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a study of national integration
in post-colonial West Africa

Denis COGNEAU
Paris School of Economics

Sandrine MESPLE-SOMPS
IRD DIAL

Gilles SPIELVOGEL
Univ. Paris 1 Panthéon Sorbonne

G-MonD

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Development at the border: a study of national integration in post-colonial West Africa[*]

Denis Cogneau[†], Sandrine Mesplé-Somps[‡] and Gilles Spielvogel[§]

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Abstract

In Africa, boundaries delineated during the colonial era now divide young independent states. By applying regression discontinuity designs to a large set of surveys covering the 1986-2001 period, this paper identifies many large and significant jumps in welfare at the borders between five West-African countries around Cote d'Ivoire. Border discontinuities mirror the differences between country averages with respect to household income, connection to utilities and education. Country of residence often makes a difference, even if distance to capital city has some attenuating power. The results are consistent with a national integration process that is underway but not yet achieved.

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JEL classification codes: O12, R12, P52

[†]Corresponding author. Paris School of Economics - IRD, and DIAL. PSE, 48 bd Jourdan - 75014 Paris. Tel: +33-143136373. E-mail: cogneau@pse.ens.fr

[‡]Institut de Recherche pour le Développement (IRD), UMR 225 DIAL, Université Paris Dauphine. E-mail: mesple@dial.prd.fr

[§]Université Paris 1 Panthéon-Sorbonne, UMR 201 "Développement et Sociétés" (Université Paris 1 - IRD), and DIAL. E-mail: spielvogel@dial.prd.fr

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1   Introduction: The question of African boundaries

State consolidation is widely considered as the most important issue for the development of Africa, and state failure is often related to the difficulties raised by artificial boundaries. For the most part, the boundaries between African countries have been fixed by European colonial powers at the end of the 19th century, after the 1884 Berlin Conference and the so-called "Scramble for Africa" (Brunschwig, 1972; Packenham, 1991; Wesseling, 1991). They were to a large extent arbitrarily delineated; nevertheless they have been hardly modified since then (Brownlie, 1979).[1]

Are African borders still weak and abstract lines drawn on a map, or have they become strong and real discontinuities revealing an ongoing process of national integration? Are border neighboring regions alike or do they rather mirror their respective national core? These are the questions we ask in this paper.

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[1]According to Alesina, Easterly and Matuszevski (2006), 80% of African borders follow latitudinal or longitudinal lines. During the colonial period, borders' modifications mainly arose from the World Wars and the loss of colonial possessions by Germany then Italy. In the post-independence period, the secession of Eritrea from Ethiopia constitutes the only significant exception to the general rule of borders' intangibility.

The identification of the impact of national institutions on economic outcomes is traditionally based on correlations extracted from macroeconomic data (e.g., La Porta et al., 1999; Acemoglu, Johnson and Robinson, 2002), whose limitations are more and more discussed (e.g., Pande and Udry, 2005). Recent works exploiting province or district-level data within large nations or empires prove that a higher level of disaggregation, both on outcomes and institutions, can provide new interesting results (e.g., Banerjee and Iyer, 2005; Huillery, 2009). Here, drawing from a set of large sample household surveys undertaken around 1990, we compare the development outcomes of neighboring localities on both sides of the borders between Cote d'Ivoire, Burkina Faso, Ghana, Guinea and Mali. We examine a large array of variables including monetary welfare, connection to utilities, and adult literacy. We assess the impact of migration flows in and out border regions. Last, we use regression discontinuity designs to test for the insulating power of national boundaries.

The literature on Africa's development displays a variety of arguments regarding the role played by boundaries between states. A first bunch of contributions conveys the idea of boundaries weakness and porosity. According to Herbst (2000), the guaranty from the Organization for African Unity (OAU) and the United Nations discourages African states from investing in territorial control; who holds the capital city holds the country, "the broadcast of power radiating out [from the political core] with decreasing authority" (Herbst, p.171). These "territory-states", as opposed to nation-states, are somewhat in keeping with pre-colonial political institutions, in a persistent context of low population density. Furthermore, African boundaries "dismember" ethnic groups who still today live on both sides of borders (Englebert, Tarango and Carter, 2002). Common languages and cultures contribute to informal cross-borders flows of goods, money and people. According to Easterly and Levine (1998), growth in African countries is strongly influenced by neighbors, meaning that boundaries do not work as a

powerful insulating device.[2] Finally, another class of papers states that climate, terrain or ecology, rather than national institutions, have a large direct influence on economic outcomes, especially in an agrarian context (e.g., Bloom and Sachs, 1998): in that case again, borders should be very much invisible.

A second strand of the literature rather stresses the salience of national idiosyncrasies and a centripetal effect of boundaries. As noted by Robinson (2002) in his review of Herbst's book, the boundaries of Latin American countries, who became independent at the beginning of the 19th century and are now considered as well-established nation-states, also exhibit some degree of arbitrariness. Besides, ethnic salience is no fate: Posner (2004) studies two ethnic groups living across the border between Malawi and Zambia, and argues that ethnic identification varies with the demographic size, hence the political weight, of each group. Miguel (2004) also suggests that the promotion of national identity by the Tanzanian leader Julius Nyerere succeeded in canceling out the negative impact of within-village ethnic heterogeneity on public goods provision that one observes in neighboring villages of Kenya.[3] Finally, at the macroeconomic level, the inequality of income between African countries is larger than usually thought: in Schultz (1998), one can observe that the log variance of GDP per capita in PPP reaches 0.415 in 1989 Africa (including North Africa), i.e. by far the highest level among all other regions

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[2]A related political economy literature considers that African boundaries are strong enough to be a major impediment to growth, in that they create heterogeneous political entities, but too weak to generate homogenizing forces for national integration. They however do not provide a clear-cut prediction on borders' insulating power. Easterly and Levine (1997) explain "Africa's growth tragedy" by ethnic heterogeneity among national states, and Englebert, Tarango and Carter (2002) also argue that states "suffocate" because of political culture heterogeneity. Likewise, Alesina, Easterly and Matuszevski (2006) contend that African boundaries have created "artificial states" whose difficult political economy hampers growth.

[3]In comparison with Miguel's paper, this one looks at differences in development levels rather than differences in ethnic heterogeneity influence, on a set of five countries instead of two, and in Western, rather than Eastern, Africa. It also provides a more thorough testing of cross-border discontinuities.

in the world. Furthermore, this number is twice as high as in 1960 (0.213); the only other region that records such an intercountry divergence during the same period is East Asia (from Korea to Myanmar), although at much lower levels (from 0.067 to 0.197). Of course, income divergence between African countries could only reflect the divergence of their centers, not so much of their border regions; its is however difficult to reconcile it with a strong influence of neighbors on growth.[4]

Section 2 sets down the analytical methodology and argues that the African borders we study can be seen as "natural experiments" that make it possible to estimate, at least locally, the causal treatment effect of living in one country or another.

Section 3 presents our compilation of survey and geographical data, and how we implement our border treatment effects estimators.

In section 4, we compute simple mean differences between border districts, and show they are often in keeping with national level differences, even though pretty much attenuated in many cases. Border differences in welfare also follow the relative ups and downs of national macroeconomic conjunctures. Besides, we reveal the long-term divergence in adult literacy between Cote d'Ivoire and the four other countries after 1960; strikingly enough, for cohorts born in border districts before independence, only the already existing international border with Ghana made a significant difference. We observe migration flows in and out border regions but show that their influence on comparative development is modest.

In section 5 at last, we implement regression discontinuity designs that formally test for the existence of a significant jump in outcomes at national borders; these tests robustly confirm the significance of many but not all border differences

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[4]The insulating power of boundaries is not necessarily for the good: the 'balkanization' of Africa is often considered as preventing the exploitation of returns to scale, despite efforts of regional trade integration. However the impact of full political integration is different from a simple size merger, and it can be less easy for two countries to have convergent interests in the former: in Africa, Spolaore and Wacziarg (2005) find only one country-pair for which the cancelation of political borders would be mutually beneficial, i.e. Mali and Niger.

in terms of consumption expenditures, connection to electricity, access to water and adult literacy. It is in the peripheral areas that are the most remote from the countries' centers (Guinea/Mali/Cote d'Ivoire) that we find border discontinuities to be blurred or erased: the above mentioned "radiating core" model from Herbst finds here an illustration. Otherwise, when looking at borders that divide countries with close development levels and whose distances to both capital cities are also close (Cote d'Ivoire/Ghana and Mali/Burkina Faso), we still find significant discontinuities whose size and sign may vary with the ups and downs of countries macroeconomic climates.

Section 6 concludes: National borders already matter in Africa, and the country of residence makes a difference.

2 Analytical methodology: Borders as experiments

We ask here whether the borders we study are historical "natural experiments" that have divided territories with initial identical characteristics, so that any observed border discontinuity could be attributed to distinct national idiosyncrasies having emerged later on. In more technical terms, do border differences allow to identify "national treatment effects"? Consider a person born somewhere in the area now named Cote d'Ivoire. What would her welfare be if Cote d'Ivoire had been colonized by the British instead of the French, like Ghana? It is certainly difficult to say, for at least three reasons: (i) the British could have set different institutions to rule Cote d'Ivoire; (ii) Ghana and Cote d'Ivoire merged would not be the same, if only because of market size and general equilibrium considerations; (iii) even if Ghana's institutions had been kept the same, we have no clue how Cote d'Ivoire initial characteristics would interact with them. Now take a person born in Cote d'Ivoire at the border of Ghana, and imagine the border was some kilometers further. Including this person into Ghana would have a marginal and insignificant impact on Ghana's institutions and economy. Besides, it is very probable that this close neighbor of actual Ghanaian people shares with them the same

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geographical constraints and the same anthropological characteristics.

Let Y be some outcome variable (income, connection to electricity, etc.), as observed over a sample of people living in two countries at the same date. Let $C = 0, 1$ be the dummy variable indicating the country of residence. Let $Y_i(0)$ be the outcome if and when the individual (or household) i lives in the country $C = 0$, and $Y_i(1)$ in the country $C = 1$. Observed outcome reads:

$$Y_i = (1 - C_i).Y_i(0) + C_i.Y_i(1) \tag{1}$$

We are seeking to approach $E[Y(1) - Y(0)]$ that is the average treatment effect (ATE) of living in the country 1 rather than in the country 0. A regression discontinuity (RD) design based on distance to the border appears as an obvious candidate. Let D_i stand for the distance to the border of the locality of residence, positively signed for country 1 and negatively signed for country 0, so that: $C_i = 1\{D_i \geq 0\}$.

2.1 Required assumptions for a border RD

Under the assumption that $E[Y(0)|D = d]$ and $E[Y(1)|D = d]$ are continuous in d, $\lim_{d \to 0^+} E[Y|D = d] - \lim_{d \to 0^-} E[Y|D = d]$ provides an estimation of the average treatment effect at the border (i.e. at $D = 0$) (Hahn, Todd, Van Der Klauw, 2001). It is the so-called "sharp" RD estimator. As Lee (2008) argues in another context, this continuity assumption is difficult to assess and impossible to test. Lee's reformulation elucidates the conditions under which a RD replicates a random assignment around the threshold $D = 0$. From now, we refer to Lee's reformulation. Assume Y is generated by a partially unobservable random variable W: $Y(0) = y_0(W)$ and $Y(1) = y_1(W)$. W represents individuals, households or localities "type" with respect to Y. Last, let $F(d|w)$ stand for the cdf of D conditional on W. Lee's conditions are as follows (Lee, 2008, pp.679):

(i) $F(d|w)$ is such that $0 < F(0|w) < 1$
(ii) $F(d|w)$ is continuously differentiable in d at $d = 0$, for each w in the support

of W

Condition (i) requires that D can be written $D = Z(W) + e$ where Z is the predictable component of D and e an exogenous random chance component, so that the probability of receiving treatment is somewhere between 0 and 1 for each type. Condition (ii) implies that conditional density $f(d|w)$ is continuous in d at $d = 0$. In our case, this implies that the probability of being allocated on either side next to the border are the same for each "type" of individuals w. However, in the overall population, D can be arbitrarily correlated with $Y(0)$ or $Y(1)$; Y may also be directly generated by D, in addition to W (Lee, 2008, p.680). Under these conditions, the RD estimand is a weighted average of the difference $y_1(w) - y_0(w)$ for each type w, with weights equal to the probability of being close to the border: $f(0|w)/f(0)$.[5]

At the locality level, these conditions require that border localities are not sorted by "types" w between the two countries. This randomness of distance to the border stems from the historical hazards of boundaries alignment during the colonial period, that we document thereafter.

At the individual level, Lee's conditions require that people do not "manipulate" their distance to the border through migration, thus affecting their locality of origin "type". It is typically an issue for embodied outcomes like human capital. International migration based on $y_1(w) - y_0(w)$, or more generally on w, is obviously the worst case. However, even internal migration flows based on w are a source of bias, because the center of one country can be more attractive than the other for a given type w (for instance, more good schools or good jobs in Abidjan than in Accra). In section 4, we correct for migration bias by computing mean differences between border natives rather than between border residents.

As we do not observe types w we cannot test directly for the validity of these assumptions, namely that the distribution of the "types" w is the same on both

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[5]Another obvious condition is to have a non empty border, i.e. $f(0) > 0$ where $f(d)$ is the marginal density of d.

sides very near the border. However, as Lee argues, we can test for the absence of discontinuity in the distribution of predetermined observable variables X, like geographical or anthropological variables. We perform this kind of test in section 5. We also check the continuity of the density $f(d)$ at $d = 0$.

Due to differences in countries' shape and spatial organization, a specific variable has only few chances to pass this test: the distance to the country capital city.[6] Herbst's model of radiating core cited in introduction justifies granting a special attention to this variable. We can think of estimating directly this model by introducing the distance to the capital city as a control in the RD estimation. However, the interpretation of this kind of estimates would be highly heroic, as it is difficult to think of any real world experiment that would simulate a large 200 or 300 kilometers move of the capital city of any of these countries. In 1983 Cote d'Ivoire official administrative capital indeed became Yamoussoukro, but Abidjan still remained by far the largest city in terms of population and income. It can also be argued that for a locality within the border region the counterfactual impact of being annexed by the neighboring country indeed includes a change of capital city, and consequently a jump in the distance to it. For instance, reduced distances to the core are a structural advantage of small size countries that should not be discarded from our estimates. The RD border treatment effect is anyway *local*; it cannot be read as the differential advantage of dwelling or being born in one country, under a "veil of ignorance" that would hide the exact place of residence or of birth. In particular, differential discrimination by the central states against some border regions also enter in our estimates. Non-local national treatment effects, or even their difference, cannot be identified, and one can doubt they have any meaning at all.

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[6]For instance, if we consider the Cote d'Ivoire borders with its four neighbors Ghana, Guinea, Mali and Burkina Faso, they are on average in our samples respectively 236, 566, 637 and 528 km away from Abidjan, against 346 km from Accra, 639 km from Conakry, 302 km from Bamako and 368 km from Ouagadougou. The difference is by far the highest in the case of the border with Mali.

2.2 Historical background and arbitrariness of borders

To further comfort the RD assumptions, we document the alignment of the boundaries we are interested in, drawing from the historical literature and from a dedicated research in French colonial archives.[7] Hargreaves (1985) confirms that the drawing of boundaries in Western Africa was arbitrary to a large extent. The data collected by Englebert, Tarango and Carter (2002) indicate the presence of the same ethnic groups on both sides of each border.[8] We additionally test for geographical and anthropological continuity at borders using our survey data (see section 5). In the case of the border of Cote d'Ivoire with Ghana, long-lasting negotiations between the two colonial powers finally resulted in partitions of pre-colonial political entities in the middle part of the border (Gyaman, Indenie, Sefwi); in its southern part (Sanwi), a rebelion unsuccessfully challenged the border alignment after independence. The three other borders of Cote d'Ivoire are much less clearly demarcated on the field, however they were never contested or challenged. The hazards of French conquest and of the wars against the Almami Samori Ture at the end of the 19th century very much presided to the boundaries alignment within the French Empire; they also resulted in partitions of some former political entities (Kenedugu, Kong and Bouna kingdoms). Those borders were only stabilized after World War I; the border with Burkina-Faso (Haute-Volta) was even erased between 1932 and 1947, and then redrawn in its 1919 version. We also use French data on these border regions during the early colonial era (1910-1928), and explore differences in initial conditions between the seven out of eight border areas that pertained to the French empire: Pairwise comparisons do not reveal significant differences in initial conditions between border sides, whether in terms of indigenous population density, European settlement or trade tax revenue.[9] Hence

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[7]Appendix A provides detailed descriptions of the border areas involved in our estimations, as well as illustrations of the randomness implied in the alignment of these boundaries during colonial times.

[8]Data is accessible at http://www.politics.pomona.edu/penglebert/, accessed July 8, 2009.

[9]See table A.1 in appendix A.

we can be fairly confident that present-day national boundaries do not divide areas that were already different in pre-colonial or early colonial times.

3   Data and implementation of border RD estimators

3.1   Data on development outcomes

We gather a large database made of 14 multi-topic household surveys: 5 for Cote d'Ivoire, 4 for Ghana, 2 for both Burkina Faso and Mali, and 1 for Guinea; those surveys were implemented between 1985 and 2001. We divide the time line into three periods: 1986-1989, 1992-1994 and 1998-2001. Table 1 lists pairwise comparisons between Cote d'Ivoire and one of its neighbors, and provides survey names and household sample sizes. For the sake of space the bulk of this paper focuses on Cote d'Ivoire borders; however, section 5 additionally considers the borders between adjacent Cote d'Ivoire neighbors (Guinea/Mali and Mali/Burkina Faso, and Burkina Faso/Ghana). We summarize here the variables construction, more details being provided in appendix B.

[Insert Table 1 about here]

The first surveys for Cote d'Ivoire and Ghana are "integrated" Living Standard Measurement Surveys (LSMS) designed by the World Bank in the 1980s; the other surveys are inspired from them. In all cases, face-to-face interviews were conducted by trained staff.

We pay a lot of attention to the measurement of outcome variables in order to achieve strict comparability between surveys and countries. We construct a household expenditures variable under a common methodology, including all current expenditures like food, clothing, transportation, housing and imputed rents, etc., and expenditures for education; we only exclude too infrequent or badly measured expenditures like those in health, durable goods, and transfers. We also extract the value of consumption of own food production (except for Mali 1994),

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that we add to household expenditures to obtain our total consumption variable. As surveys sometimes cover periods where price inflation was high, we use monthly data on national consumer price index and express individual household consumption in a common base-year (1988, 1993 or 1998). Comparisons of household consumption levels are then made in current dollars at base year exchange rates and prices (1988, 1993 or 1998). Cote d'Ivoire, Burkina Faso and Mali share the same currency unit, the CFA franc, so that conversion in dollar is innocuous. For Ghana and Guinea, we use either the official exchange rate or the parallel market exchange rate as reported by African Development indicators (World Bank, 2008). We check that these survey figures for household consumption are consistent with national accounts figures (appendix B). We also compare non-food budget shares, that are unaffected by base price levels and exchange rates, and should be positively correlated with consumption levels.

We also extract a dummy variable indicating whether the household is connected to electricity; we additionally consider a dummy for access to water other than rainfalls or rivers. Those welfare variables involve public investments on the supply side and private income on the demand side.

Finally, adult literacy is measured as the self-assessed capacity to read and to write. There is some influential variation in the question asked (read a newspaper vs read) that prevents comparison between the 1980s LSMS surveys (for Cote d'Ivoire and Ghana) and the others; we are therefore cautious not to mix or compare incomparable sources. We also extract the dummy variable saying whether the individual has ever attended school, and check that its evolution across cohorts is broadly in line with that of adult literacy. In the case of Guinea, we disregard the literacy variable which is little comparable to others.[10]

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[10]These surveys are more suited to our purpose than Demographic and Health Surveys (DHS) that are also available for the same set of countries, some of which also including GPS data. First, income or consumption data is absent from DHS surveys. Second, most individual data on adults is restricted to 15 to 49 years-old women, or to rather small sub-samples of men. Third, the set of DHS surveys for Cote d'Ivoire, the pivotal country of our analysis, is reduced to years

3.2   Geographical data

For all these surveys, the sample designs are regionally stratified and two-stage. Within each strata, a first random draw of primary sampling units (PSUs, or survey clusters) is made among a list of localities or cities sub-sectors established from the most recent national census. After enumeration of households within PSUs, a fixed number of households is then randomly drawn in each. Each cluster contains between 12 and 25 surveyed households. The resulting sample comes with a set of unequal weights attached to each PSU (except in the GLSS1 and 2 surveys which are self-weighted).

Within each survey, we first select border areas using the administrative divisions at hand (see figure B.1 in appendix B), and compute simple mean differences at borders that are compared to national mean differences, in section 4. We tighten a bit this selection by excluding the districts whose all survey PSUs are too far, that is more than 100 km away, from the borders; this leads us to restrict our comparisons to the southern parts of the borders of Cote d'Ivoire with Ghana and Guinea. As district and country of birth is known for each individual in Cote d'Ivoire, Ghana and Guinea, we are also able to identify internal and international migrants in these countries. This allows computing mean differences between border natives rather than border residents. This alternative border comparison is particularly meaningful when looking at human capital variables across time, as we do in section 4.

In most surveys, excepting Cote d'Ivoire 1998 and Ghana 1992, having the detailed names of survey PSUs allows to code the precise latitude and longitude of even small localities. For each survey cluster, we compute the distance to each border and match its coordinates with NASA datasets that provide geographical indicators: altitude, rainfalls (1984-2001), distance to the closest river within the hydrological basin. Again, more details about variable definition and construction

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1994 and 1998, with a very small sample (2,100 households) for this latter year; in the case of Guinea, the first DHS is for 1999.

are provided in appendix B. Thanks to this geo-referencing, we abstract from each country's administrative divisions and we are able to implement regression discontinuity designs in section 5.

3.3   Implementation of border RD estimators - Optimal bandwidth and Placebo RDs

To implement the border RD estimator described in section 2, the regression functions $E[Y(1)|D = d, C = 1]$ and $E[Y(0)|D = d, C = 0]$ must be estimated around the border point $D = 0$. The rather small number of survey clusters (localities) on both sides of the border precludes using more flexible but slowly converging non-parametric estimators. We therefore need to add parametric assumptions, as is also very often done in the literature.

The simplest (and strongest) one is to assume that $E[Y|D = d]$ is constant in administrative districts next to the border. This is what we do in section 4, where we simply compute simple mean differences between residents or natives of border districts. This assumption also allows us to exploit some survey data where the exact location, and hence distance to the border, are not available.[11]

However, it is certainly debatable that outcomes could be independent from the distance to the border, even within some range. First, localities that are far from the border are also more often closer to the country center, and their expected benefit of being aggregated to the center may be greater than for peripheral localities. Second, distance to the border can be correlated to both observable and unobservable characteristics that also influence outcomes, in particular geography or anthropology. In section 5, to relax this assumption of invariance, we estimate the two regression functions $E[Y(1)|D = d, C = 1]$ and $E[Y(0)|D = d, C = 0]$ by locally linear regressions within a large set of bandwidths:

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[11]Of course, even if outcomes vary with the distance to the border, the magnitude of such border differences is still revealing of how much border regions look like each other, and may still be contrasted with country mean differences. But it can not be interpreted as the causal effect of the country of living.

$$Y = \gamma(h).C + \alpha_0(h) + \beta_0(h).D + [\beta_1(h) - \beta_0(h)].C.D + \varepsilon \tag{2}$$

for $-h \leq D \leq h$, with $h \in \{50, 55, 60, ..., 145, 150\}$.

Like in section 2 notations, $C = 0, 1$, is the country of residence (e.g., $C = 1$ in Cote d'Ivoire, 0 in other countries), and D is the distance to the border: $C = 1\{D \geq 0\}$. In the case of discrete outcomes, like connection to electricity, we use a probit specification instead of a linear specification, and in the case of non-food expenditures share, that ranges between 0 and 1, a logistic transformation $(\ln(x) - \ln(1 - x))$ is applied; the standard errors of border discontinuities are then computed using the delta-method. Errors (ε) are always clustered by surveys PSUs.

Regarding the choice of the bandwidth h, we implement the "leave one out" cross-validation procedure described in Lee and Lemieux (2009), and inspired from former contributions of Ludwig and Miller and Imbens and Lemieux (Lee and Lemieux, 2009, pp.40-43). The idea is to predict by linear regression the outcome Y_i of observations i close enough to the cutoff ($D_i \leq \Delta$), while using only observations on the relevant side of i: $D_i - h \leq D < D_i$ if i is on the left of the cutoff (in our case $D_i < 0$ and $C_i = 0$), or alternatively $D_i < D \leq D_i + h$ if i on the right of the cutoff (i.e. $D_i \geq 0$ and $C_i = 1$). The optimal bandwidth then minimizes the average prediction error: $h_{CV}^{opt} = \arg\min_h CV_Y(h)$, with $CV_Y(h) = \sum_{|D_i| \leq \Delta}(Y_i - \hat{Y}(D_i))^2$.

In the case of the border of Cote d'Ivoire with Ghana, this procedure proves a bit difficult to apply because of a large spatial heterogeneity: Abidjan, the capital city of Cote d'Ivoire, is 100 km away from the border, and its marginal inclusion in the samples used for computing local predictors $\hat{Y}(D_i)$ results in large increases in prediction errors and hence in $CV(h)$ level. In appendix C, figure C.4 plots $CV_Y(h)$, for Y = cash expenditures per capita, against h with limit distances $\Delta = 25, 50$ and 100 and for each border. With the Ghana border, whatever the subset of observations we select, Abidjan is responsible for a hump in the CV criterion whose

location and width change with the value of Δ. This characteristic of the Cote d'Ivoire/Ghana border at least suggests that Abidjan should be excluded from the computation of equation (2), and hence that bandwidths strictly lower than 100 km should be preferred. From the subset with maximum distance $\Delta = 25$ and with the constraint $h < 100$, we determine $h_{CV}^{opt} = 80$. With the other borders, the $CV(h)$ criterion reveals much less sensitive to the choice of Δ. We then straightforwardly select h_{CV}^{opt} for $\Delta = 100$. The $CV(h)$ minima all point to rather large optimal bandwidths: respectively 130, 120 and 135 kilometers for the borders with Guinea, Mali and Burkina Faso.[12]

Alternatively to the determination of an optimal bandwidth, we also plot the estimated border discontinuity, $\gamma(h)$ of equation (2) against all possible bandwidth h between 50 km and 150 km, in order to check its robustness with respect to bandwidth choice.

For the bandwidth h_{CV}^{opt} whose determination has just been discussed, we also run "placebo RDs" that shift the border by a given number of kilometers k. We define $D^{(k)} = D + k$ and $C^{(k)} = 1\{D^{(k)} \geq 0\}$ and successively run:

$$Y = \gamma^{(k)}.C^{(k)} + \alpha_0^{(k)} + \beta_0^{(k)}.D^{(k)} + [\beta_1^{(k)} - \beta_0^{(k)}].C^{(k)}.D^{(k)} + \varepsilon \qquad (3)$$

for $-h_{CV}^{opt} \leq D^{(k)} \leq h_{CV}^{opt}$ and $k \in \{-100, -95, ..., 0, ..., 95, 100\}$. By plotting $\gamma^{(k)}$ against k we can then check for the existence of discontinuities at other cutoffs than the actual border. In the cases where a significant border discontinuity is found (i.e. $\gamma^{(0)}$ significantly different from zero), we check in particular that the discontinuity fades away on each side for "high enough" absolute values of k like $|k| = 25$ km, i.e. $\gamma^{(-25)} = \gamma^{(25)} = 0$.

4   Border differences versus national differences

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[12]As for the four other borders we consider later on, i.e. Guinea/Mali in 1993-94, Burkina Faso/Mali in 1993-94 and 1998-2001 and Burkina Faso/Ghana in 1998, we apply the same method with $\Delta = 100$ and find respectively h_{CV}^{opt}=75, 125, 125 and 105.

We start our empirical analysis by looking at district level information, i.e. we draw comparisons between the means in outcomes of administrative districts located on both sides of a given border. As already mentioned, this simple procedure has two advantages: first, it allows including survey years for which the precise location of surveys PSUs is unknown (Cote d'Ivoire 1998 and Ghana 1992); second, for some borders and years, it allows the calculation of districts of birth (rather than of residence) mean differences, hence correcting for some of the bias attached to migration.

The figures 1 and 2 display on a map the means of cash expenditures per capita and the rates of connection to electricity for the period 1992-94. The two maps isolate the administrative border areas from the rest of the countries. Let us underline that the 1992-94 period is the worst of all for Cote d'Ivoire, as it corresponds to the climax of the economic crisis that opened in 1989 and closed with the CFA franc devaluation in 1994. Still, these figures illustrate that the higher development of the Cote d'Ivoire country center translates to peripheral border districts. Around the year 1993, we estimate national levels of cash expenditures per capita to be 395$ in Cote d'Ivoire against 222$ in Ghana, 217$ in Guinea, 113$ in Burkina-Faso and 174$ in Mali.[13] Contrasts between border districts are statistically significant, and very close in magnitude, in three cases out of four: with Ghana (+93$ at the advantage of the Cote d'Ivoire side), Burkina Faso (+86$) and Mali (+110$). These are large differences amounting to 50% of border districts income in the case of Ghana, and even 100% in the cases of the two others. Hence, even for the 1993 bad year, on the grounds of monetary welfare or income poverty, people should have preferred to live in Cote d'Ivoire rather than in another neighboring country, or at least should have been indifferent in the case of Guinea. The same conclusion holds with connection to electricity (figure 2): Cote d'Ivoire significantly dominates its three northern neighbors, even Guinea,

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[13]Corresponding figures for total consumption are 478$, 281$, 255$ and 149$ with no number for Mali where consumption of own food production is not available.

border districts in these countries being barely connected, whereas the difference is not significant with Ghana. Comparisons for the earlier (1986-89) or the later (1998-2001) periods deliver the same message: better to live in Cote d'Ivoire, even if differences are often attenuated at borders (see detailed tables at the end of appendix B).

[Insert Figures 1 and 2 about here]

For comparisons where districts of birth are available on both sides, i.e. with Ghana and Guinea, we can correct for internal migrations in and out border districts, by looking at mean differences between border natives wherever they live in the country, in the spirit of an equality of opportunity approach of welfare. International migrations are negligible in those two cases and are disregarded. Given the higher relative income of Cote d'Ivoire center in all years, these modified comparisons turn even more favorable to this country, without changing the broad picture. Results not presented show that the most salient change occurs for the comparison with 1994 Guinea in terms of electricity connection (+24 percentage points instead of +17).

For Mali and Burkina Faso where district of birth is not recorded, we can still implement an imperfect correction for international migrations: (i) we identify nationals of these two countries in the Cote d'Ivoire surveys (we stick to nationality because country of birth is not available in the Cote d'Ivoire surveys for 1992-93 and 1998); (ii) assuming uniform international migration rates across regions of Mali and Burkina Faso, we reweigh these international migrants and include them in the difference in means computation. For males born 1930-80, this procedure results in international migrants weighting respectively 6 and 10% in native populations. Here, as Malian and Burkinabè migrants benefit from better living conditions in Cote d'Ivoire, putting them back in their country of origin slightly attenuates the estimated national and border contrasts; however, the correction for internal migrations from Cote d'Ivoire northern borders to the country center

plays in the other direction.

Estimations of in- and out-migration rates for border areas are also broadly consistent with differences in living standards (see appendix B for details). Indeed, northern Cote d'Ivoire displays high rates of internal out-migration towards the country center: net outflows of males born between 1930 and 1980 respectively reach 16, 25 and 12% of native populations in border districts with Guinea, Mali and Burkina Faso. Conversely, internal migration inflows and outflows are balanced on the Guinea side, this confirming the relative wealth of this region (that already appeared no poorer than its Cote d'Ivoire counterpart in figure 1). As for the cases of Mali and Burkina Faso, the welfare advantage of living in Cote d'Ivoire finds an additional powerful illustration in international migration patterns: indeed, Malian and Burkinabè migrants are no less numerous in the border districts of Cote d'Ivoire than in the center of this country (see again appendix B).

The border districts between Cote d'Ivoire and Ghana display positive inflows of migrants on both sides, being main cocoa producing regions and lying rather close to the capital cities Abidjan and Accra. Here, the availability of three surveys on each side for 1986-89, 1992-93 and 1998 allows to study the temporal link between border differences and national differences, thus providing a more dynamic approach to the insulating power of country boundaries. This is what figure 3 illustrates for a variety of welfare indicators.

[Insert Figure 3 about here]

The period between 1989 and 1993 designates the end of the golden age for Cote d'Ivoire while for Ghana it corresponds to the beginning of recovery after twenty years of macroeconomic collapse. Then, between 1993 and 1998, Cote d'Ivoire experiences a rebound, following the devaluation of the CFA franc, while growth plummets in Ghana. As seen in the top left picture of figure 3, these differences in macroeconomic developments translate into the variations of the Cote d'Ivoire/Ghana total consumption gap that falls from 432$ per capita in

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1988 to 158$ in 1993, and then rises again to 255$ in 1998; these surveys figures are pretty much consistent with national accounts. In comparison with the national level, border differences are attenuated, but still reflect the convergence between the two countries: the consumption per capita gap falls from 345$ to 130$ between 1988 and 1993, and then remains stable. Other outcomes strikingly exhibit the same two patterns: border differences are attenuated in levels but follow the same evolutions as national differences. This is the case for cash expenditures (not shown), non-food expenditure shares (top right picture), and for the two other variables depicted in the bottom panel of figure 3: connection to electricity and improved or safer access to water.

The insulating power of country boundaries can also be observed for longer term evolutions over fifty years, like with adult literacy figures for cohorts born between the middle of the colonial era (1930) to cohorts born twenty years after countries' independence (1980). The six graphs of figure 4 depict separately for men and women the evolution of literacy across time, with cohorts' date of birth on the horizontal axis and differences in the share of literate individuals on the vertical axis. This difference is estimated by regressing the literacy dummy on a quartic (polynomial of degree four) of date of birth, for each country, each gender and each population (whole country natives or border natives/residents). Confidence intervals are derived from variance-covariance matrices estimated with PSUs clustering. As corrections for migration are even more relevant for embodied human capital, we also consider border natives (long dash lines) aside to border residents (short dash lines) comparisons. As Cote d'Ivoire internal migrants are slightly more educated than stayers, and more relatively so than in other countries, comparisons are a bit more in favor of Cote d'Ivoire when taking natives instead of residents, the only exception being women at the Ghana border. Furthermore, in the case of Burkina Faso and Mali, it is internal (within Cote d'Ivoire), rather than international migrants (from the two northern countries), who make the difference. Anyhow, the contrast between natives and residents differences in means is never

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statistically significant.

The graphs tell the story of the gradual emergence of a Cote d'Ivoire advantage in terms of literacy, whatever the neighboring country that is considered. The comparison with Ghana shows Cote d'Ivoire catching up during the colonial era, and then achieving a little better, at least for males born after 1955 and for women born after 1970. This differential performance appears as quickly at the border as at the national level. Additional (not reported) analysis of primary school enrolment data shows that this result is obtained through a spread of school enrolment combined with a higher efficiency of schooling in Cote d'Ivoire, i.e. a higher return of a school year in terms of literacy. In all former French colonies, the spread of primary school was so limited before the end of World War II that almost no difference is observed between border districts natives born before 1945 in Cote d'Ivoire, Guinea, Mali and Burkina Faso. Afterward, the border differences in literacy progressively emerge; they do so at a lower pace than the national differences, as is revealed by the fact that solid lines (national) always dominate dashed lines (border), especially at northern borders: the Cote d'Ivoire educational expansion is indeed strongly biased towards the country core. It is with Burkina Faso that border differences don't seem very acute, even for the youngest cohorts born during the 1970s.

[Insert Figure 4 about here]

5   Development discontinuities at borders

This last section further explores the robustness of welfare differences that were identified at the borders of Cote d'Ivoire with its four neighbors, and looks at whether these differences can be given a causal interpretation in terms of 'counterfactual history', as stated in section 3. We build on the coding of latitude and longitude of survey clusters that allow computing regression discontinuity (RD) estimators at the border of Cote d'Ivoire with Ghana for the period 1986-89, and

at the borders of Cote d'Ivoire with Guinea, Mali and Burkina Faso for the period 1992-94. Other comparisons in other periods are precluded because the names of survey clusters are absent from the Ghana survey for 1992-93 and from the Cote d'Ivoire survey for 1998. Still, we can also look at the border discontinuities between neighbors of Cote d'Ivoire that happen to be adjacent. This makes a set of four additional country-period pairs: Guinea/Mali in 1993-94, Burkina Faso/Mali in 1993-94 and in 1998-2001, and Burkina Faso/Ghana in 1998.

Figure 5 draws the map of the survey clusters for the above mentioned pairs at Cote d'Ivoire borders, within a 100 kilometers bandwidth around each border. In this section, with the computation of the distance to the border for each survey cluster, we completely abstract from the arbitrary grid imposed by administrative districts. Unfortunately, as precise location of birth place is not available for migrants, we are unable to include them in estimation. But fortunately, the previous section has shown that not correcting for migration only generates a very limited and most often insignificant downward bias against Cote d'Ivoire.

[Insert Figure 5 about here]

As recommended by Lee and Lemieux (2009), we first test for the continuity of the distance to the border density at the cutoff point (distance to border equal to zero).[14] For each country-period pair, we plot the relative sample weights of 10 kilometers range bins along the whole support of the distance to the border variable; we also regress the sample weights on a quartic of distance to the border. This latter polynomial fit reveals that density continuity is slightly debatable in the case of the border with Burkina Faso. The map of figure 5 indeed exhibits a low density of survey clusters on the Cote d'Ivoire side; the middle part is in particular empty, as it includes a national park. We have no reasons to believe that this discontinuity reflects cross-border endogenous migration flows; indeed, these flows would be expected to run from Burkina Faso to Cote d'Ivoire.

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[14]See figure C.1, appendix C.

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We then check for the absence of discontinuities in predetermined variables, in keeping with the spirit of the tests for observational comparability of treatment and control groups in randomized designs. Three geographical variables are examined: rainfalls (average millimeters per day over the 1984-2001 period), altitude (in meters above the sea level), and hydrography (distance in kilometers to the closest river within the hydrological basin). We additionally look at latitude for North-South oriented borders and at longitude for West-East borders; in the case of the borders of Guinea with Cote d'Ivoire and Mali, and of Burkina Faso with Mali, we look at both.

We last test for the continuity in ethnic composition, using the shares of two broad ethnic groupings: the Akan at the Cote d'Ivoire/Ghana border and the Mande-Voltaic at the three other borders. The locally linear estimator described in equation (2) shows that we can most often reject with confidence the existence of border discontinuities in geography or ethnic composition, for all bandwidths between 50 km and 150 km in four cases out of eight, or at least for the optimal bandwidth h_{CV}^{opt} that we selected in two additional cases (Cote d'Ivoire with Ghana and Burkina Faso).[15] The two exceptions that arise are the borders of Guinea. At the border with Cote d'Ivoire a discontinuity is observed for rainfalls, altitude and hydrography: the Guinea side is 200 meters more elevated, further away from rivers, and receives a rain supplement of 3.7 millimeters per day. At the border of Mali, the Guinea side appears 180 meters lower in altitude and more distant to rivers by 10 kilometers, however no difference in rainfalls is observed. We conclude that the comparisons at Guinea borders can be questionable because of boundaries following terrain discontinuities and rivers, as our research concerning the alignment of boundaries indeed confirms (see appendix A).

We now turn to border discontinuities in development outcome variables. We first focus on cash expenditures per capita because this variable constitutes the most obvious welfare indicator. Total consumption expenditures, i.e. including

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[15]Appendix C provides a few figures illustrating these facts: see C.2a, C.2b and C.3.

consumption of own food production, is more dependent on differences between surveys and on pricing choices, and is not available for Mali 1994. Results obtained for this latter variable are however consistent with those obtained with the former. We also look at the non-food expenditures share (the denominator being here total consumption). The first column of figure 6 features the results of equation (2) estimation of discontinuities in cash expenditures per capita at the four Cote d'Ivoire borders and for the whole span of bandwidths ranging from 50 km to 150 km; the second column presents the results of equation (3) placebo border discontinuities. Figure 7 provides the same for the four borders between Cote d'Ivoire neighbors. Table 2 gathers the results obtained at optimal bandwidths whose determination was explained in section 3 above, and which are indicated by vertical lines in the first columns of figures 6 and 7; the RD estimates are compared with differences in final consumption expenditures per capita from national accounts and with differences in national means of cash expenditures per capita from the surveys.

[Insert Figure 6 about here]

Two large discontinuities are revealed at the borders of Cote d'Ivoire with Ghana and Burkina Faso, while at the borders with Guinea and Mali results convey a much more ambiguous conclusion.

In the case of Ghana, a jump of around 200 dollars (at 1988 prices and dollar) is observed with bandwidths ranging between 50 km and 95 km, as well as with wider ones above 145 km (see top left graph of figure 6). For bandwidths ranging between 100 km and 140 km, the inclusion of Abidjan, the capital city of Cote d'Ivoire, into the estimation sample results in a steep downward slope to the border and in a spurious cancelation of the border effect. At the selected bandwidth of 80 km, the discontinuity reaches 241 dollars, compared to 341 dollars for the national means difference, and 467 dollars for national accounts final consumption (table 2); bandwidths larger than 140 km also point to the same magnitude. Hence, as with border districts comparisons in means (see above section 4), some attenuation

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occurs at the border, but we still find a very significant contrast in income when crossing the border. Placebo regressions show that this 241$ discontinuity no longer holds as soon as the border line is shifted by more than 25 kilometers on either side (figure 6, top right graph). On the Cote d'Ivoire side (right part of the graph), the placebo discontinuities that arise at higher distances, a negative one at around 35 kilometers followed by a positive one around 80 kilometers, are due to the already mentioned Abidjan perturbation.

In the case of Burkina Faso, almost all bandwidths point to a discontinuity ranging between 200 and almost 300 dollars (figure 6, left graph of second row), the maximum of 298 dollars being reached at the optimal bandwidth of 135 km (table 2), here with no attenuation with regard to the national means difference. Here again, the placebo RDs are very neat and confirm that the discontinuity indeed lies at the border and not elsewhere.[16]

[Insert Table 2 about here]

Conversely, Guinea and Mali figures only exhibit significant discontinuities for bandwidths lower than 75 km that we cannot entirely rely upon. Indeed, at optimal bandwidths of respectively 130 and 120 kilometers, the estimated border treatment effects are small in magnitude and insignificant. In the case of the Guinea border, the result fits with the negative and insignificant district-level mean differences already observed in section 4. We should also recall that it could uncover geographical discontinuities that make its interpretation difficult. In the

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[16]In relative terms, that is when divided by the estimate at $D = 0$ for the corresponding comparison country, these numbers mean respectively a doubling of cash expenditures when crossing the Ghana border toward Cote d'Ivoire, and a tripling at the Burkina Faso border. Very similar figures are obtained when taking total consumption instead of cash expenditures. When looking at non-food expenditures share, in the case of Ghana a significant discontinuity of more than 7.5 percentage points is only observed with bandwidths over 140 km, while in the case of Burkina Faso a large discontinuity ranging between 10 and 20 percentage points is observed at almost all bandwidths.

case of the Mali border, the outcome varies with distance to the border on the Cote d'Ivoire side, cash expenditures being lower for households who live closer to the border. This explains why the RD estimate is not the same as from district-level mean differences. All we can say is that the discontinuity lies between 0 and 100 dollars, and as such is much lower than the one observed at the Burkina Faso border, despite the fact that the two northern countries have rather close national incomes (table 2).

These discontinuities in cash expenditures at Cote d'Ivoire borders are strikingly consistent with the discontinuities prevailing at borders between Cote d'Ivoire neighbors, that are displayed in figure 7 and in the bottom part of table 2. The border between Guinea and Mali again provides an ambiguous figure: no discontinuity at all when taking bandwidths from 50 to 110 km, the optimal bandwidth being set at 75 km; or some Guinean advantage between 100 and 150 dollars with bandwidths ranging from 110 to 150 km. Among the triangle formed by border areas between Cote d'Ivoire, Guinea and Mali, we cannot definitely reject the welfare ranking Cote d'Ivoire > Guinea > Mali that corresponds to national accounts or national samples figures. However, we cannot reject either the assumption of an homogenous space. And at optimal bandwidths, border discontinuities rather tell that Cote d'Ivoire = Guinea = Mali, or at least that discontinuities in income are too small to be identified. And geographical discontinuities that were spotted above come to blur the picture even more.

[Insert Figure 7 about here]

Conversely, among the triangle formed by border areas between Cote d'Ivoire, Burkina Faso and Ghana, the welfare ranking is clearer, even if discontinuities are evaluated at different periods: Cote d'Ivoire > Ghana > Burkina Faso. Indeed, the last graph of figure 7 and the last row of table 2 show that an unambiguous discontinuity holds at the border between Ghana and Burkina Faso in 1998, with a 50$ or so advantage for Ghana (at 1998 prices and dollar exchange rates). The

border discontinuities are pretty much consistent with Cote d'Ivoire remaining wealthier than Ghana even in 1993 or 1998, in spite of some convergence since 1988, but with Ghana standing in between Cote d'Ivoire and Burkina Faso, as reflected by official national accounts data and border districts comparisons mentioned in section 4.

Between Mali and Burkina Faso, it is striking that at optimal bandwidths there is a small Malian advantage of 60$ around the years 1993-94, then followed by a Burkina Faso advantage of 51$ in the years 1998-2001. The latter figure of switched positions is less robust than the first in terms of bandwidth variation, but we can tell that the border discontinuity most probably lies between 0 and 50$ in 1998-2001. Anyway, the two figures are rather consistent with the evolution of national accounts and national samples contrasts that reveal a melting down of the Malian income advantage. Like in the 1986-1998 evolution analyzed in section 4 figure 3 at the Cote d'Ivoire/Ghana border, this is revealing of the insulating power of borders that help in preserving countries from the macroeconomic ups and downs of neighbors. Indeed, 2001 is a bad year for Mali as it corresponds to a long-lasting strike of cotton producers who are located in the southern part of the country, i.e. near the borders with Cote d'Ivoire and Burkina Faso. Last, if we stick to the 1993-94 figure, we preserve the following transitive ranking Cote d'Ivoire $\geq$ Mali > Burkina Faso.

Figure 8 displays RDs estimates and Placebo RDs for connection to electricity. With this variable, inference is more difficult due to spatial auto-correlation. However, the Cote d'Ivoire advantage is fairly robust at the borders with Ghana and Guinea: in both cases, the border RD is estimated between 15 and 50 percentage points of connected individuals. It is also salient at the Burkina Faso border, and using the optimal bandwidth delivers the same order of magnitude i.e. around 30 percentage points, although the RD coefficients are less robust to bandwidth variation. Conversely, the Cote d'Ivoire advantage is definitely canceled out at the borders with Mali. In the case of Mali, the 25 percentage points difference provided

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by district-level analysis gets down to an insignificant 5 points difference with the 120 kilometers optimal bandwidth. Like with the consumption comparisons examined above, the lack of precision and arbitrariness of the administrative grid can explain the bias of district-level means comparisons: in particular, the southern part of Cote d'Ivoire border districts includes larger cities (Odienne, Boundiali, Korhogo) that are well-connected, whereas villages located near the border are not.[17]

[Insert Figure 8 about here]

Turning back to the case of Guinea, the connection to electricity figure seems to contradict the absence of discontinuity in terms of living standards, and to be revealing of a difference between the determinants of public investment and of private income; however, the geographical discontinuities that were spotted at this border could also explain why more mountainous areas on the Guinea side have less chances to be connected. Still, no discontinuity in connection to electricity is observed at all the other borders between Cote d'Ivoire neighbors (results not shown), even if the coastal countries, Ghana and Guinea, display much higher national rates (respectively 27 and 20% in 1992-94) than landlocked countries, Mali and Burkina Faso (both 5% only). This allows to consider that it is truly the higher public investment effort of wealthier Cote d'Ivoire that translated into peripheral areas, the border with Mali standing as an exception.

We last look at discontinuities in adult literacy, to be compared with national and district-level differences depicted in figure 4 shown above. For the sake of space we only summarize the results here. RD estimates are broadly in line

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[17]Access to safe water other than rainfall and rivers (wells, taps, etc.) also jumps at the borders of Cote d'Ivoire with Ghana (by more than 20 percentage points) and with Burkina Faso (by more than 35 points) at optimal bandwidths. No discontinuities are found at the borders with Guinea and with Mali. In the case of Guinea however, the hydrographic discontinuity already spotted, with Guinean localities being further away from rivers, precludes an unambiguous conclusion.

with border residents mean differences of figure 4. Recall that we cannot correct here for migration, as distance to the border is not available for internal migrants (only district of birth is recorded, not precise place of birth). As already seen, this generates a little attenuation bias of the Cote d'Ivoire advantage. For men born between 1930 and 1959 a large discontinuity is observed at the advantage of Ghana against Cote d'Ivoire (more than 20 percentage points), but thanks to Cote d'Ivoire catching up, this advantage is canceled out for men born after 1960. No discontinuity in adult literacy is observed between border residents of the four former French colonies for people born before 1960, i.e. before national boundaries came into being. Conversely, for people born after independence, some discontinuities are observed at optimal bandwidths: at the border of Cote d'Ivoire with Guinea for women (around 20 percentage points), and at the border with Burkina Faso for both men and women (20 points again). In this latter case, district-level mean comparisons of figure 4 reveal more blurred than RDs; consistently enough, between Ghana and Burkina Faso a significant RD of around 20 points is observed for both men and women born after 1960, at the advantage of the former country. Finally and again, the border of Cote d'Ivoire with Mali provides a more ambiguous picture, as we detect no significant RD whether in adult literacy or in past school attendance (ever been at school), in contrast with what figure 4 suggested.

To summarize, the advantage of being included in one of the two wealthiest countries, first Cote d'Ivoire and second Ghana, is still fairly visible very far from the capital cities Abidjan and Accra and from the coast, in the northeastern area around Burkina Faso, where we spot large discontinuities prevailing in terms of monetary welfare, connection to electricity or access to water, and adult literacy. In the northwestern part around Guinea and Mali, the existence of border discontinuities is much less obvious, depending sometimes on the bandwidth that is chosen, the less ambiguous case being electricity connection at the Cote d'Ivoire / Guinea border. This northwestern part, and in particular the border with Mali, is precisely the furthest away from the capital city of Cote d'Ivoire, Abidjan, so that

Herbst's model of radiating core finds here an illustration. However, when looking at borders which divide countries with closer levels of development *and* whose distance to both capital cities is broadly the same, like between Cote d'Ivoire and Ghana on the one hand, or Burkina Faso and Mali on the other hand, significant discontinuities are also observed, even if of smaller magnitude. The size and the sign of these discontinuities are determined by the ups and downs of the national macroeconomic climates, which is revealing again of the insulating power of national borders.

6   Conclusion: Borders matter

In Africa, boundaries delineated during the colonial era now divide young independent states. The borders between Cote d'Ivoire and four of its neighbors (Ghana, Guinea, Mali and Burkina Faso) separate fairly comparable areas in terms of geography, anthropology and pre-colonial history. Nevertheless, by applying regression discontinuity designs to a large set of household surveys covering the 1986-2001 period, this paper identifies many large and significant jumps in welfare at borders. Border discontinuities mirror the differences between country averages with respect to household income, public investment and education, and are revealing of the centripetal forces of national markets and public investment policies. Taking into account migration flows does not change this diagnosis, as they are rather part of the story.[18] However, distance to the capital city has a strong power of attenuation, so that border discontinuities are blurred or even erased in the most remote peripheral areas. These results are very consistent with a national integration process that is underway but not yet achieved. National borders already matter in Africa, and the country of residence makes a difference.

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[18]As shown, intense and selective migration flows run from peripheral areas to the centers, but international migrants from poor landlocked countries also find beneficial to settle just on the other side of the border next to their country of origin.

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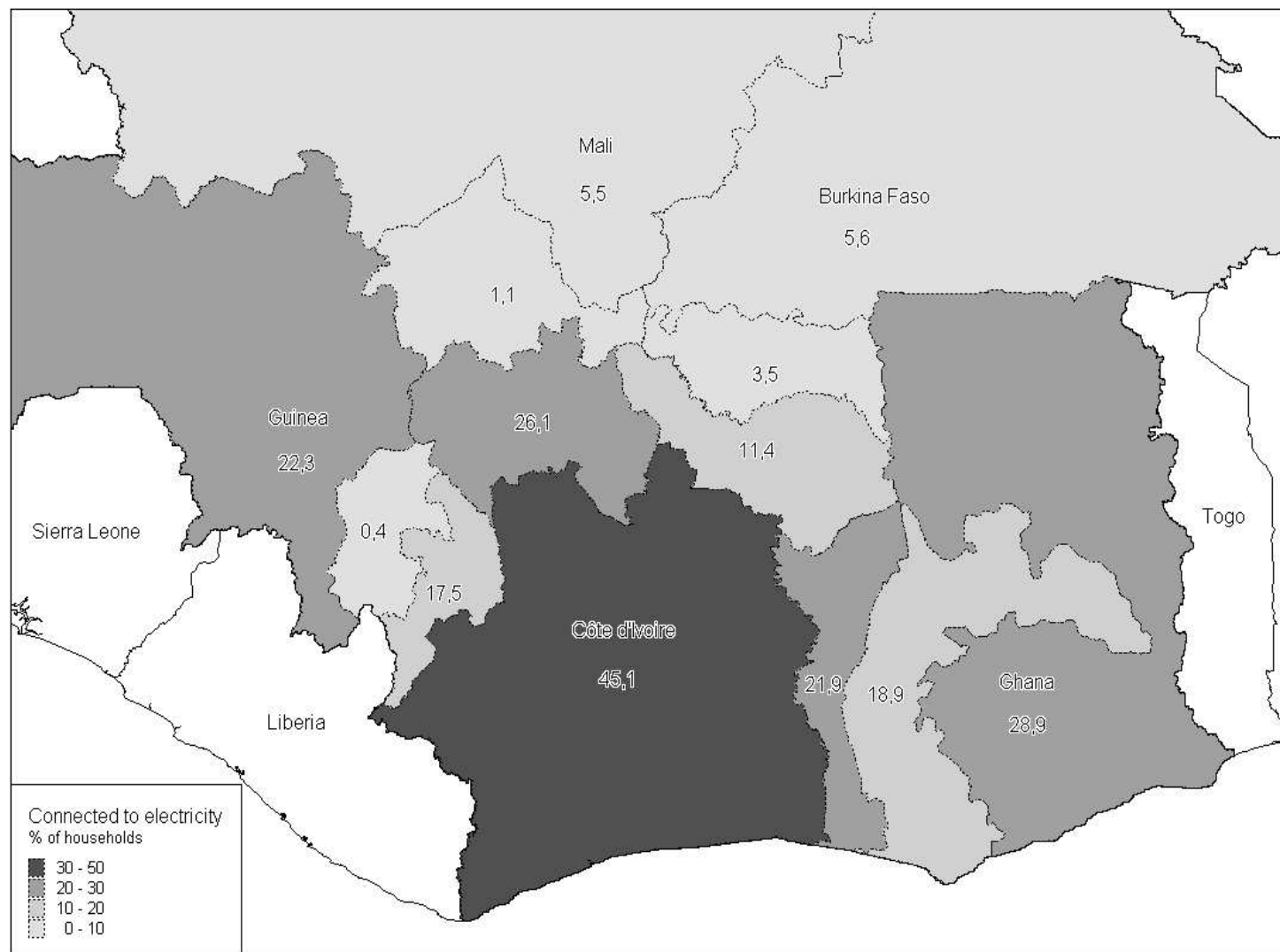Figure 1: Cash expenditures per capita: National and border levels around 1993
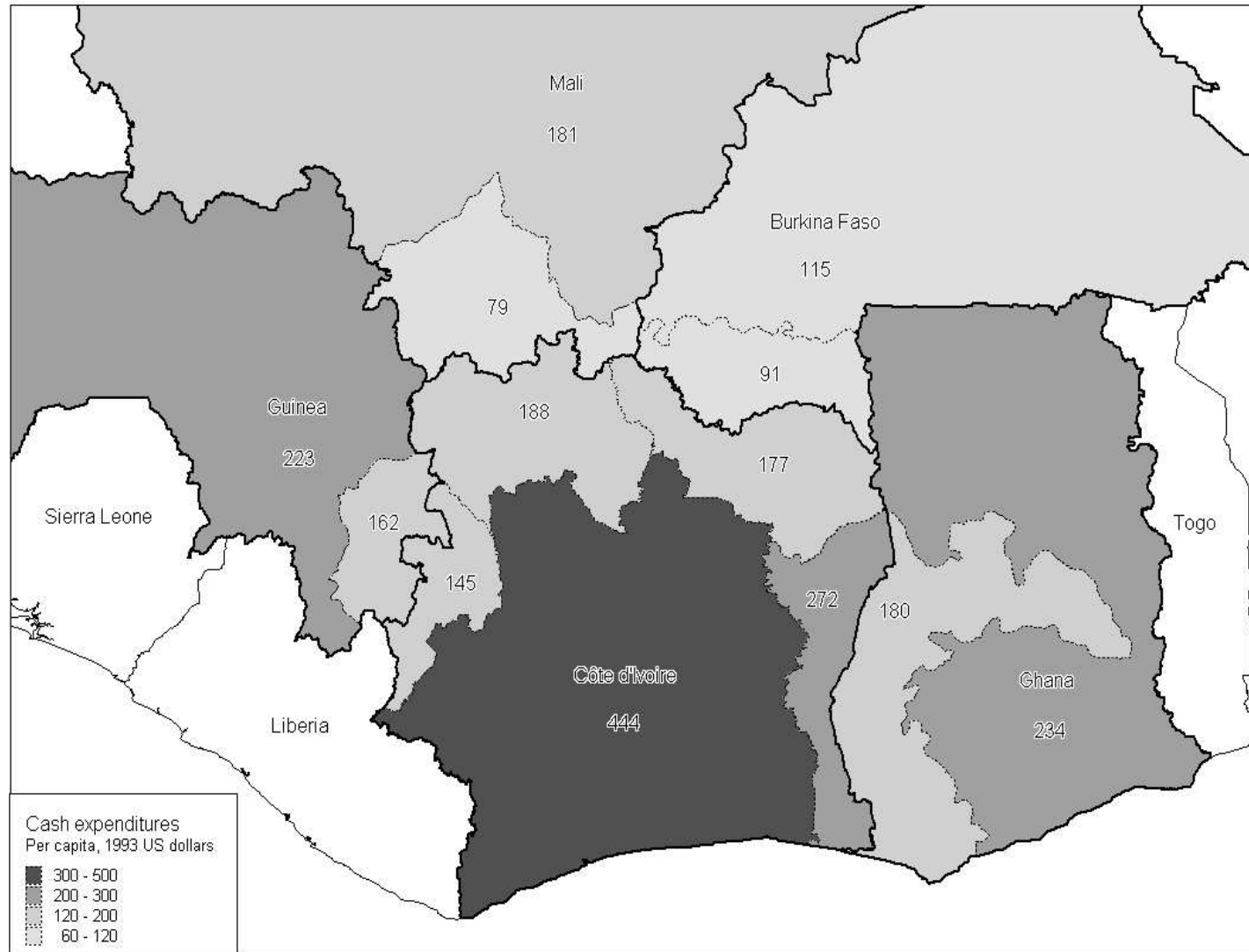
Reading: The map distinguishes the administrative border districts means and the rest of the country means. In the case of the borders with Mali and Burkina Faso, the Ferkessedougou district is included in both border means on the Cote d'Ivoire side (see also appendix A, figure A.1). Unit: 1993 prices and 1993 dollars.
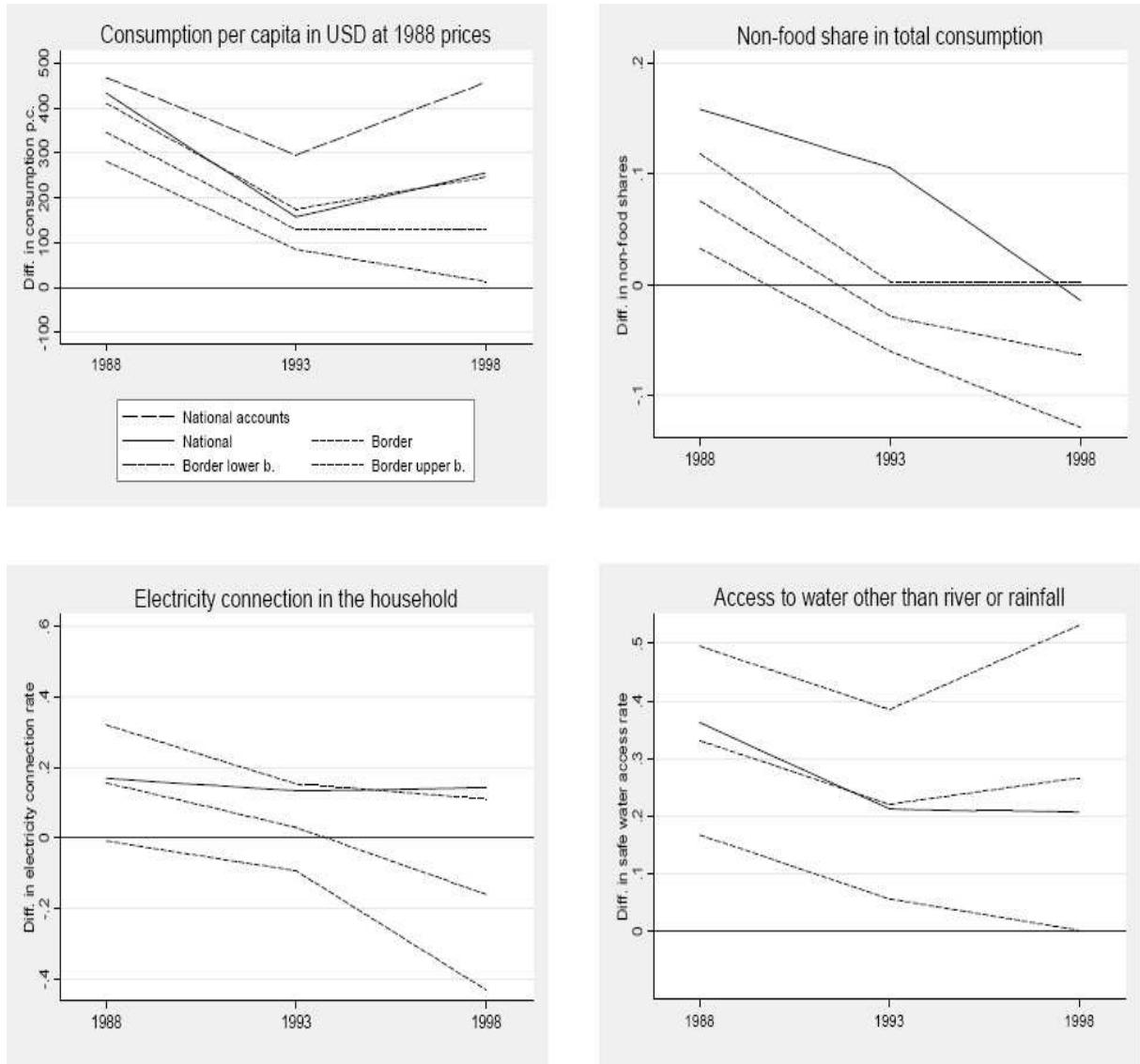
Figure 2: Connection to electricity: National and border levels around 1993

Reading: The map distinguishes the administrative border districts means and the rest of the country means. In the case of the borders with Mali and with Burkina Faso, the Ferkessedougou district is included in both border means on the Cote d'Ivoire side (see also appendix A, figure A.1).

Figure 3: Living standards across time at Ghana border

Consumption per capita in USD at 1988 prices

Non-food share in total consumption

National accounts
National   Border
Border lower b.   Border upper b.

Electricity connection in the household

Access to water other than river or rainfall

Coverage: Households (weighted by household size and sample weights).

Reading: National means computed from surveys are in solid line, border means (along with upper and lower bounds of 95% confidence intervals) are in dashed lines. In the first graph, national accounts private consumption per capita is added (top line, long dash). Errors are clustered by PSUs.

Figure 4: Literacy at Cote d'Ivoire borders
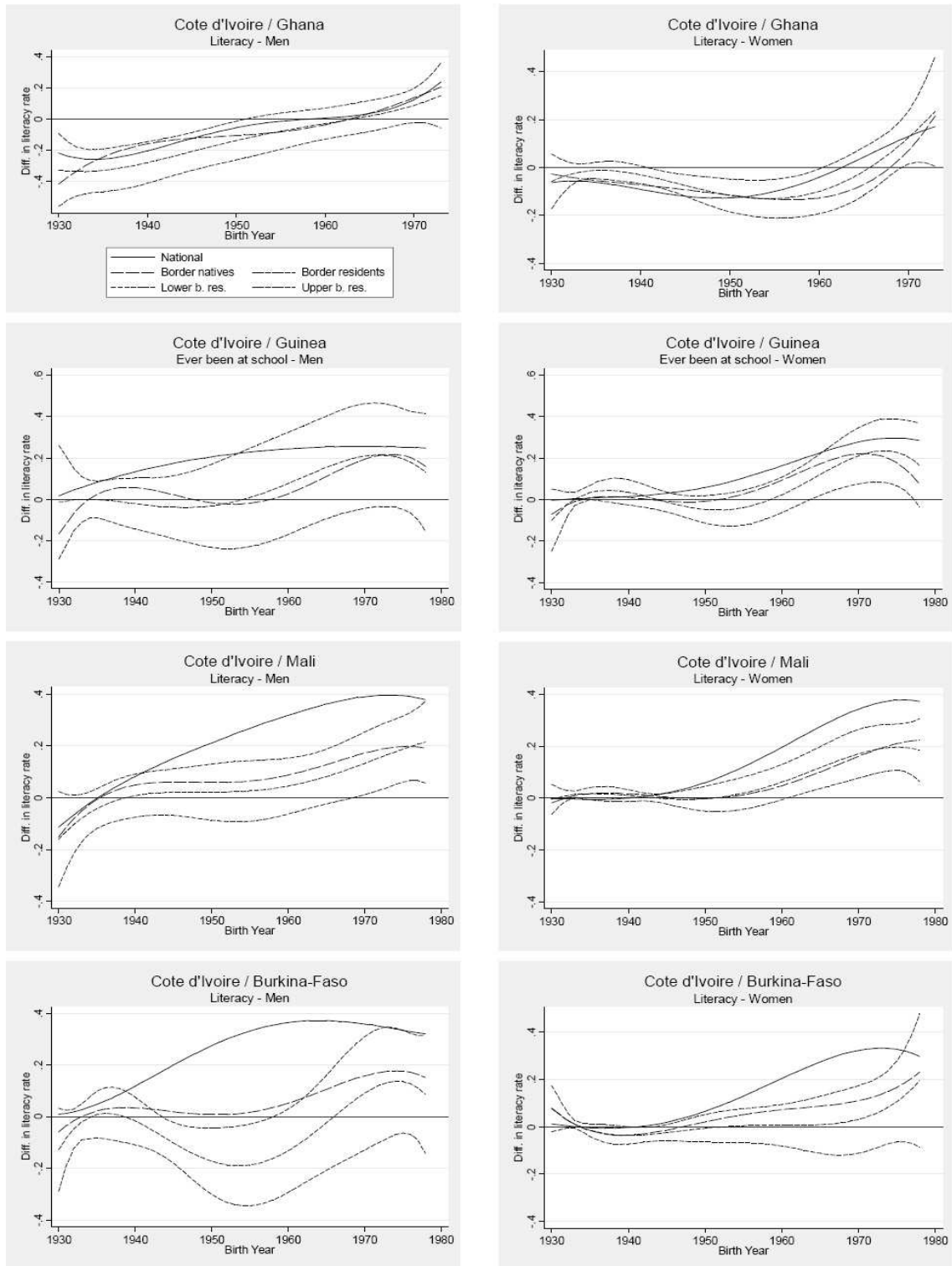
Coverage: Individuals born 1930-1980 (1974 for Ghana comparison).

Note: OLS fits of quartics in date of birth. National (solid line): Country natives (Cote d'Ivoire, Ghana and Guinea) or country residents (Mali and Burkina Faso). Border natives line (long dash): For Ghana and Guinea borders, only internal migrants on both sides. For Mali and Burkina Faso, internal migrants from border areas only on the Cote d'Ivoire side; nationals from Mali and Burkina Faso in Cote d'Ivoire surveys are included in their country of origin means, with appropriate reweighting (see text and appendix A). Errors are clustered by PSUs.

Figure 5: Map of border clusters (100 kilometers band)
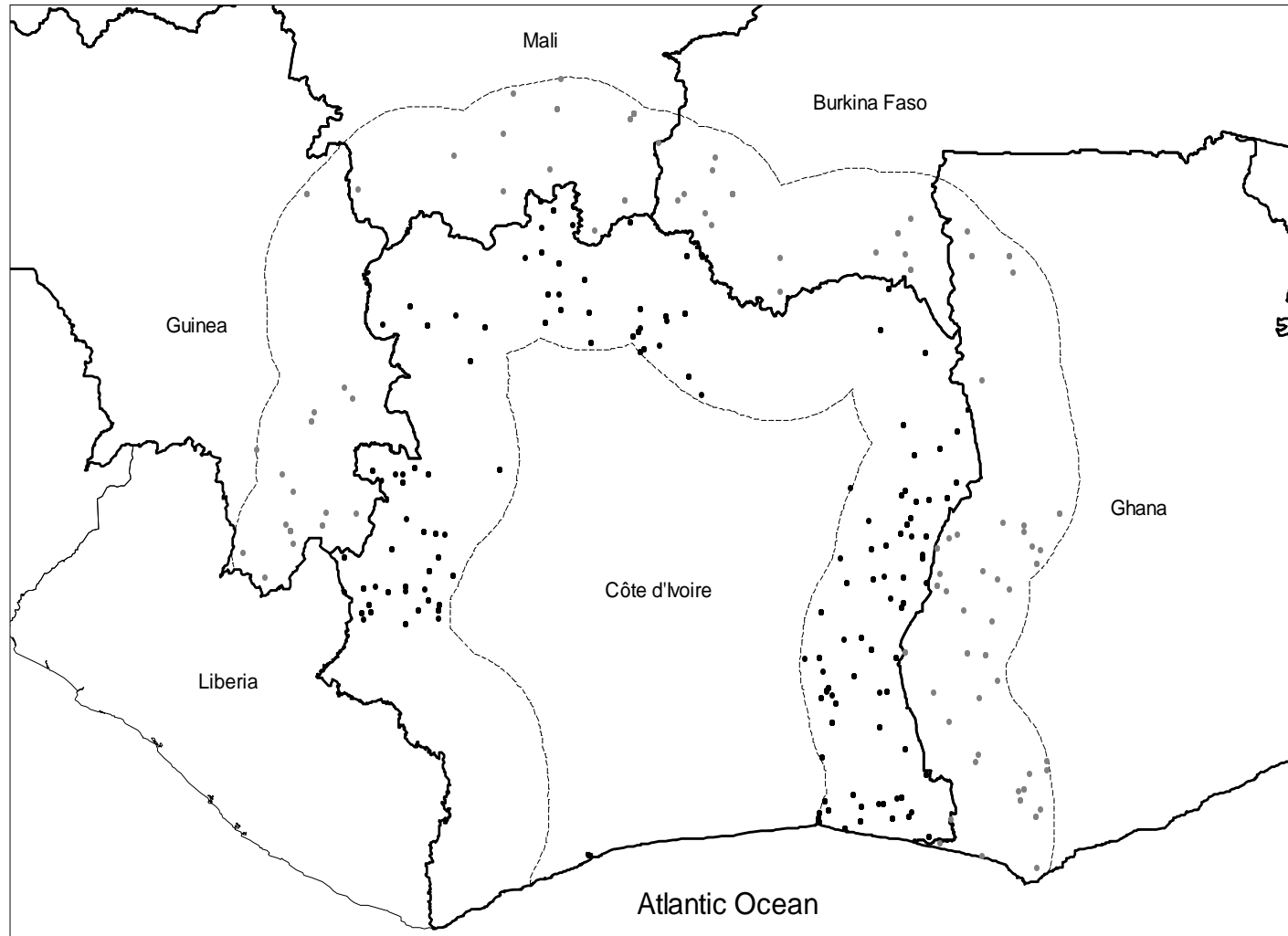
Reading: Each dot corresponds to a PSU not further away than 100 kilometers from the border. At the Cote d'Ivoire / Ghana border, only survey clusters for the 1986-1989 period are plotted; at the three other borders, only survey clusters for 1992-1994 are plotted.

Figure 6: Cash expenditures per capita: Discontinuities at Cote d'Ivoire borders
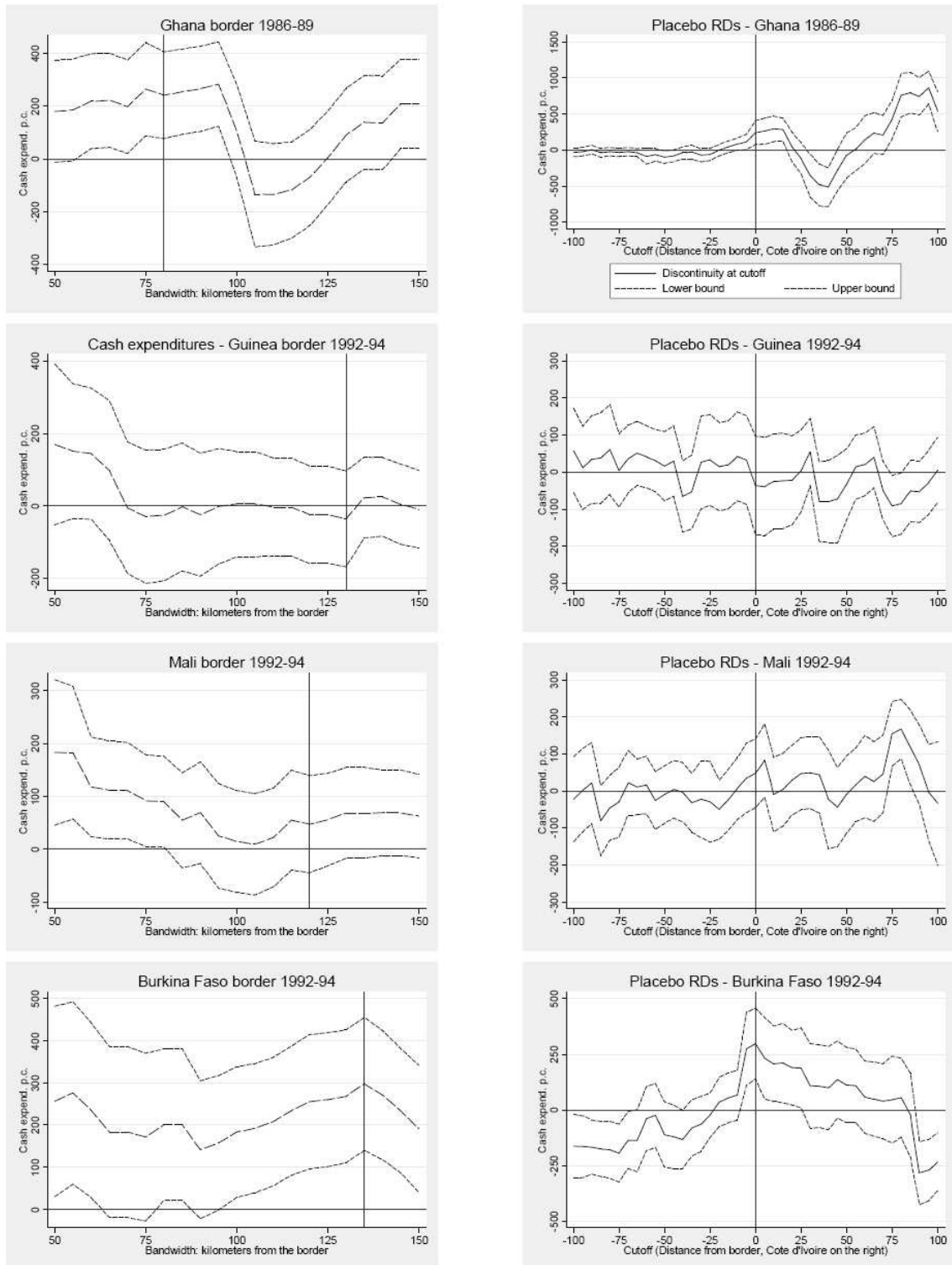
1st column: RDs at borders estimated by locally linear regressions with variable bandwidths, see equation (2) in the text. The estimated coefficient of the Cote d'Ivoire dummy $\gamma(h)$ is plotted against bandwidth h, with a 95% confidence interval band. Vertical lines indicate optimal bandwidths h_{CV}^{opt} (cross-validation criterion, see text).
2nd column: Placebo RDs, see equation (3) in the text. Bandwidths h_{CV}^{opt} are those indicated in the 1st column. The estimated coefficient for the discontinuity $\gamma(k)$ at a fictional border (cutoff) shifted from the actual border by k kilometers, is plotted against k, with a 95% confidence interval band.
Both columns: Cash expenditures at 1988 prices and in 1988 dollar for border with Ghana (top row), at 1993 prices and in 1993 dollar for others. Errors clustered by PSUs.

Figure 7: Cash expenditures per capita: Discontinuities at borders between Cote d'Ivoire neighbors
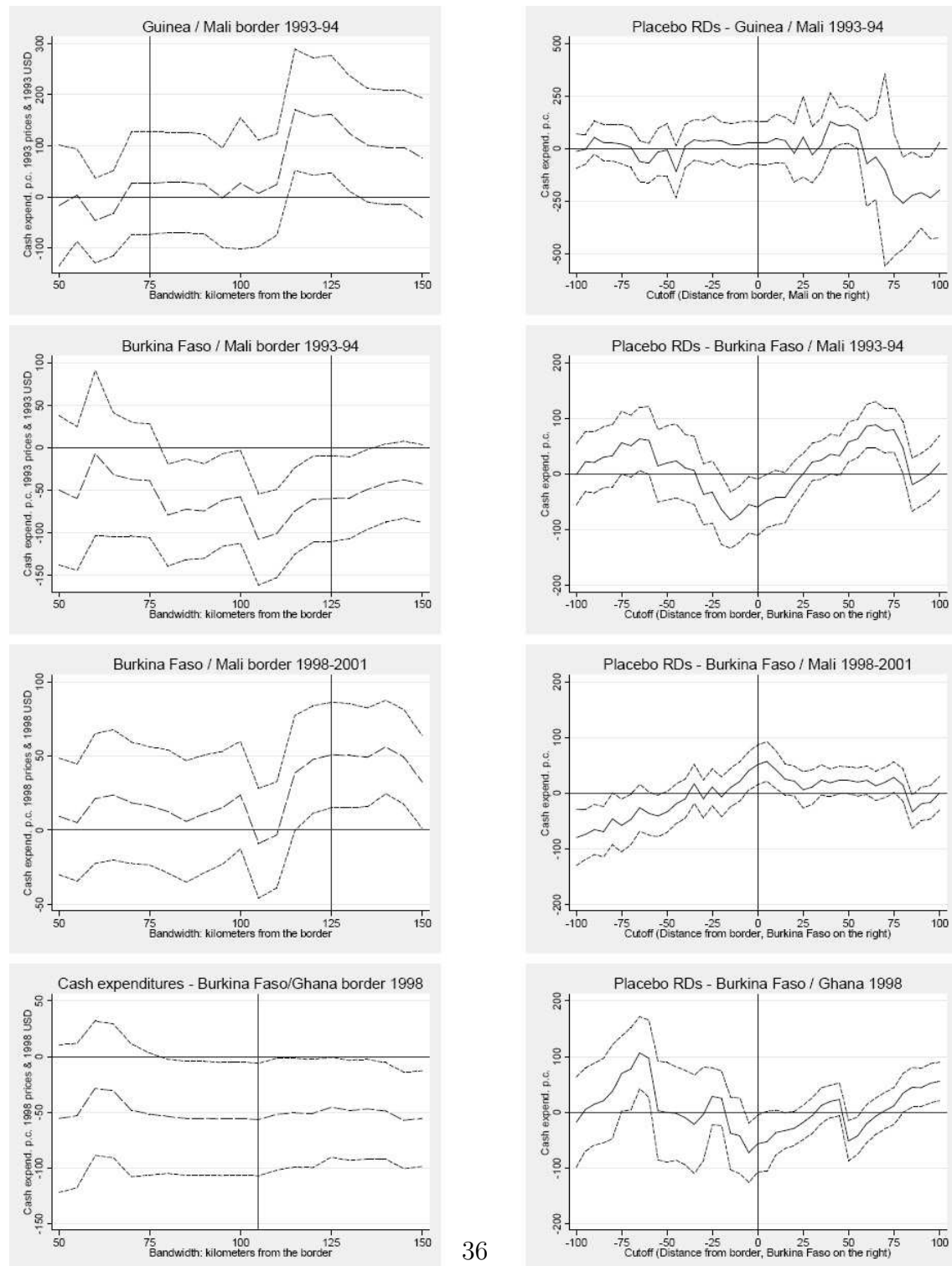
Notes: See figure 6. In the first column, a positive number indicates a welfare advantage for the first country mentioned in the title of the graph (Guinea or Burkina Faso). Cash expenditures at 1993 prices and in 1993 dollar for 1992-94 (top two rows), at 1998 prices and 1998 dollar for 1998-2001 (bottom two rows).

Figure 8: Connection to electricity: Discontinuities at Cote d'Ivoire borders
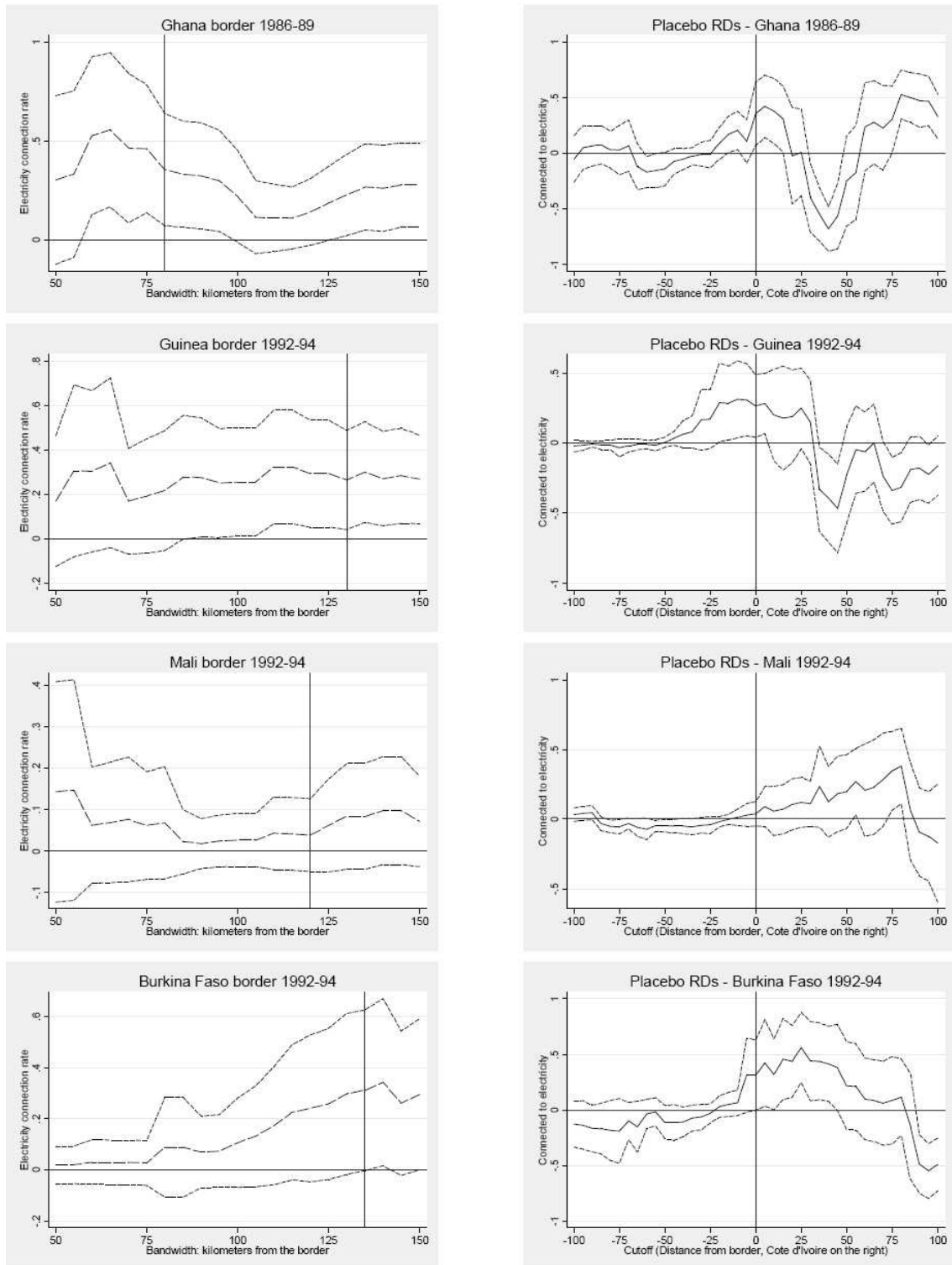
Notes: See figure 6. In the first column, a positive number indicates a discontinuity in connection to electricity when crossing the border in the direction of Cote d'Ivoire.

Table 1: Surveys

Neighbor survey	Cote d'Iv. survey	Period		Sample size (# households)	
		Comparison country	Cote d'Ivoire	Comparison country	Cote d'Ivoire
Ghana GLSS1-2	CILSS2-4	Feb.86-May.89	Mar.87-Apr.89	6,336	4,814
Ghana GLSS3	ENV1	Sep.91-Sep.92	Apr.92-Oct.93	4,558	9,598
Ghana GLSS4	ENV2	Apr.98-Mar.99	Sep.98-Dec.98	6,016	4,178
Guinea EIBC	ENV1	Jan.94-Feb.95	Apr.92-Oct.93	4,417	9,598
Mali EMCES	ENV1	Mar.94-June94	Apr.92-Oct.93	9,554	9,598
Mali EMEP	ENV2	Jan.01-Jan.02	Sep.98-Dec.98	7,365	4,178
Burkina Faso EP1	ENV1	Oct.94-Jan.95	Apr.92-Oct.93	8,642	9,598
Burkina Faso EP2	ENV2	May98-Aug.98	Sep.98-Dec.98	8,469	4,178

Note: The three first Ivorian (CILSS 2 to 4) and the two first Ghanaian (GLSS 1 and 2) surveys are stacked in order to obtain large samples covering the 1986-89 period.

Table 2: National income and discontinuities at seven borders in West Africa

	Final cons. p.c. (Nat. Acc.)	Cash expenditures p.c.	
		Survey mean	Border RD
Cote d'Iv. / Ghana 1988	+467$	+380**	+241**
Cote d'Iv. / Guinea 1993	+299$	+178**	-36
Cote d'Iv. / Mali 1993	+427$	+221**	+48
Cote d'Iv. / Burkina F. 1993	+480$	+282**	+298**
Guinea / Mali 1993	+86$	+67**	+27
Burkina F. / Mali 1993	-53$	-60**	-60**
Burkina F. / Mali 1998	+5$	-38**	+51**
Burkina F. / Ghana 1998	-121$	-247**	-97**

Coverage: Households (weighted by household size and sample weights).

Notes: Positive numbers indicate differences in favor of the first country listed (Cote d'Ivoire, Guinea or Burkina Faso depending on the row considered).

Clustered errors by PSUs. **: significant at 95%; *: significant at 90%; 2-tails tests.

Final cons. p.c. (Nat. Acc.) = Final consumption expenditure per capita from countries' national accounts for the year indicated in first column (World Bank, 2008); Cash expenditures p.c. = Household current cash expenditures divided by household size. The two expenditure variables are measured at the same year prices and converted in dollar with the same year exchange rate: 1988 in the first row, 1993 in the five middle rows and 1998 in the last two rows.

References

[1] Acemoglu, Daron, Simon Johnson and James A. Robinson. 2002. "Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution", *Quarterly Journal of Economics*, 117(4):1231-1294.

[2] Alesina, Alberto, William Easterly and Janina Matuszevski. 2006. "Artificial States", NBER WP 12328, Cambridge MA.

[3] Bloom, David E., and Jeffrey D. Sachs. 1998. "Geography, Demography and Economic Growth in Africa", *Brookings Papers on Economic Activity*, n°2, pp. 207-295.

[4] Brownlie, Ian. 1979. *African Boundaries - A Legal and Diplomatic Encyclopaedia*, London: C. Hurst and Company, Berkeley and Los Angeles: University of California Press, for the Royal Institute of International Affairs (London).

[5] Brunschwig, Henri. 1972. *Le partage de l'Afrique noire*, Paris: Flammarion.

[6] Easterly, William, and Ross Levine. 1997. "Africa's Growth Tragedy: Policies and Ethnic Divisions", *Quarterly Journal of Economics*, 112(4): 120-142.

[7] Easterly, William, and Ross Levine. 1998. "Troubles with the Neighbours: Africa's Problem, Africa's Opportunity", *Journal of African Economies*, 7(1):1203-50.

[8] Englebert, Pierre, Stacy Tarango and Matthew Carter. 2002. "Dismemberment and Suffocation, A contribution to the Debate on African Boundaries", *Comparative Political Studies*, 35(10): 1093-1118.

[9] Hahn, Jinyong, Petra Todd and Wilbert Van der Klauuw. 2001. "Identification and Estimation of Treatment Effects with a Regression-Discontinuity Design", *Econometrica*, 69: 201-09.

[10] Hargreaves, John D. 1985. The Making of African Boundaries: Focus on West Africa, in Asiwaju A.I. (ed), *Partitioned Africans, Ethnic Relations Across Africa's International Boundaries 1884-1984*, New York: St. Martin's Press.

[11] Herbst, Jeffrey I. 2000. *States and Power in Africa: Comparative Lessons in Authority and Control*, Princeton University Press.

[12] Huillery, Elise. 2009. History Matters: The Long Term Impact of Colonial Public Investments in French West Africa, *American Economic Journal: Applied Economics*, 1(2): 176-215.

[13] La Porta, Rafael, Florencio Lopez-de-Silanes, Andrei Shleifer and Robert Vishny. 1999. "The Quality of Government", *Journal of Law, Economics and Organization*, 15(1):222-279.

[14] Lee, David S. 2008. "Randomized experiments from non-random selection in US House elections", *Journal of Econometrics*, 142: 675-697.

[15] Lee, David S., and Thomas Lemieux. 2008. "Regression Discontinuity Designs in Economics", NBER working paper 14723, Cambridge MA: NBER.

[16] Miguel, Edward. 2004. "Tribe or Nation? Nation-Building and Public Goods in Kenya versus Tanzania", *World Politics*, 56(3): 327-362.

[17] Pakenham, Thomas. 1991. *The Scramble for Africa, 1876-1912*, London: Jonathan Ball Publishers.

[18] Pande, Rohini, and Christopher Udry. 2005. "Institutions and Development: A View from Below", in Blundell R., W. Newey and T. Persson, *Proceedings of the 9th World Congress of the Econometric Society*, Cambridge University Press.

[19] Posner, Daniel. 2004. "The political salience of ethnic difference: why Chewas and Tumbukas are allies in Zambia and adversaries in Malawi", *American Political Science Review*, 98(4): 529-545.

[20] Robinson, James A. 2002. "States and pover in Africa by Jeffrey I. Herbst. A review essay", *Journal of Economic Literature*, 40(2): 510-19.

[21] Spolaore, Enrico, and Romain Wacziarg. 2005. "Borders and Growth", *Journal of Economic Growth*, 10: 331-86.

[22] Schultz, T. Paul. 1998. "Inequality in the distribution of personal income in the world: how it is changing and why", *Journal of Population Economics*, 11(3):307-344.

[23] Wesseling, Henri L. 1991. *Divide and Rule: The Partition of Africa, 1880-1914*, Westport, Conn.: Praeger, english translation 1996.

[24] World Bank. 2008. *African Development Indicators*, Washington DC: World Bank publications.

Development at the border - Appendix A [Not for publication]

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[1], and that ethnic groups are historical objects that were at least influenced, if not constructed in some instances, by colonial and post-colonial politics.[2] 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.[3]

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,

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[1]Herbst, J.I., 2000. *States and Power in Africa: Comparative Lessons in Authority and Control*, Princeton University Press, pp.40-46.

[2]See, e.g., Posner, D., 2005. *Institutions and Ethnic Politics in Africa*, Cambridge, UK: Cambridge University Press.

[3]Terray, E., 1995. *Le royaume Abron du Gyaman des origines à la conquête*, Paris: Karthala.

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[4]: 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.[5] Some consideration was given to historical ties between populations, but diplomatic bargaining was the dominant feature.[6]

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[4]Cf. Terray, op. cit.

[5]Brownlie, I., 1979. *African Boundaries - A Legal and Diplomatic Encyclopaedia*, London: C. Hurst and Company, Berkeley and Los Angeles: University of California Press, for the Royal Institute of International Affairs (London), pp. 231-246.

[6]Stary B., 2003. "Un no man's land forestier de l'artifice à l'artificialité: l'étatisation de la frontière Côte d'Ivoire-Ghana", *Cahiers d'Outre-Mer*, 222:199-228.

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 [7]. 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

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[7]Brownlie, op. cit. p.246

banks of river Niger near Bamako where the French had just arrived, coming from Senegal.[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 Biankouma 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.[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, Tingrela, Boundiali, Korhogo, Ferkessedougou and Bouna on the Cote d'Ivoire side. On the Mali side, one finds the districts ("*cercles*") of Yanfolila, Bougouni, Kolondieba and Kadiolo; lastly, on the Burkina Faso side, the districts ("*départements*") of

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[8]Curtin, P., S. Feierman, L. Thomson and J. Vansina, 1978. *African History, From Earliest Times to Independence*, Harlow, England: Longman, 2nd edition 1995, p.349.

[9]Brownlie, op.cit., pp.301-303.

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.[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.[11] This most Eastern part of the border, near the

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[10]M'Bokolo, E., 1992. *Afrique Noire, Histoire et civilisations, Du XIXè siècle à nos jours*, Paris: Hatier/AUF, 2nd edition 2004, p.65

[11]Boutillier, J.-L., 1993. *Bouna, Royaume de la savane africaine*, Paris: Karthala.

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[12], and another decreee 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.[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.[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[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

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[13]Madiéga, in Massa, G., and Y. G. Madiéga (eds), 1995. *La Haute-Volta coloniale, Témoignages, Recherches, Regards*, Paris: Karthala, pp. 13-38.

[14]Brownlie, op.cit., pp.371-377.

[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
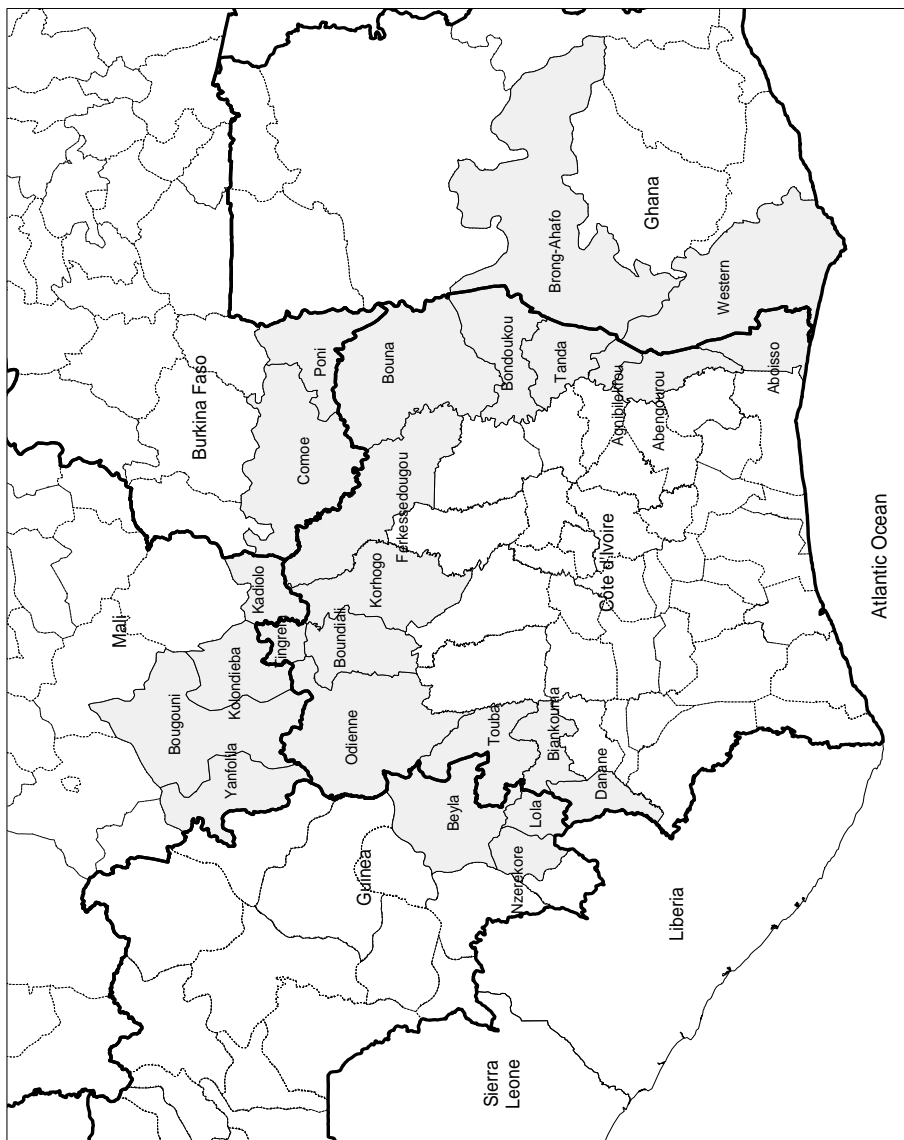
Location of border administrative districts.

Table A.1   Initial Conditions and Early Colonial Investments: Cote d'Ivoire Borders during the Colonial Era

	Ghana border	Guinea b.		Mali b.		Burkina Faso b.	
Border Side	C. d'Iv.	C. d'Iv.	Guinea	C. d'Iv.	Mali	C. d'Iv.	Burk.-F.
Population dens. 1910	1.6	5.0	6.4	4.8	6.3	4.5	8.5
Europeans per cap. 1910	9.3	0.5	0.4	0.9	0.7	0.8	0.7
Trade tax per cap. 1912	0.58	0.02	0.02	0.01	0.01	0.07	0.02
Teachers per cap. 1910-28	8.6	1.7	0.9	1.6	0.9	1.7	1.3
Health pers. p.c. 1910-28	8.8	1.1	1.5	2.2	3.2	2.2	2.1
Public works 1910-28	1.0	0.7	0.2	0.4	0.7	0.3	0.2

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.

Development at the border - Appendix B [Not for publication]

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

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[1]For 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.

exchange rates and prices (1988, 1993 or 1998), using either official or parallel (in the cases of Ghana before 1989 and Guinea) exchange rates.

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

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[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.

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

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[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, Lagunaires 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.[4] 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.

USGS EROS Data Center: http://edc.usgs.gov/products/elevation.html
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.

NASA GPCP: http://precip.gsfc.nasa.gov.

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[4]Müller, D., 2005. "Stata in space: Econometric analysis of spatially explicit raster data", *The Stata Journal*, 5: 224-238.

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:
http://eros.usgs.gov/products/elevation/gtopo30/hydro/africa.html

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 (Word 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%).

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[5]Between 1986-89 and 1992-93 - we compute averages of yearly data over those periods, national accounts indicate that private consumption per capita collapses by around 27% in Cote d'Ivoire in the first period then rebounds by 18% in the second, whereas it first increases by 14% in Ghana and then comes back to its 1988 level (World Bank, 2008). There is some uncertainty in all these figures, as the comparison between two sources like the World Bank and Angus Maddison can tell (World Bank, 2008. *African Development Indicators*, Washington DC: World Bank publications. Maddison, A., 2003. *The World Economy: Historical Statistics*, Development Centre Studies, Paris: OECD). National accounts are not necessarily more reliable than survey data: see, e.g., Deaton, A., 2005. "Measuring Poverty in a Growing World (or Measuring Growth in a Poor World), *Review of Economic Statistics*, 87(1):1-19.

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

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[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.

Figure B.1: Map of border regions
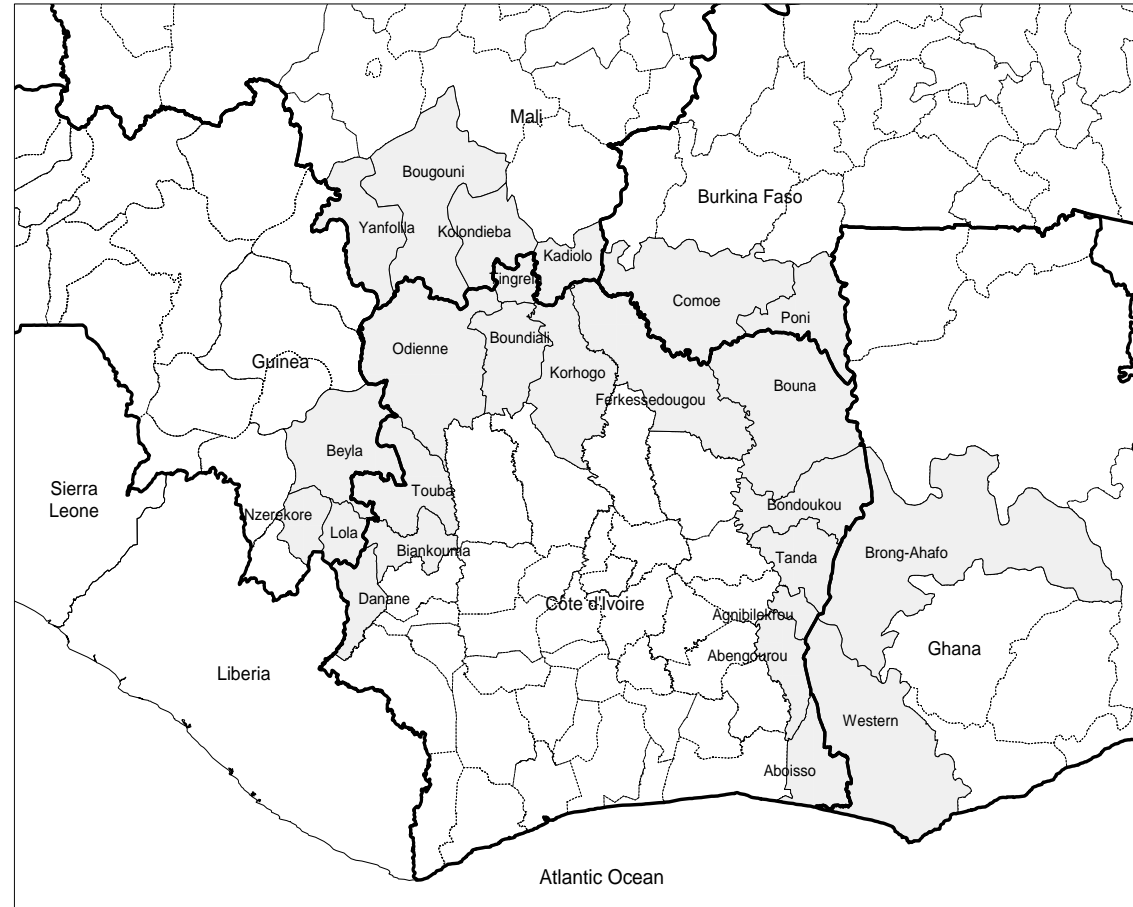
Location of border administrative districts, as described in historical appendix.

Table B.1:   Development differences at the Cote d'Ivoire / Ghana border: 1986-89, 1992-93 and 1998

	1986-89				1992-93				1998			
	C.d'Iv. nat. level	Nat. diff.	Border diff.	*Pr. > F*	C.d'Iv. nat. level	Nat. diff.	Border diff.	*Pr. > F*	C.d'Iv. nat. level	Nat. diff.	Border diff.	*Pr. > F*
Cons.p.c. 1988 p.	665$	+432**	+345**	0.022	417$	+158**	+130**	0.397	520$	+255**	+130**	0.038
Cash expend. only	553$	+380**	+237**	0.003	344$	+139**	+71**	0.036	441$	+214**	+79	0.060
Electricity conn.	39.8%	+16.8**	+15.6*	0.946	39.9%	+13.3**	+2.9	0.149	51.8%	+14.2**	-16.0	0.030
Sample sizes												
C.d'Iv.: HHs	4,854	4,854	394		9,486	9,486	937		4,117	4,117	215	
C.d'Iv.: PSUs	200	200	17		480	480	47		209	209	11	
Ghana : HHS		6,297	1,289			4,522	937			6,011	1,180	
Ghana : PSUs		309	74			365	79			300	59	

Coverage: Households (weighted by household size and sample weights).

Notes: Positive numbers indicate differences in favor of Cote 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 Cote d'Ivoire northern borders: Guinea, Mali and Burkina Faso

| | Guinea | | | Mali | | | | | | Burkina Faso | | | | | |
| | 1992-94 | | | 1992-94 | | | 1998-2001 | | | 1992-94 | | | 1998 | | |
	Nat. diff.	B. diff.	$Pr. > F$	Nat. diff.	B. diff.	$Pr. > F$	Nat. diff.	B. diff.	$Pr. > F$	Nat. diff.	B. diff.	$Pr. > F$	Nat. diff.	B. diff.	$Pr. > F$
Cons.p.c. 1993 p.	+223**	-3	0.001	n.a.			+354**	+208**	0.002	+329**	+182**	0.002	+426**	+532**	0.605
Cash expend. only	+178**	-17	0.001	+221**	+110**	0.001	+322**	+169**	0.003	+282**	+86**	0.001	+373**	+172**	0.016
Electricity conn.	+19.6**	+17.1**	0.826	+34.8**	+25.0**	0.062	+43.1**	+31.9**	0.281	+34.6**	+7.8	0.001	+45.6**	+20.0	0.113
Sample sizes															
C.d'Iv.: HHs	9,486	316		9,486	794		4,117	332		9,486	239		4,117	94	
C.d'Iv.: PSUs	480	16		480	40		209	17		480	12		209	5	
Neighb.: HHS	4,400	323		9,554	401		7,365	406		8,608	377		8,469	540	
Neighb.: PSUs	312	21		475	20		729	40		434	19		425	27	

Coverage: Households (weighted by household size and sample weights).

Notes: Positive numbers indicate differences in favor of Cote 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

	Ghana border		Guinea b.		Mali b.		B.-Faso b.	
	Ghana	C. d'Iv.	Guinea	C. d'Iv.	Mali	C. d'Iv.	B.-Faso	C. d'Iv.
Native Border Residents								
N	924	555	469	294		836		266
Immigrants[a]	34%	38%	10%	18%		12%		15%
N	472	264	86	89		146		53
Internal Emigrants[b]	15%	32%	8%	34%		37%		23%
N	161	225	91	203		464		89
International migr.[c]					6%		10%	
N					664		1,031	

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.

[a]: Border residents born outside the border; immigration rate in %: sum of weights divided by sum of weights of people born in the border districts.

[b]: 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.

[c]: 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 Cote d'Ivoire borders
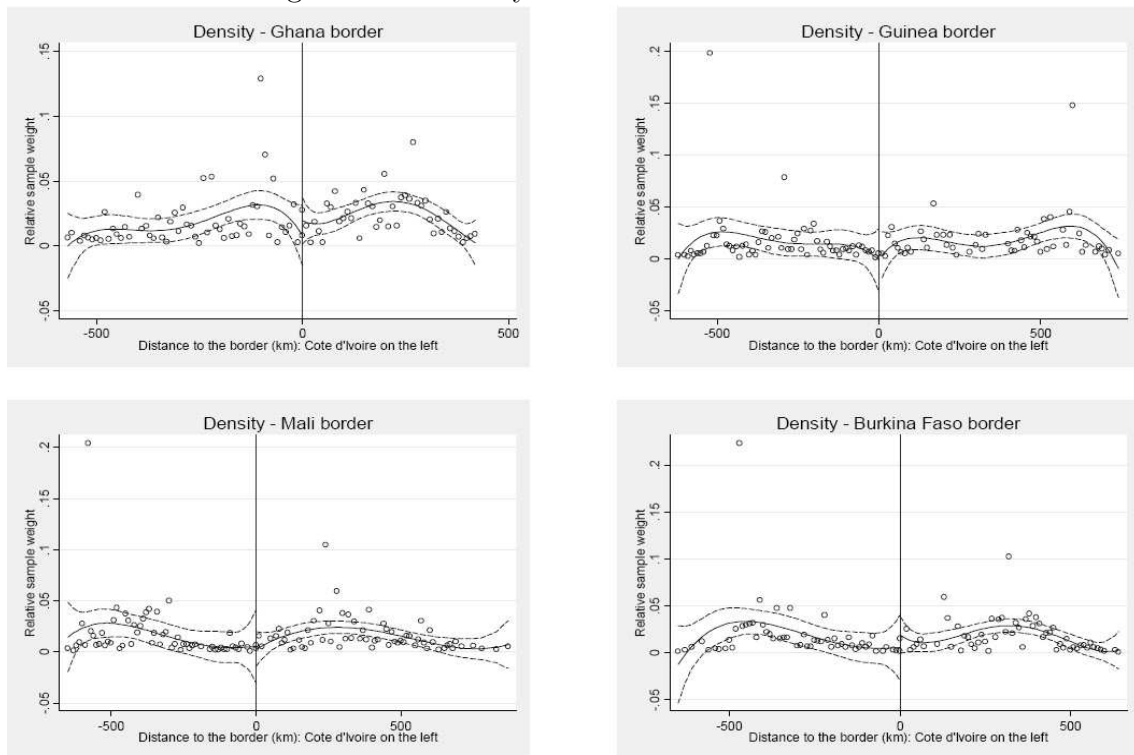
Reading: Dots represent relative sample weights for bins of 10 kilometers range. For these bins, curves are OLS
fits of quartics in distance to the border (with 95% confidence upper and lower bounds).

Figure C.2a: Geography at Cote d'Ivoire borders
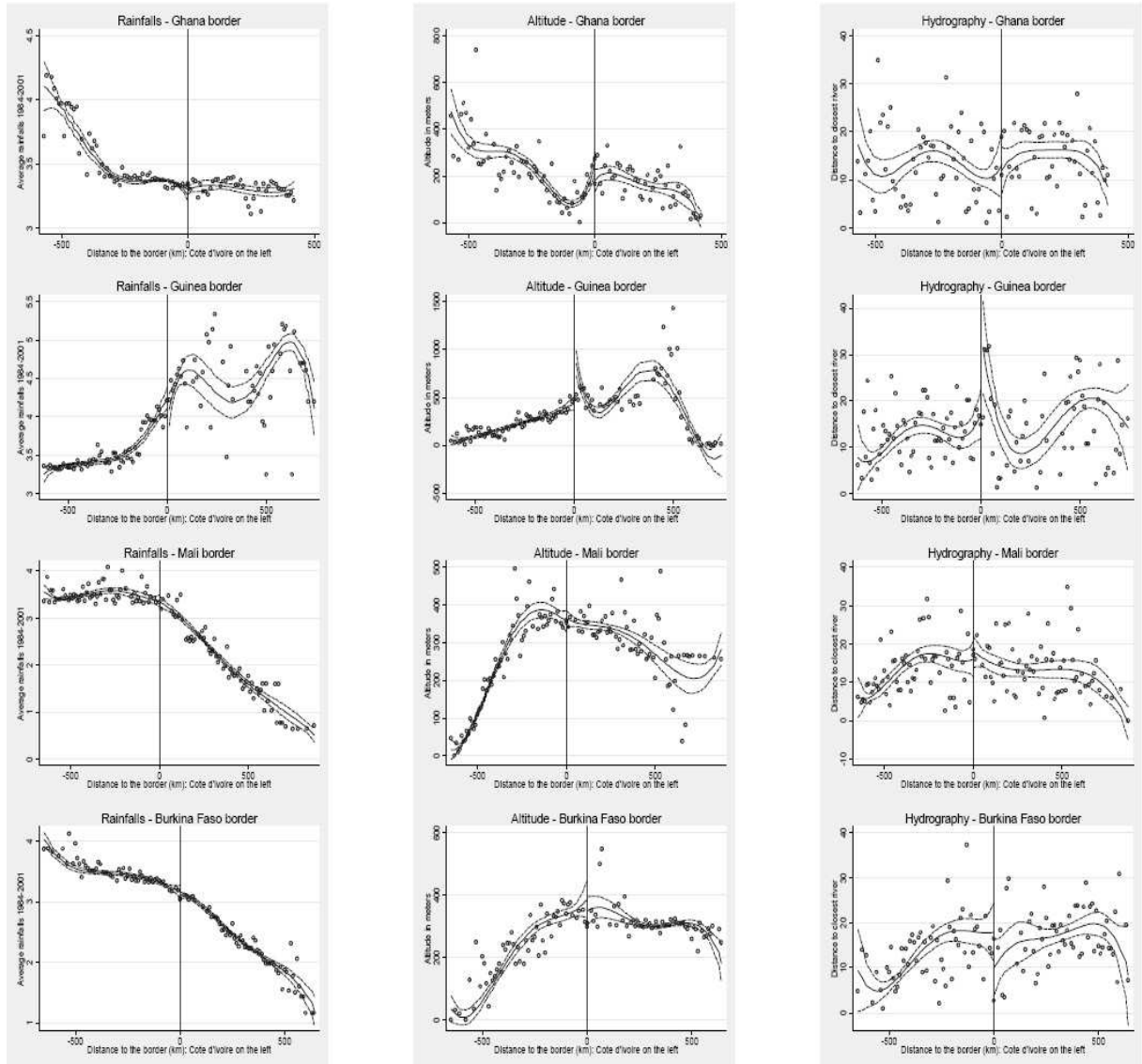
Reading: In each column, curves represent OLS fits of quartics in distance to the border (with 95% confidence upper and lower bounds). "Rainfalls" is the average number of millimeters per day over the 1984-2001 period, "Altitude" is the number of meters above the sea level, and "Hydrography" is the distance 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
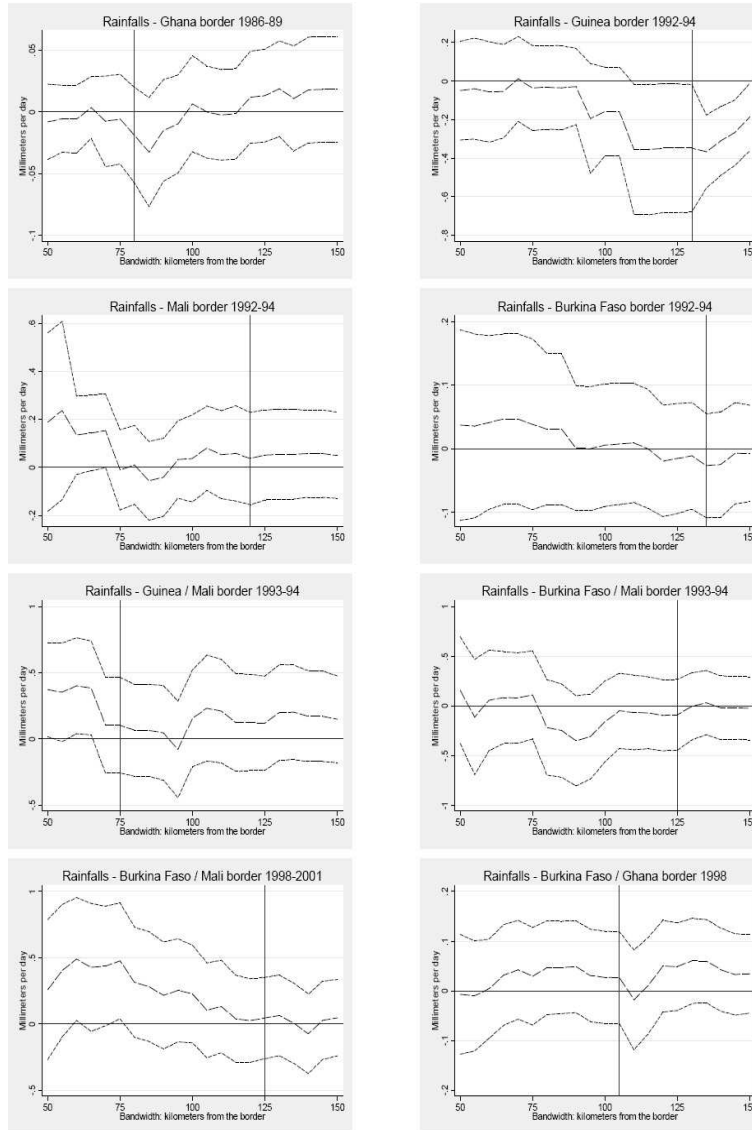
Reading: RDs at borders estimated by locally linear regressions with variable bandwidths, see equation (2) in the text. The estimated coefficient of the country dummy $\gamma(h)$ is plotted against bandwidth h, with a 95% confidence interval band. Vertical lines indicate optimal bandwidths h_{CV}^{opt} (cross-validation criterion, see text). Errors are clustered by PSUs.

Figure C.3: Ethnic groups at Cote d'Ivoire borders
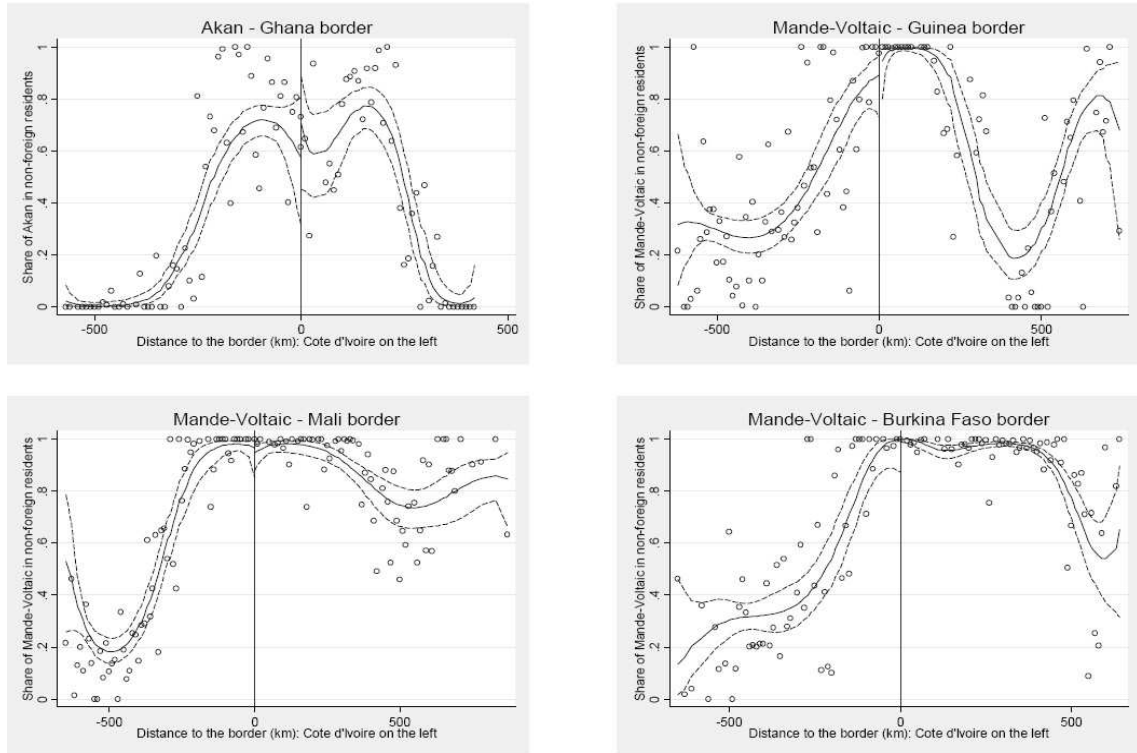
Reading: Curves represent estimated probit functions of quartics in distance to the border (with 95% confidence upper and lower bounds). See statistical appendix for details about the variables. Dots represent sample means for successive bins of 10 kilometers range. Errors are clustered by PSUs.

Figure C.4: Optimal bandwidths for cash expenditures p.c.
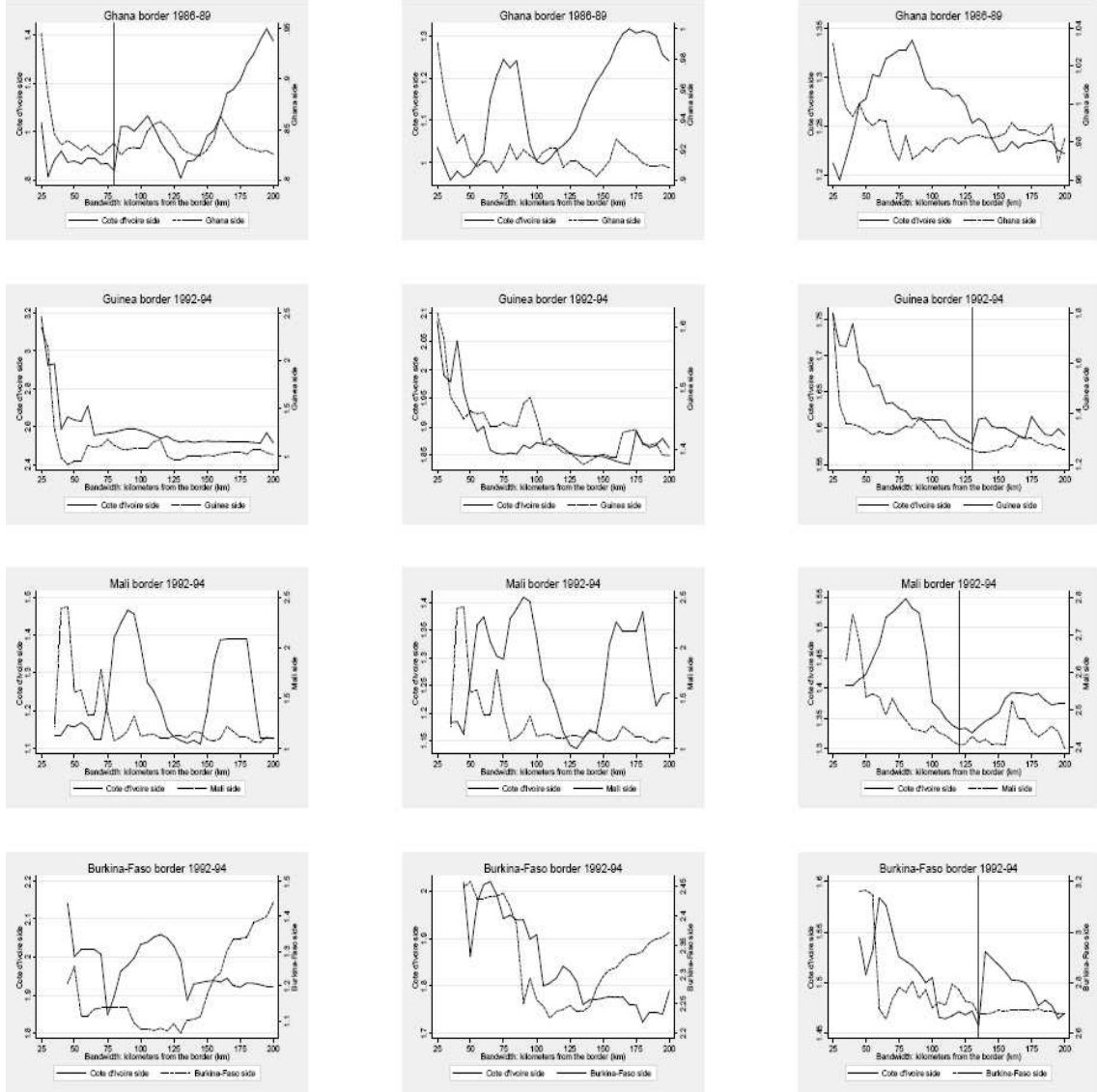
Reading: First column corresponds to cross-validation criterion $CV(h)$ curves for a subset of observation that are no further than 25 km from the border (see 3.3 in the text and Lee and Lemieux, 2009). Second column extends this maximum distance Δ to 50 km, and third to 100 km. For each side of the border that is considered, $CV(h)$ is plotted against the bandwidth h. Vertical lines indicate the optimal bandwidth h_{CV}^{opt} 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_{CV}^{opt} was determined accordingly (with $\Delta = 100$); corresponding figures are available upon request.