggregate proportion of the population in each income class,  $L_k^*$  is the corresponding cumulative income share, and  $(p_0^*, L_0^*) = (0, 0)$  – asterisks are used to denote the target values supplied by the grouped data, as opposed to the non-asterisked synthetic sample values. The parameters of the chosen distribution are then derived from these coordinates. Finally, synthetic observations are generated as percentile points (the authors recommend a minimum of 1,000 points) from that distribution. Lorenz coordinates do not preserve information about the absolute levels of income: the fitted distribution is normalized to having mean one – the correct levels are recovered at the end of the procedure, by multiplying the synthetic observations by the original mean supplied by the grouped data. This implies that the mean of each of the  $m$  income classes, which originated the  $m + 1$  Lorenz coordinates, can be expressed as:

$$(1) \quad \mu_k^* = \frac{L_k^* - L_{k-1}^*}{p_k^* - p_{k-1}^*} \quad (k = 1, \dots, m)$$

The second step consists in adjusting the distance among the observations of the initial synthetic sample until sample means exactly match the target ones. This is accomplished via a “stretching” algorithm. First, the synthetic observations are partitioned into the  $m$  classes implied by the original Lorenz coordinates. Then, sample mean incomes  $\mu_k$  are computed for each of the classes. The synthetic observations  $x_j$  that fall in between the sample means are converted into intermediate values  $\hat{x}_j$ , in a way that ensures that the true means  $\mu_k^*$  lie within each of the corresponding sample classes. This is accomplished by applying the following rules:

$$(2a) \quad \hat{x}_j = \mu_k^* + \frac{\mu_{k+1}^* - \mu_k^*}{\mu_{k+1} - \mu_k} (x_j - \mu_k) \quad \text{for } k = 1, \dots, m - 1 \text{ and } x_j \in [\mu_k, \mu_{k+1})$$

$$(2b) \quad \hat{x}_j = \frac{\mu_1^*}{\mu_1} x_j \quad \text{for } \hat{x}_j < \mu_1$$

$$(2c) \quad \hat{x}_j = \frac{\mu_m^*}{\mu_m} x_j \quad \text{for } \hat{x}_j \geq \mu_m$$

The intermediate sample hereby produced undergoes a final adjustment that ensures correspondence between sample and target class means. This is accomplished as follows. Define the lower bound of each income class as:

$$(3) \quad c_1 = 0; \quad c_k = \frac{1}{2} \left( \max_j \hat{x}_{k-1,j} + \min_j \hat{x}_{k,j} \right) \text{ if } k > 1$$

The class bounds are kept fixed, and the intermediate synthetic observations,  $\hat{x}_{kj}$ , are converted into the final observations  $\hat{x}_{kj}^*$ , by compressing the gaps between the sample values and the upper (lower) bound of the group if the sample mean  $\mu_k$  is below (above) the true value  $\mu_k^*$ . This is done by applying the rules:

$$(4a) \quad \hat{x}_{kj}^* = c_{k+1} - \frac{c_{k+1} - \mu_k^*}{c_{k+1} - \hat{\mu}_k} (c_{k+1} - \hat{x}_{kj}) \quad \text{if } \mu_k^* > \hat{\mu}_k \text{ and } k > m$$

$$(4b) \quad \hat{x}_{kj}^* = c_k - \frac{\mu_k^* - c_k}{\hat{\mu}_k - c_k} (\hat{x}_{kj} - c_k) \quad \text{if } \mu_k^* < \hat{\mu}_k \text{ or } k = m$$