Borders or Barriers? The Impact of Borders on Agricultural Markets in West Africa

Jenny C. Aker, Michael W. Klein, Steve O'Connell*

December 2009

Abstract. Borders can segment markets, with important consequences for market performance and welfare. While international borders separate markets in different countries, the geographic concentration of ethnic groups may give rise to economically-relevant intra-national borders within countries in sub-Saharan Africa. In this paper we assess the extent to which international and intra-national borders segment markets for staple food and cash crops between Niger and Nigeria, and also within Niger. We find that the international border effect is statistically significant, yet of limited economic magnitude for grains and cash crops. The border effect is more pronounced for an intra-national border in Niger that separates the Hausa and Zarma regions.

* Jenny C. Aker and Michael W. Klein, The Fletcher School and Department of Economics, Tufts University, 160 Packard Avenue, Medford, MA 02155; Jenny.Aker@tufts.edu and Michael.Klein@tufts.edu.; Steve O'Connell, Swarthmore College, Swarthmore, PA. soconnell@swarthmore.edu. This research was partially funded by Gates Foundation grant to the National Bureau of Economic Research (NBER). We would like to thank participants at seminars at the Center for Global Development, National Bureau of Economic Research (NBER), Université de Clermont-Ferrand and University of Gottingen for their helpful comments and suggestions. All errors are our own.

1. Introduction

There is general agreement among economists that free trade promotes an efficient allocation of resources, and, conversely, that policies that impede trade reduce a country's standard of living. There is also evidence that trade contributes to economic growth (Frankel and Romer 1999, Feyrer 2008). Debate continues, however, on the degree to which national borders affect the integration of goods across markets in the absence of conventional restrictions on trade. The seminal contribution by Engel and Rogers (1996) finds that, conditional on distance between city pairs, price differences across Canadian and US cities for homogeneous sets of goods are considerably larger when two cities are separated by the international border than when both are in the same country. Similar research on other industrialized countries, such as the U.S. and Japan (Parsley and Wei 2001), and EU countries (Crucini and Shintani 2006, Crucini, Telmer and Zachariadis 2005), has also consistently found a relatively large border effect. Consequently, border effects have been cited as one of the "great puzzles" in international economics (Obstfeld and Rogoff 2000).

Border effects are arguably of greater importance in terms of consumer and producer welfare in low-income countries, especially the landlocked countries of sub-Saharan Africa, than in industrial countries. Despite this, border effects in low-income countries have not been the subject of much research, partly due to the lack of high-frequency data on narrowly-defined goods.[1] In this paper, we estimate border effects between Niger and Nigeria for two staple grains, millet and sorghum, and for a cash crop, cowpeas. We also consider the possibility of an economically relevant intra-national border in Niger that divides two ethnic regions, the Hausa and the Zarma, into geographically distinct regions. In Niger, as in many other West African countries, there is more ethno-linguistic commonality between specific regions of the country and contiguous regions of Nigeria than across regions of Niger itself. We show that there are economic implications of these ethnic divisions.

[1] Cross-border comparisons have typically been restricted to a few locations and a limited number of time periods. Daubrée (1995) compares the prices of a range of consumer goods between Niamey (the capital of Niger), Maradi (Niger) and Kano (Nigeria), and finds tighter co-movements between Maradi and Kano than between Maradi and Niamey. Oyejide *et al.* (2008) compare prices for markets within Nigeria with those in between the capitals of Niger, Togo and Benin, and finds suggestive evidence of a border effect. Araujo-Bonjean, Aubert and Egg (2008), use a vector autoregression model to estimate integration of millet prices between countries within the CFA zone (Niger, Mali and Burkina Faso), and find a statistically significant border effect.

Our analysis employs several empirical techniques developed in the international economics literature to study border effects, including examination of kernel distributions of conditional price differentials across pairs of markets (similar to Crucini, Telmer and Zachariadis 2005), regression analysis (taking into account the potential problems with this type of analysis discussed in Gorodnichenko and Tesar 2008), and a regression discontinuity analysis (as in Gorinchas, Gourinchas, Hseih and Li 2009). Each of these methods suggests that an international border effect exists between Niger and its primary trading partner, Nigeria, but that its magnitude is relatively limited. This result contrasts with the large border effects found for pairs of industrial countries. But, interestingly, we find evidence of a larger border across ethnic regions within Niger, than between Niger and Nigeria where proximate cross-border markets share similar ethnic profiles.

The rest of the paper is structured as follows. Section 2 provides a context for our analysis by discussing some relevant characteristics of Niger including the establishment of its international border with Nigeria and the geographic nature of its ethnic divisions. This section also describes the data we use and provides some preliminary statistics. Section 3 present the main results on international borders, and Section 4 presents the results for internal borders. We offer some conclusions in Section 5.

2. Nigerien Trade

Niger is one of the poorest countries in the world. It is ranked 174th (out of 177) on the United Nations' Human Development Index (UNDP 2008). The majority of the population of Niger consists of rural subsistence farmers, who depend upon rain-fed agriculture as their main source of food and income. As a landlocked country, Niger depends upon trade with its contiguous neighbors; primarily the coastal country of Nigeria, but also the coastal country of Benin which is also south of Niger, and the landlocked countries of Burkina Faso and Mali that lie west of Niger.

Niger's trade links with its coastal neighbors have a long and rich pre-colonial history. In the centuries prior to the arrival of the colonial powers, the Hausa ethnic group in modern-day northern Nigeria and south-western Niger was linked to the rest of the continent through a series of long-distance trading routes. The first was the trans-Saharan trade route, connecting Katsina and Kano (Nigeria) to Tripoli (Libya)

via the desert in northern Niger. Trade along this route was primarily in slaves, textiles, livestock, grains and salt. The second route was westward, and involved trade in kola nuts with regions in present-day Ghana (Hashim and Meager 1999).[2]

There were a number of significant changes in these circuits during the 1800s (Hashim and Meager 1999). The slave trade became less important in the export portfolio of West African states, and European goods became increasingly important as imports. Nevertheless, the direction and composition of the trade circuits were still primarily based upon ecological specialization and comparative advantage. During this time, Hausa became the *lingua franca* along the east-west trading routes when an eastward shift in the trans-Saharan trade route coincided with a dramatic expansion of the economy of Sudan and a growing dominance of the Hausa trading networks (Lovejoy 1980).

The 1,500-km border between Niger (a former French colony) and Nigeria (a former British colony) reached its current configuration in the wake of the 1884-1885 Berlin Conference. The border's placement reflected the opposing territorial interests of the French and British colonial administrations; the French government wanted access to Chad across southern Niger, thus moving the border from the northern desert regions to a location within the arable zone further south, while the British government insisted that the Hausa-Fulani kingdoms of northern Nigeria be kept intact, in light of previous civil conflict between the groups. As shown in Figure 1, the border that emerged in 1906 separated the Hausa, Zarma, Fulani and Kanuri ethnic groups between the two countries.[3] It also created a Niger that included eight ethnic groups (Hausa, Songhai/Zarma, Toureg, Fulani, Kanuri, Arab, Toubou and Gourmantche) which were, for the most part, situated in geographically distinct regions.[4]

[2] In addition to these primary trading circuits, there was also an east-west route between Kano and Mecca that combined pilgrimage with trade.

[3] Asiwaju (1985) states that the Niger/Nigeria border created a 'partitioned culture area' among Hausa and Fulani populations. Miles (2005) reports that, at the outset of the international demarcation, inhabitants with farmland straddling the boundary had to choose one colonial side or the other. French subjects were not supposed to farm on 'English' territory, and vice versa.

[4] A map of Nigeria in 1957-58 (not shown) also suggests that the geographic location of ethnic groups in Niger and Nigeria seems to be time-invariant, as it is similar to the ethnographic maps for 2008.

During the colonial period, few road networks were developed linking Niger and Nigeria.[5] For this reason, there were relatively few official border crossing stations by the time of independence in 1960. Building more stations was a low priority for the newly independent and relatively poor states of Nigeria and Niger. Consequently, borders remained porous, patrolling haphazard, and smuggling a major economic activity.[6] Agro-pastoral products (grains, legumes and livestock) constituted an important commodity of cross-border trade (Collins 1976), and "unofficial traders" brought petroleum and farm-chemical products into Niger (Charlick 1991). In 1971, a Nigeria–Niger Joint Commission (NNJC) was created with the purpose of harmonizing relations between the two states. Despite a series of border closings between 1983 and 1986, often related to political instability in Nigeria, both the National Boundary Commission of Nigeria and the NNJC convened trans-border workshops to address issues of cross-border trade. Currently, both Niger and Nigeria are members of the Economic Community of West African States (ECOWAS), a trade union created in 2001 among all West African states.

Any border effects on prices between Niger and Nigeria during the sample period of this study (1999 – 2007) are not due to official trade restrictions, but could be due to costs due to delays, harassment or banditry. Furthermore, trade between these two countries could be impeded by costs associated with changing currencies between the *Communauté Financière Africaine* (CFA) franc of Niger and the Nigerian naira. There are also linguistic differences, both between the official languages of Niger and Nigeria (French and English, respectively), and in local languages in different regions of each country.

3. Effects of the International Border on Agricultural Trade

The motivation for using prices in different locations to test for the presence of an international border is straightforward; if borders impose costs that undermine trade, then, conditional on distance between markets and other location-specific factors, price differences between markets located in different countries should be larger than those between markets in the same country. We begin this section with a

[5]The British completed a railway between Lagos (southern Nigeria) and Kano (northern Nigeria) in 1911, unifying Nigeria's coast with its north-eastern interior and undermining the long-distance trade between Kano and Tripoli (Hopkins 1973).

[6] Azam (2007) provides an analytical treatment of the determinants of illegal cross-border trade in the region.

discussion of the data we use to test for the border effect between Niger and Nigeria, which includes both price data and other data used to control for distances between markets and location-specific features. We then present three different analyses of the border effect; a graphical analysis of conditional price differences, a regression-based analysis, and a Regression Discontinuity (RD) analysis.

3.1 Data and Measurement

The analysis in this paper uses a dataset that draws on both primary and secondary sources in Niger and Nigeria. The price data represents monthly observations of prices of two grains (millet and sorghum) and a cash crop (cowpea) over a nine-year period (1999-2007) across 48 domestic and cross-border markets. Each of these commodities is produced and consumed in both countries, is heavily traded on an annual basis and is fairly homogeneous in terms of their quality.

Time-series data on gas prices, cell phone coverage, rainfall, road quality, trade flows, district population levels, cell phone rollout and coverage and the Naira-CFA exchange rate were also collected. In addition to these time series, we also employ data on the latitude and longitude of each market, the location of the international border and the road distances between market pairs. These series enable us to calculate the distance to the international and internal border of each market in the dataset, as well as the actual road distances between market pairs and the Euclidean distances. The third data series is a unique panel survey of traders, farmers, transporters and market resource persons collected in Niger by one of the authors (Aker) between 2005 and 2007. The survey data draws on interviews with 415 traders and 205 farmers located in 35 markets and 40 villages across six geographic regions of Niger, as well as in five Nigerian markets. A census of all grain traders was conducted in each market in which traders and market resource persons who participated in the survey provided detailed information about their demographic and socio-economic background and commercial operations. These data allow us to construct measures of the ethno-linguistic fractionalization (ELF) for each market, village and region, to identify ethnic "borders" and to measure the number of traders operating in these markets over time.

Table 1 presents summary statistics between 1999-2007 for markets located within a 150-km radius of the Niger-Nigeria border. In general, prices for staple grains (millet and sorghum) are higher in Niger as

compared to Nigeria, with a statistically significant difference between the two. This is consistent with the direction of trade between the two countries, with Niger importing grains from Nigeria. By contrast, cowpea prices are lower in Niger, and this is as expected since Niger primarily exports to Nigeria. We do not reject the equality of means or distributions for most other observable characteristics, with the exception of the Zarma ethnic group and cell phone coverage. However, the difference in cell phone coverage as of 2007 is only statistically significant at the 10 percent level. In addition, the Nigerian markets in our sample are only located in the Hausa region of that country, and none are in Nigeria's Zarma region.[7]

3.2 Graphical Analysis

We first use the data described above to construct kernel distributions for conditional price differences across countries and within countries. We estimate regressions of the form

$$|\ln (p^i_{jt}/p^i_{kt})| = \beta_0 + \beta_1 X_{jkt} + \theta_t + a_{jk} + \varepsilon_{jkt} \quad (1)$$

where p^i_{jt} is the naira price of good i in market j at time t, p^i_{kt} is the price of good i in market k at time t, X_{jkt} is a vector of observable characteristics that affect price dispersion between two markets, including transport costs between markets j and k at time t, a dummy variable that equals 1 if one and only one of the two markets is urban, another dummy variable that equals 1 if one and only one had a drought at time t, and θ_t are time fixed effects. In some specifications, market-pair fixed effects, α_{jk}, are also included. Separate regressions are run for market pairs within each country, and also for cross-border pairs. We plot a kernel distribution of the residuals from each regressions, ε_{jkt}, to examine relative conditional deviations from the Law of One Price.

We begin with a cross-section analysis. Figures 2(a) – 2(c) present the kernel distributions of $\varepsilon_{jk,t}$ from a regression of equation (5) for millet, sorghum and cowpea, respectively, for the 1999 – 2007 period. Each of these three figures includes the kernel distribution for the residuals of a regression using intra-Niger market pairs, a regression using intra-Nigeria market pairs, and a regression using cross-border (Niger-Nigeria)

[7] While members of the Zarma ethnic group live within Nigeria, it represents a small percentage of the population (approximately 88,000 people, or less than .0007 percent) and is geographically focused in the far northwestern region of the country on the border with Benin and Niger (Birin n'Kebbi region).

market pairs. Visual inspection of the kernel distributions suggests that the underlying volatilities of market-pair price differentials are similar across countries for grains and cowpeas. The distributions show a modest horizontal displacement across countries, suggesting thateven if there is a statistically significant border effect it may not be economically important.

These cross-sectional results, however, may mask differences across time. In particular, we are interested in investigating whether exchange rate movements between the Naira and CFA franc alter relative prices, which would be consistent with a lack of full market integration in cross-border markets. There was a strong appreciation of the CFA franc relative to the Naira between 1999-2001 and 2002-2004.[8] If cross-border markets were not well-integrated, we would expect to see increases in the relative price of millet, sorghum and cowpeas in Niger relative to those in Nigeria during these periods.[9]

To investigate conditional price dispersion over time, we estimate equation (1) for cross-border pairs separately for three marketing years (1999 – 2000, 2000 – 2001, and 2001 – 2002) using the observed price differences (rather than absolute values, as above) between Niger and Nigeria for millet, sorghum and cowpeas, and plot the kernel distributions of the residuals from these regressions in Figures 3(a) – 3(c). Figures 3(a) and 3(b) show a rightward shift in the distributions of millet and sorghum, respectively, between 1999-2000 and 2000-2001, the period during with there was an appreciation of the CFA/Naira exchange rate. This suggests that relative prices follow the CFA franc-Naira exchange rate, which could reflect a lack of market integration.

3.3 Regression Analysis

An early and influential contribution to the estimation of the border effect is Engel and Rogers (1996). They compare price volatility for fourteen categories of goods among 228 pairs, where each pair represents two cities in the United States, two cities in Canada, or one in the United States and the other in Canada through regressions with the specification

[8] There was a 16 percent appreciation of the CFA against the Naira between 1999 and 2001.

[9] Gopinath, Gourinchas, Hsieh, and Li (2009) find that costs of goods in Canada relative to those in the US closely tracks the exchange rate.

(2) $$\sigma_{ij} = \beta_1 \ln(d_{ij}) + \beta_2 B_{ij} + \sum_{m=1}^{N} \gamma_m D_m + \varepsilon_{ij}$$

where σ_{ij} is a measure of price volatility between cities i and j, d_{ij} is the distance between these cities, B_{ij} equals 1 if cities i and j are in different countries and 0 otherwise, and D_m is a set of city-specific dummy variables. The estimated coefficient β_2 represents the conditional change in price variability between two cities due to the fact that they are in different countries. The estimated border effect, that is, the distance-equivalent effect of the border, is $exp\frac{\beta_1}{\beta_2}$.

Engel and Rogers find strikingly large effects of the international border on price variability; one estimate puts the distance-equivalent effect at over 70,000 km. Other research reports similar magnitudes for border effects between industrial countries. But, Gorodnichenko and Tesar (2009) show that differences in underlying price volatility in two countries can result in an upwardly biased estimate of the border effect since comparing cross-country pairs of prices reflects both differences in underlying price variability in one of the countries as compared to the other as well as the costs associated with crossing the border between the countries. They demonstrate that the inclusion of a dummy variable for pairs of locations within one country can result in very different estimates than those obtained when including a dummy variable for pairs of locations in the other country if there are wide differences in price volatility across the two countries. For example, with the Engel and Rogers data, the estimated distance-equivalent border effect based on a specification that includes a Canada – Canada fixed effect is 47 km while the one based on a specification that includes a US – US fixed effect is 108 million km.

The Gorodnichenko and Tesar effect might be expected to be less of a concern for our analysis than for those like Engel and Rogers since, as shown in Figures 2 (a), (b), and (c), there is a similarity in the distribution of absolute differences of pairs of prices for Niger-Niger pairs and Nigeria-Nigeria pairs. As will be shown, this conjecture is supported by a comparison of the border effects in regressions that include a dummy variable for Niger-Niger pairs to those that use a dummy variable for Nigeria-Nigeria pairs

In consideration of the Gorodnichenko-Tesar critique, we estimate an equation of the following form:

$$\ln | p^i_{jt} / p^i_{kt} | = \beta_1 B_{jk} + \beta_x X_{jk,t} + \sum_{m=1}^{N} \gamma_m D_m + \theta_t + \varepsilon_{jk,t} \quad (3)$$

where B_{jk} and D_m are defined as above, $X_{jk,t}$ is a vector of variables that might affect price dispersion between two markets, such as drought, road quality, transport costs and other time-varying factors, and θ_t, are monthly fixed effects. One version of this specification does not include a dummy variable for country-specific pairs, another contains a dummy variable that equals 1 if the both locations in the pair are in Niger, and a third specification includes a dummy variable that equals 1 if both locations in the pair are in Nigeria.

Table 2 shows the results of the regressions from equation (3). There is a separate panel for each of the three commodities. Column 1 of each panel shows that the international border is associated with a statistically significant increase in price dispersion for each of the three commodities, contributing a 2.6 percent increase in price dispersion for millet, a 2.3 percent increase for sorghum and a 2.9 percent increase for cowpeas. The magnitude and statistical significance of the border effect is robust to the inclusion of country-specific fixed effects for Niger (Column 2 in each panel) and Nigeria (Column 3 in each panel), suggesting that country-specific differences in price dispersion are not driving our results.[10]

We also present evidence that mobile phone coverage is associated with a decrease in international price dispersion. Column 4 presents estimates of a version of equation (2) that includes a variable $cell_{jk,t}$, which is equal to 1 if both markets j and k have cell phone coverage at time t, 0 otherwise. This variable enters both on its own and interacted with the border dummy variable. These estimates show that cell phone coverage is associated with a decrease in price dispersion across markets for each of the commodities. Cell phones reduce the conditional border effect by more than a third (from 3 percent to 1.9 percent) for millet, and by 75 percent for cowpeas (from 4.4 percent to 1.1 percent), although the effect is not statistically

[10] These results are all robust to the use of dyadic standard errors (not shown).

significant for sorghum.[11] Despite this, the border still "matters" for millet and cowpea since the linear combination of the border coefficient and the cell phone-border interaction remains negative and statistically significant.

3.4 Regression Discontinuity Estimates

A third method for gauging the border effect, the regression discontinuity (RD) design, has been proposed by Gopinath, Gourinchas, Hsieh, and Li (2009). Common in the treatment effects literature, the RD methodology uses a regression of the form:

$$Y_i = \alpha + \gamma T_i + \theta Z_i + \beta X_i + \varepsilon_i \tag{4}$$

where the assignment variable (Z) determines the level of treatment (T), and the question of interest is the effect of the treatment on the outcome, Y. The level of treatment jumps discontinuously at Z_0, such that, in the neighborhood of Z_0 there is a discontinuous jump in the outcome of interest (Y) (this is known as the sharp discontinuity design). The RD design is used to estimate the effect of the treatment, conditional on other factors, in the neighborhood of the assignment variable being equal to the cutoff value. It has been used primarily to estimate the causal effects of treatment when small variations in some assignment variable (Z) induce a sharp change in treatment status (T). Some basic assumption of RD design are that the assignment variable does not have a discontinuous effect on the outcome (Y) in the absence of treatment, that no other variable correlated with outcomes changes discontinuously in the proximity of the values of the assignment variable that trigger treatment, nor do these other variables have a discontinuous effect on outcomes, and that unobserved characteristics do not vary discontinuously around the threshold value of the assignment variable. Gopinath, Gourinchas, Hsieh, and Li (2009) use the RD approach to estimate the magnitude of the US-Canada border effect on prices. In this context, the assignment variable (Z) is a market's distance from the international border, which determines its treatment status, i.e. whether the market is located in the US or Canada.

[11] Aker (2008) finds the introduction of cell phones was associated with a negative and statistically significant reduction in price dispersion across millet markets within Niger, and that this effect was the strongest for markets located between 200 and 550 km apart.

We follow the strategy of Gopinath, Gourinchas, