

Income Inequality in Colonial Africa: Methods and History

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1. Introduction

In 2021, an individual in Europe earned, on average, 33,722 € per year. In Sub-Saharan Africa, adjusted for cost-of-living differences, the average income was 5,474 € - more than six times less. Differences in average income between countries are substantial, but they hide another vital source of disparity: differences *between individuals* within the same country. Indeed, almost 70% of global income inequality among individuals is explained by income differences among individuals who live in the same country. Only 30% of this is explained by countries' differences in average annual income (see World Inequality Report 2022, Summary, Figure 6).

In Sub-Saharan Africa, in 2021, the richest 10% of its population earned 55% of total income, while the poorest 50% earned less than 10%. The average income of the 10% richest individuals was 30,337 € per year, while the income of the poorest 50% was 1,004 € (calculations from World Inequality Database). Thus, there was a substantially larger difference in income between the top 10% and the bottom 50% of people in Sub-Saharan Africa (a ratio of 30) than between an average European and an average African (a ratio of 6).

There might be many reasons why one cares about income inequality. Still, one of the most compelling ones is that inequality levels can impact poverty rates, economic growth, and overall living standards. It has been shown that GDP growth is more strongly correlated to poverty reduction in countries with lower levels of initial inequality. Indeed, countries in Sub-Saharan Africa present substantial variations in their level of inequality, ranging from relatively egalitarian societies in Western Africa to very unequal economies in Central, Eastern, and Southern Africa. In 2021, the share of the total income obtained by the richest 10% of individuals ranged from 47% in West Africa to 53% in East Africa, 60% in Central Africa, and 65% in Southern Africa. The ratio of the average income of the richest 10% relative to the average income of the poorest 50% was 19 in Western Africa but 56 in Southern Africa.

Another way to evaluate the heterogeneity of African inequality is to look at the Gini index, an indicator ranging from 0, when the society is entirely egalitarian, to 1, when we have maximum inequality (we will see more details about this measure in Section 3). Table 1 reports the average Ginis in 2013-2022 across world regions, along with their standard deviations, coefficients of variation (the ratio of the standard deviation divided by the average), and minimum-maximum values. Not only does Sub-Saharan Africa have one of the highest average Gini in the world (second only to Latin America), but it also has the largest variation in Gini between countries among all world regions.

Table 1: Gini in World Regions, 2013-2022

	Average	St. dev.	Coeff. variation	Min	Max
East Asia and the Pacific	0.35	0.06	0.16	0.22	0.54
Europe and Central Asia	0.34	0.06	0.17	0.21	0.57
Latin America & the Caribbean	0.46	0.05	0.11	0.31	0.60
Middle East and North Africa	0.36	0.05	0.15	0.25	0.60
North America	0.40	0.06	0.14	0.28	0.52
South Asia	0.36	0.06	0.17	0.28	0.54
Sub-Saharan Africa	0.44	0.11	0.25	0.28	0.72
World	0.36	0.07	0.19	0.21	0.72

Source: elaborations from UNU-WIDER (November 2023).

What explains the spread between countries from some with modest income inequality to some of the most unequal in the world? Why are some countries in Sub-Saharan Africa so much more unequal than others?

Some scholars think we should search for the causes of this in Africa’s past. A group of studies highlight longer-term trends, pre-colonial legacies, and their impact on African social structures. The transatlantic slave trade influenced early inequality levels. Not all African countries were equally affected by the trade, but widespread slavery meant that in many instances local elites were able to accumulate income and wealth, either by directly selling enslaved people or by profiting from their work in the production of cash crops. This could have potential long-term consequences on current inequality levels. Research by Nathan Nunn suggests in fact that the slave trade might have influenced current outcomes, both in terms of overall income level and in terms of the social structures which affect its distribution.

Despite their theoretical appeal, it is very hard to empirically verify pre-colonial explanations for African inequality since we do not have consistent data on income or wealth distribution covering the earlier period of the continent's history. Data availability has increased in more recent times and this has pushed scholars to look into the role of colonization as a determinant of inequality. According to these theories, the heterogeneous implementation of colonial rule,

interacting with local conditions inherited from the precolonial period, would have put African countries on different paths of inequality, which would persist to the present. Other scholars, however, disagree and argue that the appeal of colonial explanations for current inequality levels is much more limited, suggesting that we should instead acknowledge the changes in inequality that occurred during and after the colonial era.

In any case, whether we want to study the colonial past to test hypotheses about the origin of current inequality or simply whether we are interested in the evolution of income inequality over time, analysing its patterns and drivers during colonial rule is worthwhile.

2. Drivers of income inequality under colonial rule

To approach these issues, the first question is to identify some factors that could have affected inequality during colonial rule. Some theories emphasize the role of European settlers and expatriate-owned trading and concessionary companies. In many colonies, settlers controlled a large share of the revenue obtainable from the export of cash crops, benefited from larger investments in public goods (better health and education), enjoyed higher salaries than most of the African population, and had more political power which translated into greater income-earning opportunities. At the same time, in many colonies, coercive institutions such as forced labour further reduced the wages paid to African workers. Similarly, compulsory cultivation and monopolistic trade practices lowered the prices African producers could obtain for their crops.

Another source of inequality during colonial rule can be related to economic forces, particularly the diffusion of capitalism. Some scholars suggest that inequality in colonial Africa rose due to the dual structure of African economies and the increasing difference between the “traditional” sector, based on subsistence farming, and the new “modern” sector, based on the export of cash crops. However, it is important to notice that not all researchers agree with this interpretation. The distinction between a “traditional” and a “modern” sector is unclear. Often, African farmers would combine cash crops and subsistence production. Moreover, linking the emergence of capitalism as a product of the colonial era can be misleading as African economies started to transition to the export of cash crops long before formal colonization. Such transition might have affected income inequality differently, mainly due to local conditions and institutions. Capital-intensive commodities, such as minerals or cattle, would increase inequality more than labour-intensive commodities, such as groundnuts or cotton. Moreover, when expatriate settlers or companies participated in the production or marketing of crops, inequality could also increase across racial lines. To evaluate these theories, we need a way to measure income inequality. Which indicators can we use? And which data are available to estimate inequality during colonial rule?

