The alignment of boundaries in colonial times

This appendix illustrates the hazards that presided to the alignment of boundaries during colonial times. When referring to pre-colonial political entities, it is worth recalling that even structured kingdoms drew no maps, and that ethnic groups are historical objects that were at least influenced, if not constructed in some instances, by colonial and post-colonial politics. Some kingdoms were composed of groups speaking different languages, on a federal basis, like for instance the Gyaman kingdom lying across the present-day Cote d’Ivoire-Ghana border.

A.1. The border of Cote d’Ivoire with Ghana

The border area between Cote d’Ivoire and Ghana stretches from the lagoon regions bordering the Atlantic Ocean to the savannah in the North. We exclude the most northern part of this border where only few survey clusters are close enough to the border, i.e. the Bouna district in Cote d’Ivoire and the northern region in Ghana. On the Cote d’Ivoire side, the southern border area is made up of five contemporary districts: the ”départements” of Bondoukou, Tanda, Agnibilekrou, Abengourou and Aboisso. This administrative definition of the border region selects survey clusters that are pretty close to the border: they range from 1 to 118 km from the border, with a mean distance of 30 km. On the side of Ghana, the available regional subdivisions provide less details: we are left with two regions, Western and Brong-Ahafo; this latter region extends far from the Cote d’Ivoire border, so that 25% of survey clusters are more than 100 km away from the border.


and the mean distance is 77 km. Excepting the lagoon in the extreme South, the part of the border we consider does not follow any natural line, as the Black Volta river only contributes to the most northern part that is out of our sample.

During the 19th century, the bulk of this border area was controlled by the Ashanti Empire whose capital town Kumasi was located in central present-day Ghana. Then, at the end of the 19th century, the French and British started to extend their domination, from trade posts located on the coast toward the North, by signing protectorate treaties with local kingdoms. The 1870 defeat of France against Prussia allowed Great Britain to extend its influence westward. A territorial exchange of the French trade posts of Grand Bassam and Assinie against British Gambia was even considered at that time. But the Binger expedition and the action of French men who had private interests in the region (Treich-Laplène, Verdier) made France regain the lost ground from 1887 by signing treaties with kingdoms located in the middle part of the border area: Indenie (around Abengourou), Sefwi (around Debiso), Gyaman. Having signed treaties with both colonial powers, this latter kingdom, located around Bondoukou, was finally cut in two halves as early as 1891: The city of Bondoukou was first taken by the British in 1887, then by the French in 1888, then by the Diula leader Samori Toure in 1895; the British reconquered it in July 1897 when called for help by the king of the Gyaman, but the French took their revenge and imposed themselves in October 1897.

The two colonial powers needed around 15 years, from 1889 to 1905, to agree upon a definitive alignment. Some consideration was given to historical ties between populations, but diplomatic bargaining was the dominant feature.

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4Cf. Terray, op. cit.
The 1905 memorandum recording the agreement between arrived at by the British and French governments stated that "any natives who may not be satisfied with the assignment of their village to one of the two Powers shall have, for the period of one year from the 1st April, 1905, the right to emigrate to the other side of the frontier"; after that one year delay, the inhabitants of villages situated near the frontier were no longer authorized to build huts on the other side. So that, in econometric terms, "manipulation of the (country) treatment" had been very much restricted at that time.

Between 1958 and 1970, a secessionist movement reclaimed the independence of the Sanwi kingdom in the most southern part of the border on the Cote d'Ivoire side, with the alleged support of Kwame Nkrumah's Ghana; this movement was toughly repressed by Felix Houphouët-Boigny, the leader of independent Cote d'Ivoire. In 1970, a bilateral commission reexamined the border alignment and achieved its works in 1976. The layout of the last demarcation on the field, with teak trees, beacons and pillars, was achieved in 1984 on the Cote d'Ivoire side, and in 1988 on the Ghana side.

A.2. The border of Cote d'Ivoire with Guinea

Like in the case of the border with Ghana, when defining the border area with administrative districts, we exclude the northern part of the border Cote d'Ivoire-Guinea from the comparison, for the survey clusters in the Guinean districts of Kankan and Mandiana are too far (more than 100 km) away from the border; we correspondingly exclude the Ivorian district of Odienne.

The first part of the southern border is made up of the Guinean district of Beyla and the Ivorian district of Touba; a sector of this border follows the Feredougouba river. This part was laid out in the context of the first war against the Almami Samori Toure whose "first empire" was centered on Kankan and extended southward in present-day Sierra Leone, eastward to Odienne, and northward to the

\[^{7}\text{Brownlie, op. cit. p.246}\]
banks of river Niger near Bamako where the French had just arrived, coming from Senegal.\textsuperscript{8} Between 1891 and 1894, these latter conquered the regions of Kankan and Beyla that were first included in French Soudan, then in 1899 merged with the other French conquests on the Western coast (1893-94) and in the Fouta Djallon mountains (1896-97) to form the Guinea colony.

The second part of the southern border area is a forest and mountainous region, which currently corresponds to the districts of Bankouma and Danane in Cote d’Ivoire, Lola and Nzerekore in Guinea; even though the Nzerekore district does not touch the border, all the survey clusters are less than 100 km away from it. The conquest of this remote forest area by the French began from the North: according to the Berlin treaty this area should have been controlled by Liberia and was not, so that France invaded it gradually and definitely annexed it in 1907. In 1911, the region ceased to be a special military zone and was merged with the rest of the Guinea colony. Because of the resistance from the Guerze people, the French military forces reached the most southern part of the Cote d’Ivoire / Guinea border only as late as in 1908.