3. How can we measure colonial income inequality?

3.1. Which indicators?

To assess inequality, we can use different measures. The most common are the Gini index, income shares, the inequality extraction ratio, and the Theil index. The Appendix of this chapter explains how all these inequality indicators can be calculated.

Gini index

The Gini index was invented by Italian statistician Corrado Gini in 1912. It ranges from 0 to 1, where a value of zero represents a situation where all individuals have the same income (maximum equality), and a value of one represents a situation where one individual has all the income, and everybody else has zero (maximum inequality). Despite being one of the most popular inequality measures, the Gini index has some important limitations. First, two very different income distributions can yield the same Gini. Second, it is not very sensitive to what happens at the distribution's tail (income change for the very rich).

Income shares

As an alternative, to get more information about the income distribution, we can measure inequality by calculating the share of the total income received by the richest x-percent of people or the poorest x-percent of people. One drawback of these measures is that they do not consider the entire population. However, they highlight aspects of inequality that are overlooked by the Gini coefficient. These are the most common measures:

- The *share of income of the richest* 0.1%, 1%, or 10% of the population.
- The *20:20 ratio* is the share of income earned by the richest 20% divided by the share of income earned by the poorest 20%. The advantage of this measure is that it reduces the influence of outliers in the extreme tails of the distribution.
- The *Palma ratio* is the share of income earned by the richest 10% divided by the share of income earned by the poorest 40%. This measure is based on the observation by Chilean economist Gabriel Palma that inequality within countries tends to be driven by the difference between the richest 10% and the poorest 40% of the population. In comparison, the 50% in the middle usually earns about 50% of total income.

Inequality Extraction Ratio

An important consideration must be made when comparing the Gini indexes of two societies to see which is more unequal. Very little income can be distributed unequally in an impoverished society, where most of the population only has a subsistence income. As society grows richer, the scope for potential inequality also increases. This is the idea behind the concept of the *inequality possibility frontier* by Branko Milanovic, Peter Lindert, and Jeffrey Williamson. The inequality possibility frontier expresses the maximum possible Gini (inequality) observable in a society given its income level. To properly evaluate inequality differences among societies with different income levels, we should compare a society's actual Gini index to its maximum attainable Gini. This is the idea of the *inequality extraction ratio* or IER, which is the ratio between actual and maximum Gini.

Theil index

The Theil index, developed by economist Henri Theil in 1967, is another measure of income distribution or inequality within a population. Unlike the Gini, the Theil is more sensitive to changes in the income at the tail of the distribution and less to changes in the middle. Moreover, the Theil is particularly useful for evaluating societies where individuals' income is affected by their social group (for example, nobles and peasants, rural and urban workers, workers in different regions or sectors, etc.). The Theil can, in fact, be expressed as the sum of two components: the within-group component, which measures the inequality among individuals within each group, and the between-group component, which measures the inequality between the different groups.

3.2. Which data sources?

To decide which data sources to use to measure inequality, we first need to choose the *type of inequality* we want to calculate. The first choice is whether we want to measure inequality in the distribution of income or consumption. According to the definition by the Canberra Group, income includes employee income, income from self-employment, rentals, property income, and net transfers received. Following the definition proposed by economists Deaton and Zaidi, consumption includes food, non-food items, durable goods, and housing. Both approaches have advantages: consumption may be easier to measure, especially in countries with large agrarian sectors, while income may be easier to define. At the end of the day, the choice is mostly driven by data availability. However, it is important to remember that inequality estimates based on consumption tend to be lower than estimates based on income since richer individuals save larger proportions of their income (thus, consumption differences are less pronounced than differences in income).

The second choice concerns the population for which inequality is measured. Should we measure inequality among households or individuals? Household-based estimates recognize that individuals in the same household share economic resources. On the other hand, measurements of inequality among individuals can highlight the fact that not all household members might necessarily have equal access to the common resources given their different income-earning potential.

According to the guidelines of UNU-WIDER's World Income Inequality Database, inequality should be measured across households, adjusting each household's income by considering the household size. In some cases, however, especially when we do not have information on household composition, inequality can be computed instead among individuals in the labour force. Generally, modern inequality estimates are based on household surveys representative of the entire population. The problem is that such surveys started to be carried out in Africa only in the 1950s for some countries and much later (1980s) for many others. Hence, there is no such data to study the colonial era. So, which alternative sources are available to scholars who want to measure African inequality before the availability of household surveys?

From the colonial inequality literature, two approaches emerged. The first one is to use **tax records** collected by colonial governments, especially during the late colonial period. This methodology measures inequality by computing the share of total income earned by the top x-percent of earners. This approach is valuable as inequality trends tend to be driven by what happens in the upper tail of the distribution. On the other hand, tax records are often available only for the late colonial period onwards and miss a large part of the population that did not pay income taxes (especially in the rural sector). Moreover, to calculate income shares, we need information on total income or GDP that cannot always be precisely estimated. Income shares from tax records have been computed for South Africa, Algeria, Cameroon, Tunisia, and several British colonies, by economists Alvaredo, Atkinson, Cogneau, and Piketty, mostly working at the Paris School of Economics. Interested students can check the website of the World Inequality Database (<https://wid.world/>) to learn more about their work and access top income shares data.

An alternative approach to estimate income inequality is to use **social tables**. This methodology simplifies a society's income distribution into a limited number of income groups, so-called 'social classes', estimating inequality not among all households/individuals but only among the identified groups. Different sources are used to reconstruct the number of individuals in each social class and their income, ranging from official statistical publications and censuses to qualitative records from historical and anthropological studies. As each country's social structure is different, the type of sources is necessarily heterogeneous. The main advantage of the social tables approach is that it can capture incomes for the full population. However, as it assigns the same income to all members of

the same class, it is not able to consider within-class inequality, and it can provide reliable estimates of inequality only in those cases where the social tables are fairly detailed and classes do not overlap. Social tables covering different periods have been constructed for Algeria, Botswana, Côte d'Ivoire, Ghana, Kenya, Senegal, Tunisia, and Uganda. Many of these tables were the fruit of the efforts of the AFLIT- African Long-term Inequality Trends group, a research network aiming to reconstruct inequality estimates in the sub-Saharan African region by using the social tables approach. More information and data are available at the network website (<https://www.aflit.net/>).

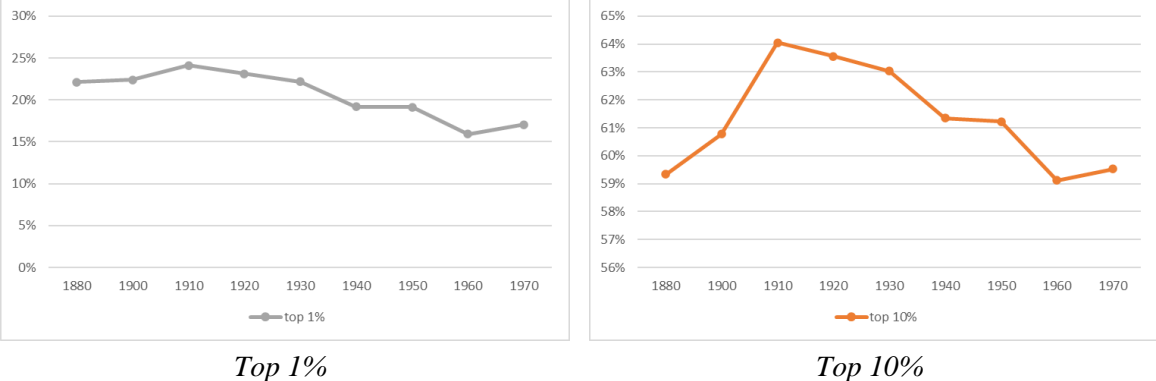
4. Income inequality in Africa under colonial rule: levels, trends, and drivers

Based on information gathered from tax records and social tables, what can we say about African income inequality during colonial rule?

4.1. Trends and levels of income inequality

Figure 1 presents estimates of the shares of income earned by the richest 1% and 10% of individuals in Sub-Saharan Africa between 1880 and 1970. During colonial rule, on average, the richest 10% earned about 61% of total income and the richest 1% earned 21%. The bottom 90% of the population earned less than 40% of the total income. As measured by top income shares, income inequality was higher in African colonies than in the UK or France. The large majority of the top 1% earners were Europeans. Over time, since the early 20th century, the shares of income obtained by the top earners declined. Nevertheless, this was at least partly the fruit of the convergence among Europeans (within and outside the top 1%) and less of the reduction in the income gap between Europeans and Africans.

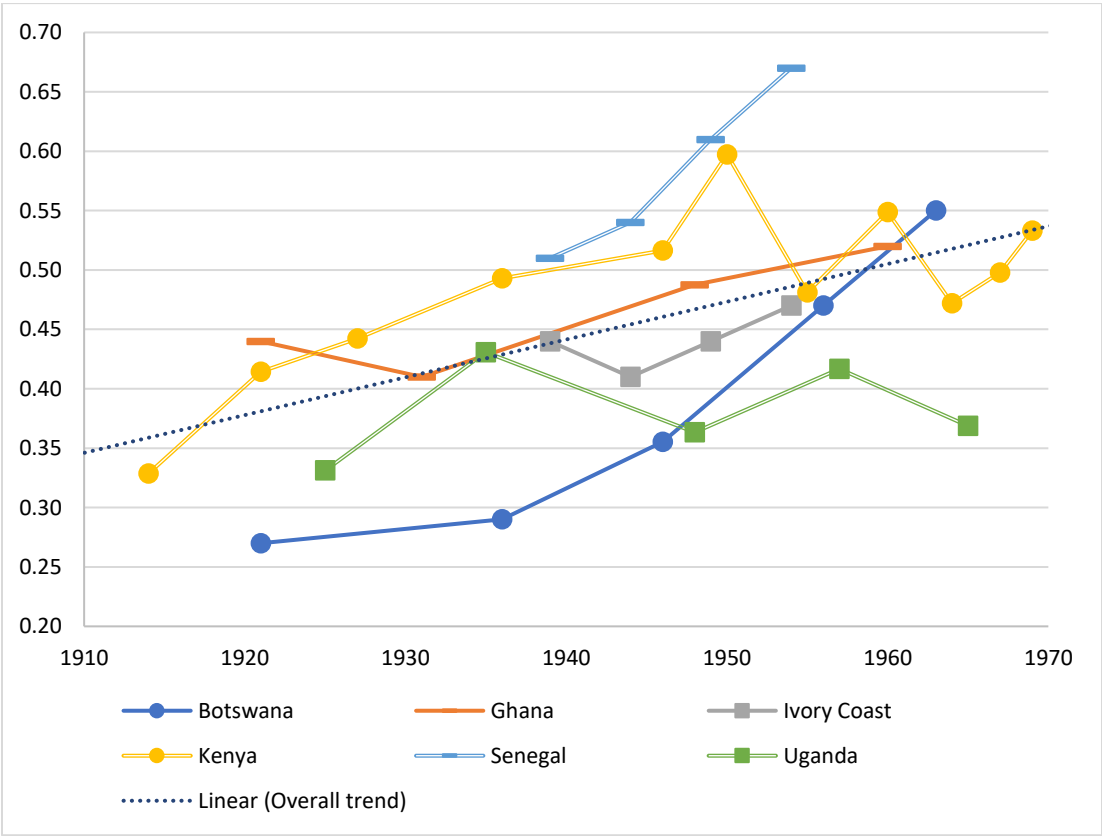
Figure 1: Share of income earned by the richest 1% and 10%, sub-Saharan Africa



Source: Calculations from World Inequality Database (<https://wid.world/data/>).

And indeed, top income shares tell us little about how inequality changed in the rest of the income distribution. To fully evaluate inequality trends, we can rely on Gini indexes calculated based on social tables, which are now available for several countries. Figure 2 shows Gini coefficients for a sample of six colonies between around 1910 and 1970. The average Gini was 0.46, higher than the global mean in the same period (0.41, as reported by UNU-WIDER). The overall trend was an increase in inequality (positive linear trend), from a Gini of about 0.35 in the early 20th century to a Gini of more than 0.50 at the time of independence.

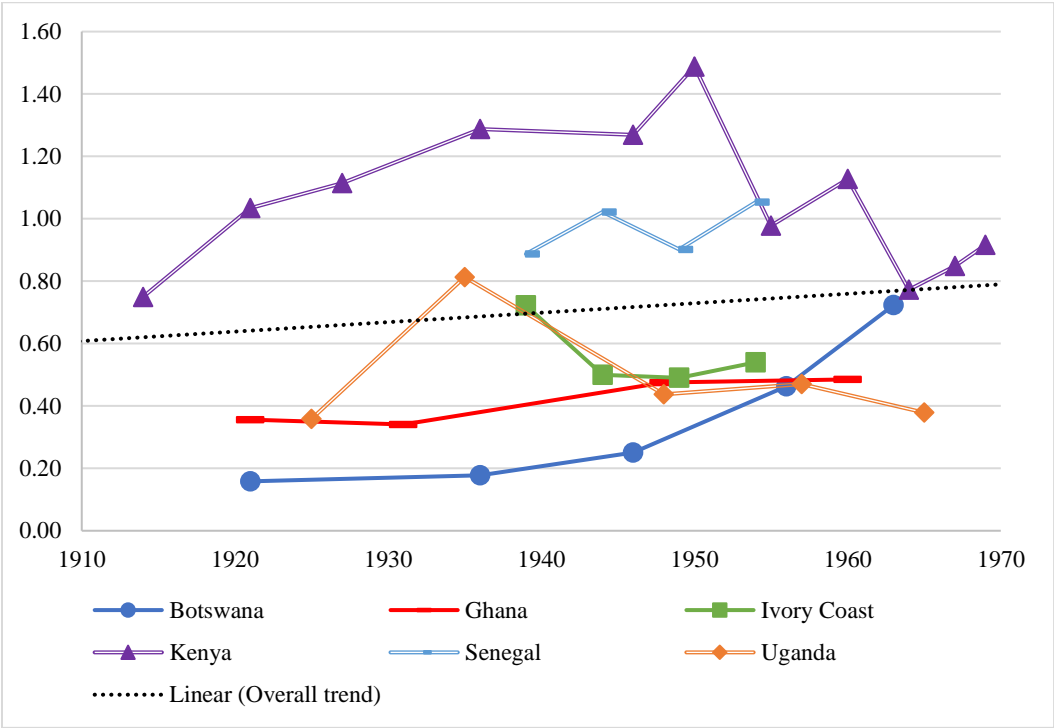
Figure 2: Gini Coefficients in a Sample of Colonies



Source: Hillbom, Bolt, De Haas & Tadei (2023).

How could top income shares decline (Figure 1) while Gini coefficients increase (Figure 2) at the same time? Let us remember that what drives change in Gini is especially changes in the share of income earned by the middle class and not in the share earned by top earners (see Section 3.1). Thus, top income shares might decrease as inequality between the top earners and the rest of the individuals declines, and, at the same time, Gini might increase as inequality between the middle and the bottom part of the income distribution rises. Indeed, Theil indexes, which are more sensitive to changes in top income shares, also show, in some cases, a decline (see Kenya, Ivory Coast, and Uganda in Figure 3), consistently with the trend in top income shares.

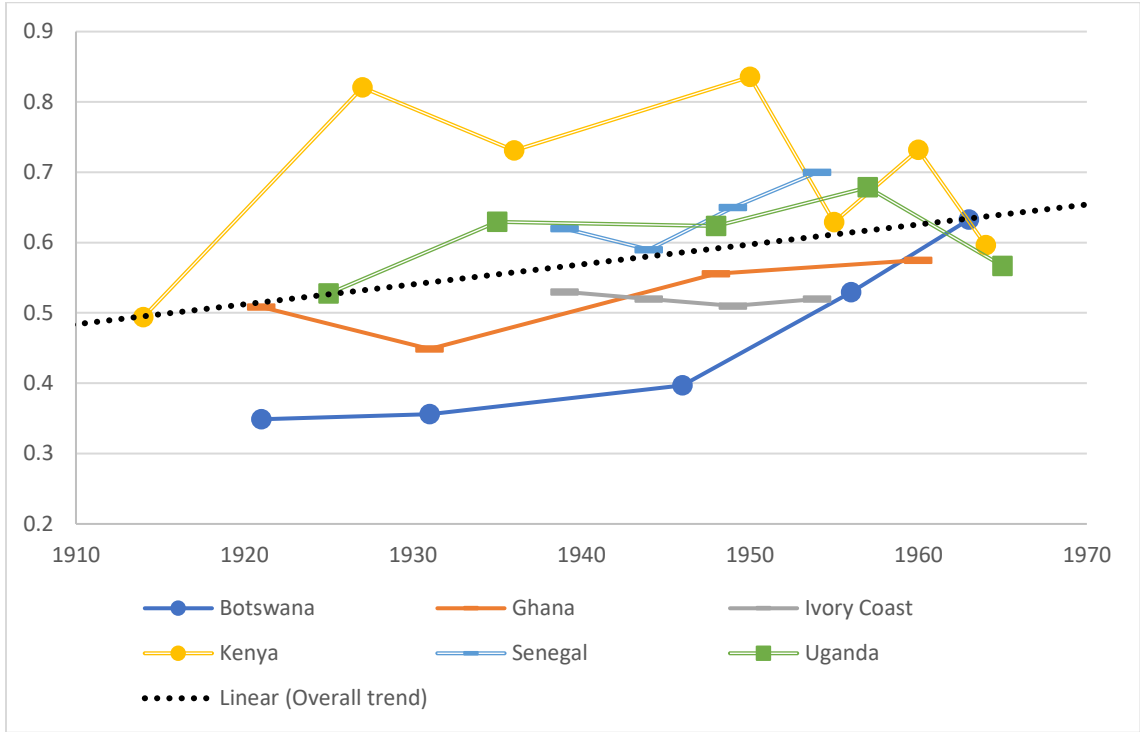
Figure 3: Theil Indexes in a Sample of Colonies



Source: Hillbom, Bolt, De Haas & Tadei (2023).

Overall, however, income shares and Gini suggest relatively high levels of income inequality in Africa under colonial rule, at least for the period under consideration. Yet, as seen in Section 3.1, if the Gini increases, that does not necessarily mean that a society becomes more unequal. In fact, as income grows, also the scope for potential inequality increases. Thus, it is not possible to simply compare the Ginis of two societies with different income levels to determine which one is more unequal. To answer this question, we could look instead at *inequality extraction ratios*. Figure 4 illustrates them for the same sample of colonies. Between 1910 and 1970, the average ratio of inequality extraction was 0.57, lower than the average of pre-industrial societies of 0.77. Nevertheless, the increasing trend implies that, in most cases, African colonial societies tended to become more unequal over time.

Figure 4: Inequality Extraction Ratios in a Sample of Colonies



Source: Hillbom, Bolt, De Haas & Tadei (2023).

4.2. Drivers of income inequality

What can explain these relatively high and increasing inequality levels? Based on the theoretical discussion in Section 2, we can emphasize two main factors:

1. Colonial institutions
2. Economic forces

The data indeed confirm that colonial economies were characterized by large income differential between the high-earning expatriate minority (mostly Europeans) and the majority of the African population. In the six countries for which we have information on full income distribution based on social tables, shown in Table 2, expatriates accounted for less than 1-2% of the labor force but earned up to 37% of the total income (i.e., expatriate earned between 19 and 35 times their proportional share).

Table 2: Share (%) of workers and share of income

		Botswana	Ghana	Côte d'Ivoire	Kenya	Senegal	Uganda
<i>Share of workers</i>	Expatriate wage-earners	0.09%	0.04%	0.24%	1.18%	0.71%	0.30%
	Expatriate self-employed	0.00%	0.00%	0.14%	0.54%	0.38%	0.29%
	African wage-earners	10.66%	21.44%	7.17%	19.20%	9.47%	6.89%
	African self-employed	89.25%	78.53%	92.45%	79.08%	89.44%	92.53%
<i>Share of income</i>	Expatriate wage-earners	1.71%	0.99%	7.96%	18.08%	17.49%	8.36%
	Expatriate self-employed	0.00%	0.00%	5.21%	18.68%	9.42%	6.02%
	African wage-earners	17.72%	30.83%	9.79%	22.90%	20.63%	9.42%
	African self-employed	80.57%	68.18%	77.04%	40.34%	52.47%	76.21%
<i>Period</i>	1921-63	1921-60	1939-54	1914-69	1939-54	1925-65	

Source: Hillbom, Bolt, De Haas & Tadei (2023).

Part of this racial inequality can be attributed to the fact that most Europeans worked for wages in the urban sector (many in the colonial administration), while the largest part of Africans were self-employed and worked in the agricultural sector. Only a minority of Africans participated in the wage economy, and even then their wages did not reach the levels of Europeans. For example, in 1939, the wage of a European skilled worker in Senegal or Côte d'Ivoire was about 10 times the wage of an equivalent African worker. This difference reduced over time and, in 1954, European wages were about double the level of African wages.



Racial disparities increase inequality

Source: <https://www.hipuganda.org/>.

Table 2 indicates that the high salaries paid to Europeans by the colonial administration further exacerbated racial inequality. For example, until around 1930, the administration of French West Africa spent about twice as much on the salaries of the top 130 French officials (about 10-20% of total expenditure) than on education and health (about 5-10%). This disparity is even more important considering that it was taxes levied on Africans that funded most of the salaries of the colonial administration. Generally, larger colonial bureaucracies were associated with elevated levels of inequality. This is the case of Senegal, where the administration of French West Africa was located. In other cases, such as in Kenya, high inequality was explained by the presence of a relatively sizeable European settler community.

The second factor to consider in explaining African inequality during colonial rule is economic forces, particularly the role played by commodity trade. Since the mid-19th century, African countries increasingly participated in international trade by exporting commodities such as palm oil and kernels, cocoa, groundnuts, cotton, and coffee. As exports increased and the commercialization of the economy progressed, this boosted opportunities for earning income. Yet, not all social groups benefited in the same way, increasing inequality by stimulating capital accumulation processes.



Cattle



Cocoa

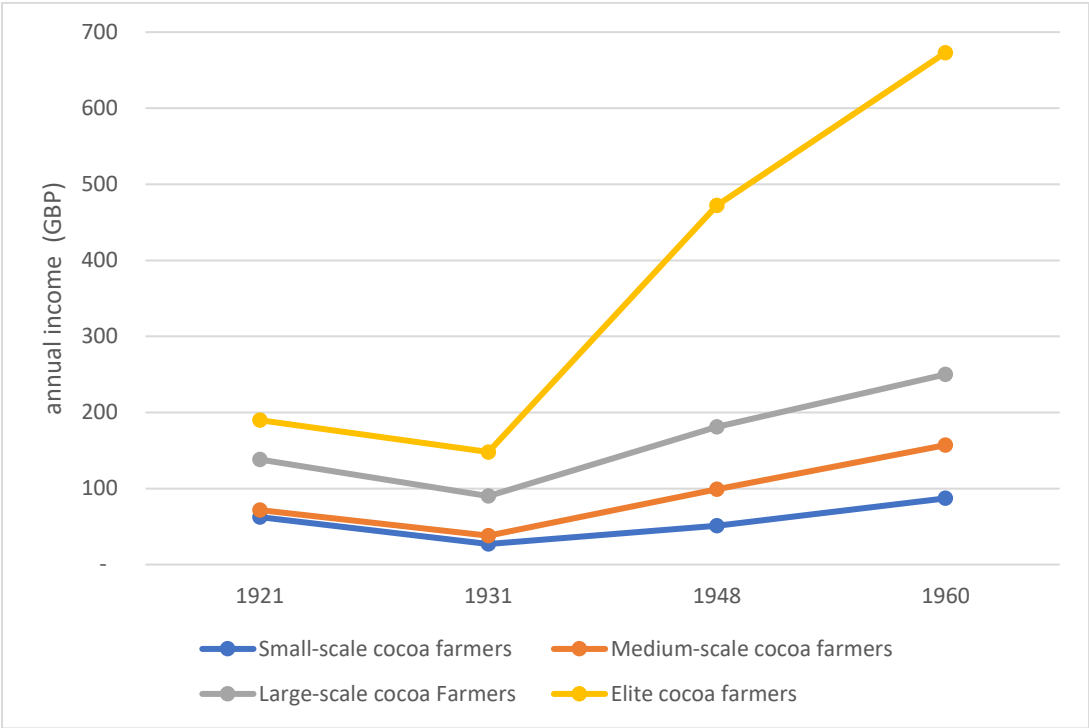
Commercialization opportunities increase inequality

Source: Mahalapye cattle in Botswana (photo credit: ILRI/Saskia Hendrickx); cocoa plantation in Ghana (photo credit: jbdodane).

Different commodities affected the process of capital accumulation in different ways. On one hand, capital-intensive commodities, such as cocoa, require a “capital investment” to plant trees and wait for them to mature. For this reason, larger farmers in Ghana were more likely to benefit from commercialization and exports, as indicated in Figure 5. Similarly, in the case of Botswana, only larger cattle owners could sell part of their herd for income without reducing the possibility of doing so in the future (you need to reach a certain herd size before you can sell cattle for income sustainably). In the case of minerals (Belgian Congo, Northern Rhodesia, and South Africa), the required capital investment was even larger. This likely increased inequality by concentrating income-earning opportunities in a small number of

firms. On the other hand, other commodities, such as groundnuts in Senegal or cotton in Uganda, were annual crops, required lower capital investments, and generated less scope for income differentiation. As a consequence, income inequality increased as commercialisation progressed, particularly in those colonies which exported capital-intensive commodities.

Figure 5: Income gaps increase among cocoa farmers in Ghana, 1921-1960



Source: Elaborated from Aboagye & Bolt (2021).

In the cases where expatriates were particularly involved in the production or marketing of export crops (such as Kenya and Uganda), commercialization also increased inequality across racial lines. Moreover, pre-colonial social structures also affected inequality levels during colonial rule. African societies were characterized by different levels of social hierarchy associated with different levels of initial inequality. In highly stratified societies, the elite benefitted to a larger extent from commercial opportunities, increasing the income gap between the elite and the majority of the population.

Conclusion

Only about 30% of global income inequality among individuals is attributable to differences in average income among countries, while 70% is due to within-country differences among individuals. Moreover, within-country inequality not only explains the greatest part of inequality among individuals but can also affect poverty rates and economic growth. Today,

Sub-Saharan Africa presents substantial variations in its level of inequality, ranging from relatively egalitarian societies in Western Africa to very unequal economies in Central, Eastern, and Southern Africa. What can explain such differences in inequality levels? Could current inequality levels be, at least partially, explained by political and economic processes that unfolded during colonial rule?

Theories of inequality during colonization emphasize, on one hand, colonial institutions and the presence of European settlers and companies and, on the other hand, economic forces, such as the emergence of capitalism and cash crop exporting economies. To evaluate these theories, we first discussed how we can measure inequality. We can use different indicators such as the Gini index, income shares, the inequality extraction ratio, and the Theil index. Each of these indicators has advantages and disadvantages, and the choice depends on which aspects of inequality we want to emphasize and on which data are available. Regarding sources, inequality estimates for the colonial periods are often based on tax records, which allow us to estimate top income shares, or on social tables, which can measure inequality across the full income distribution using various quantitative and qualitative records.

We used recent inequality estimates to discuss the features and drivers of income inequality in Africa during the colonial period. Overall, income disparities were large, and inequality increased during the 20th century. Two factors especially drove inequality levels and trends:

1. Colonial institutions created a dualistic economic structure characterized by a high-income formal sector (mostly including wage workers) and a low-income informal sector (mostly including self-employed), with the majority of Europeans working in the formal sector and many Africans working in the informal sector.
2. Second, economic forces, particularly the commercialization of export commodities, generated additional scope for income differentiation, especially among African farmers. However, the effect of commercialization on increasing inequality was not the same everywhere as it depended on the type of commodities (capital-intensive commodities tended to increase inequality more), on how much expatriates were involved in agricultural production and exports, and on local social structures, as highly stratified societies allowed the elite to benefit more from commercial opportunities.

Study questions

1. List the advantages and disadvantages of each of the measures of inequality that we discussed (Gini, Theil, income shares, and inequality extraction ratio).
2. What are Africa's main income inequality trends during colonial rule?
3. Do you observe differences among colonies?
4. Which factors can explain such trends and differences?
5. Each student should roll a die. The number you obtain is your income. Calculate Gini, Theil, top 10% share, 20:20 ratio, Palma ratio, and inequality extraction ratio of the class "income distribution" (for the IER, assume that the subsistence income is 1). Note: to answer this question, you should read the appendix.

Discussion exercise

Consider two societies. In society A, the average annual income is 12,000 \$, the richest 10% of individuals make 90,000 \$ and the poorest 10% make 1,000 \$. In society B, the average income is 6,000 \$, the richest 10% make 30,000 \$, and the poorest 10% make 2,000 \$. Which society do you prefer? Why? Try with different income levels and distributions.

Suggested readings

- Aboagye, P. and Bolt, J. (2021). Long-Term Trends in Income Inequality: Winners and Losers of Economic Change in Ghana, 1891-1960. *Explorations in Economic History* 82:101405.
- Alvaredo, F., Cogneau D., and Piketty, T. (2021). Income inequality under colonial rule. Evidence from French Algeria, Tunisia, Cameroon, and Vietnam, and comparison with the British Empire 1920-1960. *Journal of Development Economics* 152 102680.
- Alvaredo, F., and Atkinson, A. B. (2022). Top incomes in South Africa in the twentieth century. *Cliometrica* 16: 477–546.
- Bolt, J. and Hillbom, E. (2016). Long-term trends in economic inequality: lessons from colonial Botswana, 1921–74. *Economic History Review* 69: 1255-1284.
- De Haas, M. (2022). Reconstructing income inequality in a colonial cash crop economy: five social tables for Uganda, 1925-1965. *European Review of Economic History* 26 (2): 255-283.
- Frankema, E., De Haas M., Van Waijenburg, M. (2023). Inequality regimes in Africa from pre-colonial times to the present. *African Affairs* 122: 57–94.
- Hillbom, E., Bolt, J., de Haas M., and Tadei F. (2023) Income inequality and export-oriented commercialization in colonial Africa: evidence from six countries. *Economic History Review*, <https://doi.org/10.1111/ehr.13304>.

Suggested databases and reports

African Long-Term Inequality Trends, <https://www.aflit.net/>.

Chancel, L., Piketty, T., Saez, E., and Zucman, G. (2021) World Inequality Report 2022.
World Inequality Lab.

UNU-WIDER World Income Inequality Database, <https://www.wider.unu.edu/data>

World Bank Open Data, <https://data.worldbank.org/>

World Inequality Database, <https://wid.world/data/>

About the author



Federico Tadei is an Assistant Professor in the Department of Economic History at the University of Barcelona. His research focuses on understanding how historical events and institutions shaped development paths in African countries, with an emphasis on trade and inequality. In particular, he has studied the structure and the short and long-term effects of colonial trade policies in British and French Africa and the role that colonial institutions and economic development played in income inequality.

Technical Appendix: How to Calculate Inequality Indicators

Consider the society represented in Figure A. There are 100 people, and the total income is 100,000 \$. If we had perfect equality, then every person should earn 1,000 \$. Yet, in this society, the poorest 10 people earn no income at all...and the richest 10 people have an income of 5000 \$ each. This is quite an unequal society, but exactly *how* unequal is it?

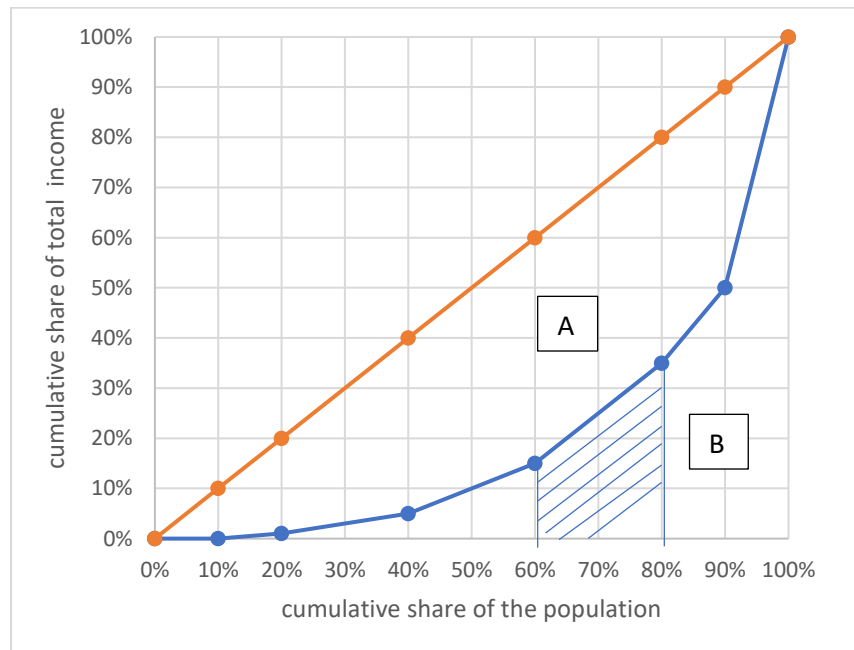
Table A: Example of Income Distribution

number of people	average income	social group
10	0	A
10	100	A
20	200	A
20	500	A
20	1,000	B
10	1,500	B
10	5,000	B
Total people: 100	Total income: 100,000	

Gini index

To calculate the Gini index, we proceed in the following way. First, we sort people from the poorest to the richest. Then, we calculate the cumulative share of the population and the corresponding cumulative share of income, as shown in Figure B. The blue line also called the Lorenz curve, represents the actual income distribution (i.e., the poorest 10% of people have 0% of the total income, the poorest 20% have 1% of the total income, the poorest 40% have 5% of the total income, and so forth). The orange line represents the distribution of income if the society were egalitarian (i.e., the poorest 10% of people have 10% of the total income, the poorest 20% have 20% of the total income, the poorest 40% have 40% of the total income, and so forth). So, the closer the blue line is to the orange line, the more egalitarian the society is. The Gini index is simply a measure of how far the blue and orange lines are from each other.

Figure B: How to Calculate the Gini Coefficient



In practice, it can be calculated as the size of area A (the area between the two lines) divided by the sum of areas A and B (areas below the blue line), that is, $Gini = A / (A+B)$. Since the axes are from 0 to 1, the area $A+B$ is equal to 0.5 (formula for the triangle area: base x height x 1/2). Thus, $A = 0.5 - B$. Then, $Gini = (0.5 - B) / (0.5 - B + B) = (0.5 - B) / 0.5 = 1 - B/0.5 = 1 - 2*B$. We can calculate B by summing the areas of all trapezoids below the blue curve. One of them is represented by the shaded area. The area of a trapezoid is calculated as $(b+B)*h/2$, where $b+B$ is the sum of the bases (the two parallel sides) and h is the height (the distance between the bases). So, in the shaded area in the example, b is the share of income owned by the poorest 60% of the population (15%), B is the share of income owned by the poorest 80% of

the population (35%), and h is the share of people between the poorest 60% and the poorest 80% (20%). Thus, the area is $(15\%+35\%)*20\%/2=0.05$. Summing all trapezoids, we see that area B is equal to 0.194. The Gini is then $1-2*0.194=0.612$.

Notice that the Gini index is not very sensitive to what happens at the top tail of the distribution (change in income for the very rich). Suppose, for example, that the average income of the richest 10% of our society in Figure A doubles from 5,000 \$ to 10,000 \$, an increase of 100%. The Gini index only increases from 0.61 to 0.71, an increase of about 16%.

Income shares

- The share of income of the richest x -% of the population. In our example, the richest 10% of people (100 people) earn 50% of the total income ($100*5,000\$ /100,000\$= 50\%$). Notice how much more sensitive this measure is to changes in the distribution's tails. If the average income of the richest 10% doubles, their share of income increases from one-half to two-thirds ($100*10,000\$ /150,000\$=66.6\%$), a 34% increase.
- The 20:20 ratio is the share of income earned by the richest 20% divided by the share of income earned by the poorest 20%. In our case, the top 20% earns 65% of total income, and the bottom 20% earns 1% of income, thus the 20:20 ratio is 65.
- The Palma ratio is the share of income earned by the richest 10% divided by the share of income earned by the poorest 40%. In our example, the richest 10% earn 50% of income and the poorest 40% earn 5% of income. The Palma ratio is then 10.

Inequality extraction ratio

The inequality extraction ratio (IER) can be calculated by dividing the Gini by the maximum attainable Gini, given the society's income. The maximum Gini is equal to $(a-1)/a$, where a is how many times larger the average income is relative to the subsistence income. If everybody lives at subsistence (the average income equals the subsistence income), $a=1$, and the maximum possible Gini is zero. As society becomes richer, a increases and the maximum possible Gini increases too.

In our example, the average income is 1,000\$. Suppose that the subsistence income is 100\$. Then $a=10$ (the average income is 10 times the minimum subsistence income) and the maximum possible Gini = $(10-1)/10=0.90$. The actual Gini is 0.61. Thus, the IER is $0.61/0.90= 0.67$. If our society were poorer, with the average income being only 5 times the subsistence income, then $a=5$, the maximum Gini would be 0.80, and the IER would be 0.76.

Theil index

The Theil can be calculated using the following formula:

$$T = (1/n) * \sum (x_i/Y) * \ln(x_i/Y)$$

where:

- T is the Theil index
- n is the number of individuals or households in the population
- x_i is the income or wealth of the individual i
- Y is the average income of the population.

In our case, the Theil is 0.71.¹ Notice how much more sensitive Theil is to changes in income in the distribution's tails compared to the Gini. If the richest 10 people double their income from 5,000 to 10,000, the Theil increases to 1.07, a 51% increase (the Gini only increased by 16%).

In the society in Figure A, we have two social groups (A and B). How much of total inequality depends on differences between the two groups, and how much depends instead on individual differences within each group? The *within-group* component of inequality is calculated by multiplying the group's Theil index by the group's share of the total income. In our example, the within-inequality of group A is 0.05, and group B's is 0.22.

The *between-groups* component of inequality is calculated by taking the difference between the Theil index of the total population and the sum of the within-group inequality of all groups. In our example, the between-group inequality is 0.43. Thus, about 61% of total inequality can be attributed to income differences between groups (0.43/0.71), about 31% to inequality among individuals in group B (0.22/0.71), and the remaining 8% to inequality among individuals in group A (0.05/0.71).

¹ To be able to calculate the Theil, we assume that the income of the poorest 10 people is 0.001, not 0. Otherwise, the log would be undefined.