There is no detailed description of the border alignment between Cote d’Ivoire and Guinea, whether in French colonial enactments, or in international agreements since independence.\textsuperscript{9} No demarcation is known to have taken place, so that French maps still provide the best available evidence, revealing that some sectors are still indefinite. However no dispute has ever been reported between the two countries.

A.3. The borders of Cote d’Ivoire with Mali and Burkina Faso

This border area includes the districts (“départements”) of Odienne, Tingoora, Boundiali, Korhogo, Ferkessedougou and Bouna on the Cote d’Ivoire side. On the Mali side, one finds the districts (“circles”) of Yanfolila, Bougouni, Kolondieba and Kadiolo; lastly, on the Burkina Faso side, the districts (“départements”) of...
Comoe, Leraba, Poni and Noumbiel.

In that region, the French were again confronted with the Almami Samori Toure they had already defeated in 1894 and whom they had pushed to the East (cf. supra on Guinea border). In 1896, his ”second empire” covered all northern Cote d’Ivoire from the banks of the Sassandra river (East of Odienne) to Korhogo and Bondoukou, and even extended to southern Burkina Faso and northern Ghana.\(^\text{10}\)

The northern neighbors of this empire were the Kenedugu kingdom (capital Sikasso in present-day Mali), Kong and Bouna kingdoms (with eponymous capital towns in present-day Cote d’Ivoire). Under the king Tyeba (1870-1893), the Kenedugu first fought against Samori whose siege of Sikasso failed in 1887, and made an alliance with the French. After 1896, Samori rallied his successor, the king Babemba, by conceding him Tingrela (present-day Cote d’Ivoire), before it was finally taken by the French in 1898. Conversely, the Kong chiefs first allied with Samori but the latter pillaged Kong city (present-day Cote d’Ivoire) in May 1897; the Kong chiefs fled to Bobo-Dioulasso (present-day Burkina Faso). Both cities were taken by the French respectively in December 1897 and February 1898. As for the Bouna kingdom (Mosi people), formerly a vassal of the Asante Empire, it had first signed a protectorate treaty with the British in 1894, then was pillaged by Samori’s son in 1896; Samori first proposed to give Bouna city to the French, but his son attacked and destroyed their military forces, so that Bouna was finally reconquered by the British in November 1897; the French finally entered Bouna in August 1898. Under French rule, the Bouna kingdom finally lost its integrity: the most important southern part, around Bouna city, was attached to the Cote d’Ivoire colony, while the northern part near Lorhoso ended in former Upper Volta (present-day Burkina Faso): the Lobi people in this latter area indeed used to pay tribute to the Bouna king.\(^\text{11}\)


Comoe river, is not very populated and includes national parks: the fauna reserve of Dida in Burkina Faso and the Comoe National Park in Cote d’Ivoire.

The French conquest of northern Cote d’Ivoire was achieved by the end of 1898 with the capture of Samori Toure. This conquest established a continuity between the French Soudan and the trade posts of Grand-Bassam and Assinie on the Gulf of Guinea. The territories that Samori had conquered in the Kong and Bouna kingdoms were put together in the colonial district of Kong and attached to the Cote d’Ivoire colony. For the purpose of pacification, the territories that had resisted Samori, around Sikasso (Kenedugu kingdom), Bobo-Dioulasso (Gwiriko people) and Gaoua (Lobi people), were gathered in the ”Second Military Territory”, also named ”Volta”. Its military status only ended in 1911, because these people also showed a lot of hostility to French rule. During the World War I, the same region was again the theater of large riots against military conscription (1914-16).

As a matter of fact, it is as if the conquests of Samori Toure had delineated the intra-colonial boundaries between Cote d’Ivoire on the one hand, and Soudan (Mali) and Haute-Volta (Burkina Faso) on the other hand. An official decree of 1902 only mentions a small adjustment of the most Eastern part of the border with Mali, between the Bagoe and Leraba rivers, and another decree of 1903 likewise very slightly modifies the North-Eastern boundary with Burkina Faso. These modifications had the objectives of putting rebel villages under martial law; apart from this peace-making territorial surgery, the layout of the border between the three French colonies remained undefined until 1947.

In 1904 the Second Military territory was attached to the French colony of ”Haut-Senegal-Niger” that covered almost all present-day Mali, Burkina Faso and Niger, that is about 2 millions of squared kilometers; the Niger colony was detached from this set in 1911. Last, in 1919, the World War I riots had decided the French to cut the ”Haut-Sénégal” in two parts in order to increase their political control: the

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12 Brownlie, op.cit., p.373.
first part, corresponding to present-day Mali, was renamed French Soudan (Sudan) a year later (1920), and the second part, corresponding to present-day Burkina Faso, constituted the Haute-Volta colony. Between 1932 and 1946, the latter was then partitioned between former Cote d’Ivoire, French Soudan and Niger, in order to increase forced labor supply in the other three colonies, in particular for cocoa production in Cote d’Ivoire.\textsuperscript{13} All the border area that we examine was therefore annexed to Cote d’Ivoire. In 1947, Haute-Volta was reconstituted in its original version; the 1919 border was never altered again afterward.

Like with Guinea, there is no detailed description of the border alignment between Cote d’Ivoire and either Mali or Burkina Faso, whether from colonial or post-colonial sources.\textsuperscript{14} According to maps, half of the alignment consists of rivers, however watercourses can be many-armed and indecisive, especially on the Malian border. For the non-river parts, no demarcation has ever taken place; no international dispute has ever been reported either.

A.4. **The borders between Cote d’Ivoire neighbors**

We did no specific historical work on these latter borders and mainly rely on Brownlie (1979).

*Ghana and Burkina Faso*\textsuperscript{15}

For its main part, the alignment of this border was fixed between 1904 and 1906; it was at that time a border between British Northern Territories of the Gold Coast (making part of Gold Coast administration since 1897) and French ”Soudan” (Sudan). The alignment was broadly a straight line following the 11th degree of north latitude. The 1904 memorandum acknowledges that the chiefs of Lan and of Kounou (Kunu) shall be compensated by respectively the British and French


\textsuperscript{14}Brownlie, op.cit., pp.371-377.

\textsuperscript{15}Brownlie, op.cit., pp.280-295
governments for the loss of territories caused by the passage of the frontier-line. A tiny eastern part was agreed after World War I (1919) when German Togoland was split between the British and the French mandates, as again a straight line running between two pillars, at the same time when the "Haute Volta" (Upper Volta) colony was formed.

Various sources report the boundary as demarcated during the colonial era. After independence, between 1967 and 1972, some redemarcation works were launched on the basis of the original report of the British and French commissioners of 1904.

**Burkina Faso and Mali**\(^{16}\)

By a decree of March 1919 the French colony of "Haut-Sénégal et Niger" was divided and the new colony of "Haute Volta" (Upper Volta) was constituted as a separate entity from "Soudan" (French Sudan). The only existing pieces of evidence regarding the border alignment come from the maps established under the French administration (Afrique Occidentale Française). By the end of the 1970s, the border was very little demarcated on the ground, except through some segments of watercourses. In 1974 Mali claimed that the 160 kilometers long north-eastern part was to be moved between 10 and 30 kilometers southward for ethnic purposes, i.e. Touaregs and Bellah living across the border; the position of independent Haute Volta (soon to be renamed Burkina Faso) was to stick to the 1922 French colonial map.

**Mali and Guinea**\(^{17}\)

This border alignment is again founded on French administrative maps, here dating as early as 1911. However, in this case, a good proportion of the boundary follows rivers and stream, even if the latter can be sometimes fugitive. No dispute appears to have existed regarding this border.

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\(^{16}\) Brownlie, op.cit., pp.426-430
\(^{17}\) Brownlie, op.cit., pp.310-313
Figure A.1: Map of border regions

Location of border administrative districts.
Table A.1  Initial Conditions and Early Colonial Investments: Cote d’Ivoire
Borders during the Colonial Era

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Population dens. 1910</td>
<td>1.6</td>
<td>5.0</td>
<td>6.4</td>
<td>4.5</td>
</tr>
<tr>
<td>Europeans per cap. 1910</td>
<td>9.3</td>
<td>0.5</td>
<td>0.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Trade tax per cap. 1912</td>
<td>0.58</td>
<td>0.02</td>
<td>0.02</td>
<td>0.07</td>
</tr>
<tr>
<td>Teachers per cap. 1910-28</td>
<td>8.6</td>
<td>1.7</td>
<td>0.9</td>
<td>1.7</td>
</tr>
<tr>
<td>Health pers. p.c. 1910-28</td>
<td>8.8</td>
<td>1.1</td>
<td>1.5</td>
<td>2.2</td>
</tr>
<tr>
<td>Public works 1910-28</td>
<td>1.0</td>
<td>0.7</td>
<td>0.2</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Source: French colonial administration data collected by Elise Huillery (2009), hence excluding Ghana (former British).

Coverage: Administrative districts ("cercles") of the former French West Africa (Afrique Occidentale Française) located at the border of present-day Cote d’Ivoire. Ghana border: "cercles" of Assinie, Indenie and Bondoukou; Guinea border: Man (C.d’Iv. side), Beyla and Nzerekore (Guinea side); Mali border: Odienne and Kong (C. d’Iv.), Bougouni and Sikasso (Mali); Burkina Faso border: Kong and Bondoukou (C. d’Iv.), Bobodioulasso and Gaoua (Burkina Faso). In comparison with the map of figure A.1, the former colonial "cercles" were split hence the names do not correspond to present-day districts.

Notes: Population dens. = enumerated residents per squared kilometers; Europeans = enumerated Europeans per 1,000 people; Trade tax = trade tax revenue per capita in 1910 French Francs; Teachers = number of teachers per 100,000 people; Health pers. = Health personnel per 100,000 people; Public works = Public works (infrastructures) expenditures per squared kilometers in 1910 French Francs.
Details on variables construction and descriptive statistics

B.1. Consumption

The consumption variable is the sum of four distinct components: 1. Consumption of own food production; 2. Food expenditures including meals outside the household; 3. Housing expenditures: rents paid and imputed rents; home cleaning and reparation; water, electricity and other fuels; 4. Other current expenditures, including education. Consumption of own production other than food is disregarded. Gifts received in kind are not included for they were not collected in all countries. Gifts and transfers to other households are disregarded, as well as tax payments. Expenditures for ceremonies and for health were not included for being too infrequent. For the same reason, durable goods acquisition and reparation are not included (furniture, domestic appliances, radio and TV sets, vehicles).

No correction was considered for within countries regional price levels differences (this kind of information is only available for the early surveys in Cote d’Ivoire and Ghana). Monthly data on national consumer price index (CPI) was used to express all components in a common base-year (1988 or 1993), taking into account their specific recall period and the month and year of recording. Although very much imperfect as CPI are not disaggregated by products, this correction is however better than nothing for periods of high inflation: in Ghana whatever the date, in Burkina Faso and Mali just after the CFA franc devaluation in 1994.¹

Household consumption levels are then translated in current dollars at base year

¹For Mali 1994 the correction is even cruder, as the survey only covered four months (March to June), and the precise month of consumption recording has not been kept in the datafiles: we simply do as if the survey had been implemented in April 1994, we assume that all recorded food expenditures were made then, and that non-food expenditures, whose recall period is the year, were uniformly distributed along the May 1993-April 1994 period.

Regarding consumption of own food production, all surveys except EMEP (Mali 2001) directly ask households about the market value for each product, with a recall period that may vary from one survey to another. In GLSS3-4 (Ghana 1992 and 1998), EIBC (Guinea) and EMEP (Mali 2001), quantities consumed are also recorded: in that case, within PSUs median unit prices can be computed and a second market value constructed. Market values are then translated into monthly consumption (with a multiplier depending on the recall period) and divided by the corresponding monthly CPI, then turned into annual consumption using declarations about how often the product is consumed during the year (when available). They are finally summed across products. When two measurements have been constructed (cases of GLSS3-4 and EIBC), we check they are fairly correlated (minimum correlation coefficient of 0.5), and we take the average of the two.\(^2\)

Regarding food expenditures, the procedure is nearly the same, except that quantities are not collected. All surveys except EMEP (Mali 2001) record food expenditures during the last 15 days or the last month. This allows to construct a first simple measurement of food expenditures: (i) translation into a monthly basis (double the value when the recall period is 15 days), (ii) division by monthly CPI, (iii) multiplication by 12 to obtain the annual expenditures estimate. The Cote d’Ivoire (CILSS and ENV) surveys and the early Ghana surveys (GLSS1-2) additionally record how many months each product has been consumed during the year. This allows to construct a second measurement where the last step is replaced by (iii) multiplication by number of months of consumption to obtain the annual expenditures estimate. In the CILSS and GLSS1-2 this number of months is matched with a second declaration of expenditures over a recall period

\(^2\)Note that the EMCES (Mali 1994) survey does not collect any information on consumption of own production.
of one year (rather than one month). Here again, we keep the average of the two measurements after having checked their correlation.\(^3\)

Regarding housing expenditures, information usually comes from specific survey modules, and is collected over or twelve months recall period. Combined with monthly or yearly CPIs, we then straightforwardly obtain an annual aggregate at base-year prices. For house-owners or households with free accommodation, the imputed rent is the predicted value derived from a regression estimated on tenants. The regression relates the rent paid to the characteristics of the house only; one such regression is estimated for each survey, no correction for selection is made. We check that the resulting housing budget shares are sensible.

Last, for all other expenditures, the longest recall period (usually 12 months) has been preferred when two recall periods are available. Exceptions are hygiene, cigarettes and fuels. Information on education expenditures (including transportation and sometimes food) are usually derived from a specific module.

The food consumption aggregate is trimmed separately by dropping observations for which the logarithm is under or above the mean by 5 standard deviations. Households declaring no food consumption are directly withdrawn. This "clean" food consumption amount is then summed with other expenditures and the total consumption amount is trimmed again with the same ±5 standard deviations rule. In the end, in all surveys, less than 1% of households are withdrawn from the sample by this trimming procedure.

\section*{B.2. Other outcomes}

Dummy variables for connection to electricity and access to water other than rainfalls or river are directly drawn from raw data.

Adult literacy is measured as the self-assessed capacity to read and to write

\(^3\)Last, like for consumption of own production, the EMEP survey (Mali 2001) weights meal preparations to measure quantities consumed, whether purchased or produced at home; here again, PSUs median unit prices are applied to quantities of food purchased and consumed.
in English, French or any other vernacular language. As literacy hardly changes across time after 20 years of age, when comparing birth year cohorts we could theoretically pool all available surveys whatever their date. However, there is some variation across surveys in the question asked about literacy, that calls for caution: listing of possible languages or not, capacity to read a newspaper, or else capacity to read without further detail. Likewise, the question about school attendance (ever been at school) sometimes explicitly mentions Koranic schools or vocational training, sometimes not. When more than one survey is available (every country except Guinea), we check the stability of answers across time for the same birth year cohorts. People reading vernacular languages most often read the language of the former colonial power, so that the listing of languages makes little difference. Conversely the ”newspaper” mention reveals very influential in the early surveys for end-1980s Cote d’Ivoire and Ghana (CILSS2-4 and GLSS1-2), when contrasted with the surveys that were implemented later. Finally, our assessment of comparability leads us to be more selective upon what surveys to use for each country-pair comparison: we keep only the surveys implemented before 1989 for Cote d’Ivoire/Ghana, only the 1992-93 Cote d’Ivoire survey for the comparisons with Mali and Burkina Faso, and last, only the 2001 Malian survey (data on literacy in the Mali 1994 survey being obviously flawed). When looking at Guinea, we only consider the school attendance variable (ever been at school) as the literacy variable (self-assessed capacity to read and write a letter or a short note) is little comparable to any other. When possible, results obtained for literacy are also cross-checked with results for school attendance.

B.3. Ethnic groups

Ethnic categorizations are difficult to compare from one country to another, due to differences in the surveys described therafter, but also because they are not exogenous from colonial and post-colonial history.

Each survey has collected some information on the ethnic affiliation of coun-
try nationals, at least for household heads. In the Cote d’Ivoire surveys, four big ethnic headings are distinguished (Akan, Kru, Mande, Voltaic), each containing from three to six more detailed ethnic names and a residual category ”other” (other Akan, other Kru...). In the three first Ghana surveys (GLSS1-3), the classification is based on the primary language of the household head, and distinguishes seven main groups (Akan, Dagbani, Hausa, Ga-Adangbe, Nzema, Ewe, Other); in GLSS4 (Ghana 1998), the question about ethnicity is asked directly for each individual, with a code allowing for nineteen distinct ethnic names. In the Guinea and Mali 1994 surveys, only the language of interview is recorded, hence including French as a possible item: this aspect compromises strict comparability with other surveys. In the Mali 2001 survey, declared ethnic group is recorded for each individual with Malian nationality, through a list with eleven headings. Last, in the two Burkina-Faso surveys, the head’s ethnic group is recorded through a list with thirteen headings. The presence of the residual category ”other” raise an important problem of comparability, as it may often include ethnic groups whose name is recorded separately in another country.

In the end, our assessment of the comparability of ethnic lists between countries leads us to distinguish only two main groups for border comparisons. The Akan group is only present in Cote d’Ivoire and Ghana. It includes Abron, Agni, Baoulé, Lagumaires and ”other Akan” on the Cote d’Ivoire side. In Ghana it includes Asante, Akwapim, Fanti, and the ”other Akan” again as well; we also classify the small Nzema group (the one of the father of the Ghanaian nation, Kwame Nkrumah) as Akan.

The Mande-Voltaic large group is present in all the five countries. The Mande group includes in particular the Bambara, Bobo, Diula, Malinke and Soussou, while the Voltaic or Gur group includes the Lobi, Mossi and Senufo people. Mande and Voltaic groups are close together in linguistic terms and display some mixing on the map. In Burkina Faso, we chose to code the ”Gouin” ethnic group as well as all ”other ethnic group of Burkina Faso” as Mande-Voltaic.
B.4. Geographical variables

We obtain the geographical coordinates of survey clusters from combining NGA GEOnet Names Server, Falling Rain Global Gazetteer and regional maps. These coordinates are then used to construct the geographical attributes of clusters: altitude, rainfall, distance to the nearest river and distance to national borders.

NGA GEOnet Names Server: http://earth-info.nga.mil/gns/html
Falling Rain Global Gazetteer: http://www.fallingrain.com/world

Altitude

Elevation data are from the NASA Shuttle Radar Topography Mission (SRTM). The data used is from the Global Coverage 3 Arc Second database, available from the USGS EROS Data Center. The basic hgt files are first converted to Arc Grid Ascii format using the gdal_translate utility, and then to Stata format using the ras2dta program. The resolution of the original elevation files is then reduced by averaging altitudes over square blocks of 25 pixels. The coordinates of survey clusters are finally matched to those of these squares.

gdal_translate utility: http://www.gdal.org/gdal_translate.html

Rainfall

Rainfall data are from the NASA Global Precipitation Climatology Project (GPCP). We use the data for the years 1984–2001. The original monthly data are averaged over each year, and further averaged over the 1984-2001 period for the calculations in the paper.


References

Distance to the nearest river

Hydrographic data are from the NASA Hydro 1K Africa database. For each survey cluster, the distance to the nearest stream within the same drainage basin is computed using the Distance Calculator utility of Mapinfo software. NASA Hydro 1K Africa database:

Border areas and Distance to the border

Digital data maps for all the countries come from the USGS Africa Data Dissemination Service. Figure B.1 thereafter provides a map giving the location of administrative districts located in the border areas we consider (for more details, see historical appendix). Notice that the two districts of Odienne and of Bouna are not considered in the comparisons with, respectively, Guinea and Ghana, because their survey clusters are too far from the borders with these latter two countries. However, as they are included in the comparisons with respectively Mali and Burkina Faso, the complete border area of Cote d’Ivoire with its four neighbors is covered by at least one of our comparisons. Each survey cluster is used only once, with the exception of the Ferkessedougou district that contributes to both comparisons with Mali and Burkina Faso. Only the Ghanaian region of Brong-Ahafo extends very far from the border with Cote d’Ivoire, but in total only one quarter of Ghanaian survey clusters are more than 100 km away from the border, the mean distance being 77 km (GLSS1-2 and GLSS4).

Distance to the national borders is computed using the Distance Calculator utility of Mapinfo software.

USGS: http://earlywarning.usgs.gov/adds

B.5. Descriptive results: national and border districts comparisons

Table B.1 provides the differences in means between Cote d’Ivoire and Ghana, for the survey periods 1986-89, 1992-93 and 1998, and for two development out-
comes: consumption per capita and electricity connection. Within each period, in the top panel, the Cote d’Ivoire level is reported in the first column; the difference in means at the national level comes next, then the difference between border districts; the fourth and last column provides a test for the significance of the gap between the national and border contrasts. The bottom panel of the table indicates the sizes of the corresponding household samples.

The figures for the 1986-89 period reveal large differences in development between the two countries, whatever the outcome, and whatever the geographical level of comparison. For instance, the estimation of consumption per capita at 1988 prices reaches 663 dollars for Cote d’Ivoire, whereas it only amounts to 233 dollars in Ghana, this making a huge 430 dollars difference between the two countries. These figures are in line with national accounts private consumption per capita differences, that range between 401 and 467 dollars, whether they are estimated at official or parallel exchange rates for cedi, the Ghanaian currency (World Bank, 2008). Furthermore and reassuringly, the bulk of this difference lies in cash expenditures rather than in consumption of own production, the latter being more affected by measurement errors stemming from unit values calculations and the pricing procedure (see statistical appendix). Large national differences are also observed in terms of the electricity connection rate: in 1986-89 around 40% of Ivorian households are connected to electricity versus 23% of Ghanaian households.

As shown by the "Border diff." column of the 1986-89 period, these large differences in welfare are preserved when restricting the comparison to border districts. In the case of consumption per capita, border differences are significantly lower than national differences, by 100 to 150 dollars, but are still very significantly different from zero; national differences in electricity connection are purely and simply reproduced at the border.

The following period, 1992-93, corresponds to the climax of a large macroeconomic crisis for Cote d’Ivoire, while for Ghana it is rather a time of recovery.
Then, between 1993 and 1998, Cote d'Ivoire experiences a rebound, following the devaluation of the CFA franc, while growth plummets in Ghana.\(^5\) Our national level survey mean differences in consumption per capita follow this pattern of ups and downs: in Cote d'Ivoire, household consumption first collapses by 37% then rebounds by 25%, while in Ghana it first grows by 11% and then hardly moves (2%). These differences in macroeconomic developments translate into the variations of the Cote d'Ivoire/Ghana consumption gap that falls from 432$ in 1988 to 158$ in 1993, and then raises again to 255$ in 1998. In comparison with the national level, border differences are always pretty much attenuated; they still reflect the first period of convergence between the two countries, but not the end of period relative upturn of Cote d'Ivoire: the consumption per capita gap falls from 345$ to 130$ between 1988 and 1993, and then remains stable. The small size of the sample of households living on the Cote d'Ivoire border side should however lead to take the 1998 results with caution.

Table B.2 provides the same figures as Table B.1 for northern borders with Guinea, Mali and Burkina Faso. In most of the cases, international differences are either preserved or else attenuated, but rarely canceled, at borders. Out of the ten border comparisons that are shown in this table - in terms of cash expenditures and electricity connection, three cases correspond to preservation of national differences at 90% confidence level ($Pr. > F$ is higher than 10%), and five cases to attenuation (border difference is significant at 90% confidence but $Pr. > F$ is lower than 10%).

The two remaining cases are that of consumption at the Guinea border in 1992-94, and of electricity connection at Burkina-Faso border in 1992-94. In this latter case however, the non-significance of the Cote d’Ivoire advantage in terms of electricity connection could be due to the small sample size for border households on the Cote d’Ivoire side, as point estimates is far from zero (+7.8 in 1992-94), like in 1998 (+20.0, non significant at 10% although we cannot reject preservation of national difference either at 10%). Indeed, electricity connection is for obvious reasons very much spatially auto-correlated, so that good inference is dependent on having a high number of PSUs.

The cancelation of the border differences in consumption at the Guinea border is most striking. The survey national difference at 1993 prices amounts to +223$ in favor of Cote d’Ivoire; it is again reassuringly in line with national accounts data (+299$). However, this difference in monetary welfare is wiped out at the border between the two countries. This diagnosis does not depend on whether we use official or parallel exchange rates. However, public investment is fairly disconnected from private welfare, as in terms of electricity connection this border area shows the same difference with its Guinean counterpart (+17.1 percentage points) as whole Cote d’Ivoire with whole Guinea (+19.6).

At the national level, landlocked Mali and Burkina Faso clearly lag behind their southern neighbor on all dimensions. In contrast with Guinea, this Cote d’Ivoire overwhelming advantage holds at the border during the 1992-94 bad period, even if it is somewhat lessened. Here the comparisons of consumption are facilitated by the common currency unit shared by the three countries (CFA franc).\(^6\)

In 1992-94, households living in northern Cote d’Ivoire are richer than their neighbors in Mali by 110$, and richer than their neighbors in Burkina Faso by 86$; in

\(^6\)In these cases the survey averages yield lower international differences than national accounts: for instance, this latter source indicates a 480$ difference in consumption per capita between 1993 Cote d’Ivoire and Burkina Faso (vs. 336$ in table S.2 for 1992-94). Nonetheless, we also check that these discrepancies do not entirely derive from our choices regarding domestic inflation correction, knowing that the 1992-94 period covers the CFA franc devaluation.
1998, these figures again reach very close values: +169$ and +172$ respectively. At the Mali border at least, electricity connection is very much in keeping with these consumption figures: 25 additional percentage points of households are connected in 1993 on the Cote d’Ivoire side, and even 32 percentage points in 1998. As already noted, the figures for the Burkina Faso border are less robust but sample size limitations may matter.

Using data on district of birth, table B.3 provides estimates of in- and out-migration rates for border areas. It reveals that the Cote d’Ivoire side of the border with Mali exhibits the highest net outflow rate (25%=37%-12%) of male migrants born between 1930 and 1980. The Cote d’Ivoire side of the border with Guinea ranks second in that respect (with a net rate of 16%). Immigration and emigration flows are more balanced on the Guinea side (10% vs 8%); this confirms the relative wealth of this region that comparisons of consumption have already pointed out, as it appeared not poorer than its Cote d’Ivoire counterpart. Even if northern peripheral regions of Cote d’Ivoire are not poorer than their close international neighbors, the Cote d’Ivoire country core, made of the capital city and of southern cocoa producing regions, exerts a strong power of attraction. Cote d’Ivoire also attracts a lot of Mali and Burkina Faso nationals, who represent respectively 6% and 10% of the reference population of the origin countries (men born between 1930 and 1980). However, Malian and Burkinabè migrants are no less numerous in the border areas of Cote d’Ivoire with their country of origin than in the core of this country. In the 1992-93 Cote d’Ivoire survey, 4% of individuals aged 15 and over are of Malian nationality and the same share applies to the border region; likewise, no less than 6% of the Bouna and Ferkessedougou districts are Burkina Faso nationals, against 7% in the rest of the country. These latter figures suggest that the northern border regions of Cote d’Ivoire are not much less attractive than the country core for migrants coming from northern neighboring countries; the welfare advantage of living in Cote d’Ivoire, rather than in Mali or Burkina Faso, finds here another illustration. Last, the southern Cote d’Ivoire/Ghana border area
is closer to the capital cities Abidjan and Accra, and is a main cocoa producing region. Here, net migration inflows overcome outflows by 6 points on the Cote d’Ivoire side. This is even more true on the Ghana side, with net inflow rate reaching 19 points. This outstanding attraction of labor force may be explained by the post-colonial development of cocoa production in the Western region of Ghana, after it had reached the Brong-Ahafo region during the 1930s. In contrast, on the Cote d’Ivoire side, the forest areas of the Abengourou and Agnibilekrou districts (see figure B.1) are the oldest cocoa producing regions in the country (1900-1930), and cocoa production has rather expanded westward after 1960.
Location of border administrative districts, as described in historical appendix.
**Table B.1: Development differences at the Côte d'Ivoire / Ghana border: 1986-89, 1992-93 and 1998**

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</thead>
<tbody>
<tr>
<td>Cons.p.c. 1988 p.</td>
<td>665$</td>
<td>+432**</td>
<td>+345**</td>
<td>0.022</td>
<td>417$</td>
<td>+158**</td>
<td>+130**</td>
<td>0.397</td>
<td>5208</td>
<td>+255**</td>
<td>+130**</td>
<td>0.038</td>
</tr>
<tr>
<td>Cash expend. only</td>
<td>553$</td>
<td>+380**</td>
<td>+237**</td>
<td>0.003</td>
<td>344$</td>
<td>+139**</td>
<td>+71**</td>
<td>0.036</td>
<td>441$</td>
<td>+214**</td>
<td>+79</td>
<td>0.060</td>
</tr>
<tr>
<td>Electricity conn.</td>
<td>39.8%</td>
<td>+16.8**</td>
<td>+15.6*</td>
<td>0.946</td>
<td>39.9%</td>
<td>+13.3**</td>
<td>+2.9</td>
<td>0.149</td>
<td>51.8%</td>
<td>+14.2**</td>
<td>-16.0</td>
<td>0.030</td>
</tr>
</tbody>
</table>

**Sample sizes**

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<tbody>
<tr>
<td></td>
<td>4,854</td>
<td>4,854</td>
<td>9,486</td>
<td>480</td>
<td>480</td>
<td>209</td>
<td>6,297</td>
<td>1,289</td>
<td>4,522</td>
<td>309</td>
<td>74</td>
<td>300</td>
</tr>
</tbody>
</table>

**Notes:**
- Positive numbers indicate differences in favor of Côte d’Ivoire.
- Clustered errors by PSUs.
- **: significant at 95%; *: significant at 90%; 2-tails tests.
- Cons.p.c. 1988 p. = Consumption per capita in 1988 dollars (parallel market exchange rate for Ghana cedi) and at 1988 prices; Cash expend. = Cash expenditures per capita in 1988 dollars (parallel market exchange rate for Ghanaian cedi) and at 1988 prices; Electricity conn. = % of households connected to electricity. Pr. > F is the probability of mistakenly rejecting equality of national differences and border differences. Sample size : Number of households (HHs) and number of primary sample units (PSUs = survey clusters).
# Table B.2: Development differences at the Côte d’Ivoire northern borders: Guinea, Mali and Burkina Faso

<table>
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<tbody>
<tr>
<td>Cons.p.c. 1993 p.</td>
<td>+223**</td>
<td>+208**</td>
<td>0.002</td>
<td>+329**</td>
<td>+182**</td>
</tr>
<tr>
<td>Cash expend. only</td>
<td>+178**</td>
<td>+110**</td>
<td>0.001</td>
<td>+322**</td>
<td>+169**</td>
</tr>
<tr>
<td>Electricity conn.</td>
<td>+19.6**</td>
<td>+25.0**</td>
<td>0.062</td>
<td>+43.1**</td>
<td>+31.9**</td>
</tr>
</tbody>
</table>

### Sample sizes

<table>
<thead>
<tr>
<th></th>
<th>C.d’Iv.: HHs</th>
<th>C.d’Iv.: PSUs</th>
<th>Neighb.: HHS</th>
<th>Neighb.: PSUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992-94</td>
<td>9,486</td>
<td>480</td>
<td>4,400</td>
<td>312</td>
</tr>
<tr>
<td>1998-2001</td>
<td>9,486</td>
<td>480</td>
<td>9,554</td>
<td>475</td>
</tr>
<tr>
<td>1998</td>
<td>9,486</td>
<td>480</td>
<td>8,608</td>
<td>475</td>
</tr>
</tbody>
</table>
| Coverage: Households (weighted by household size and sample weights).

Notes: Positive numbers indicate differences in favor of Côte d’Ivoire. Clustered errors by PSUs. **: significant at 95%; *: significant at 90%; 2-tails tests.

Cons.p.c. 1993 p. = Consumption per capita in 1993 dollars (parallel market exchange rate for Guinean franc) and at 1993 prices; Cash expend. = Cash expenditures per capita in 1993 dollars (parallel market exchange rate for Guinean franc) and at 1993 prices; Electricity conn. = % of households connected to electricity. Pr. > F is the probability of mistakenly rejecting equality of national differences and border differences; 0.001 is p <= 0.001. n.a.: not available (variable is absent from the dataset or is flawed by collection problems). Sample size: Number of households (HHs) and number of primary sample units (PSUs = survey clusters). Only half of the sample, i.e. 4,896 households drawn randomly within PSUs, were asked about their consumption expenditures in Mali EMEP 2001.
Table B.3: Border residents and border natives: immigration and emigration rates

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<tbody>
<tr>
<td></td>
<td>Ghana</td>
<td>C. d’Iv.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native Border Residents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>924</td>
<td>555</td>
<td></td>
<td>836</td>
</tr>
<tr>
<td>Immigrants&lt;sup&gt;(a)&lt;/sup&gt;</td>
<td>34%</td>
<td>38%</td>
<td></td>
<td>12%</td>
</tr>
<tr>
<td>N</td>
<td>472</td>
<td>264</td>
<td></td>
<td>146</td>
</tr>
<tr>
<td>Internal Emigrants&lt;sup&gt;(b)&lt;/sup&gt;</td>
<td>15%</td>
<td>32%</td>
<td></td>
<td>37%</td>
</tr>
<tr>
<td>N</td>
<td>161</td>
<td>225</td>
<td></td>
<td>464</td>
</tr>
<tr>
<td>International migr.&lt;sup&gt;(c)&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>664</td>
<td>1,031</td>
<td></td>
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</tr>
</tbody>
</table>

Coverage: Men dwelling at the border or born at the border, born 1930-1980 (1975 for Ghana comparison).
Notes: In the case of Mali and Burkina Faso, district of birth is unknown.

<sup>(a)</sup>: Border residents born outside the border; immigration rate in %: sum of weights divided by sum of weights of people born in the border districts.

<sup>(b)</sup>: Border natives living elsewhere in the country; emigration rate in %: sum of weights divided by sum of weights of people born in the border districts.

<sup>(c)</sup>: Only the cases of Burkina Faso and Mali are considered, because of the large population of migrants living in Cote d’Ivoire. Burkina Faso and Mali nationals are taken from Cote d’Ivoire surveys; the region of birth in the country of origin is not known: our reweighing assumes that, for each birth year and each gender, the migration rates from the border area are equal to the national averages; share in %: sum of weights divided by sum of weights of people dwelling in the border districts.
Development at the border - Appendix C [Not for publication]
Tests for continuity in density and predetermined variables, and optimal bandwidth determination

Figure C.1: Density at Côte d’Ivoire borders

Reading: Dots represent relative sample weights for bins of 10 kilometers range. For these bins, curves are OLS fits of quartics in distance to the border (with 95% confidence upper and lower bounds).
Reading: In each column, curves represent OLS fits of quartics in distance to the border (with 95% confidence upper and lower bounds). "Rainfalls" is the average number of millimeters per day over the 1984-2001 period, "Altitude" is the number of meters above the sea level, and "Hydrography" is the distance in kilometers to the closest river within the hydrological basin. See statistical appendix for details about the variables. Dots represent sample means for successive bins of 10 kilometers range. Errors are clustered by PSUs.
Figure C.2b: Rainfalls at Cote d’Ivoire borders

Reading: RDs at borders estimated by locally linear regressions with variable bandwidths, see equation (2) in the text. The estimated coefficient of the country dummy $\gamma(h)$ is plotted against bandwidth $h$, with a 95% confidence interval band. Vertical lines indicate optimal bandwidths $h^{opt}_{CV}$ (cross-validation criterion, see text). Errors are clustered by PSUs.
Figure C.3: Ethnic groups at Cote d’Ivoire borders

Reading: Curves represent estimated probit functions of quartics in distance to the border (with 95% confidence upper and lower bounds). See statistical appendix for details about the variables. Dots represent sample means for successive bins of 10 kilometers range. Errors are clustered by PSUs.
Figure C.4: Optimal bandwidths for cash expenditures p.c.

Reading: First column corresponds to cross-validation criterion $CV(h)$ curves for a subset of observation that are no further than 25 km from the border (see 3.3 in the text and Lee and Lemieux, 2009). Second column extends this maximum distance $\Delta$ to 50 km, and third to 100 km. For each side of the border that is considered, $CV(h)$ is plotted against the bandwidth $h$. Vertical lines indicate the optimal bandwidth $h_{opt}^{CV}$ that is chosen (from the $\Delta = 25$ figure in the case of Ghana, and from the $\Delta = 100$ figures in other cases; see text). The optimal bandwidth minimizes the $CV(h)$ criterion computed with both sides taken together (curve not depicted); in the case of the border with Ghana the constraint $h < 100$ is added, in order to discard the perturbation introduced by Abidjan, capital city of Cote d’Ivoire. The same kind of curves were computed for the borders between Cote d’Ivoire neighbors, and $h_{opt}^{CV}$ was determined accordingly (with $\Delta = 100$); corresponding figures are available upon request.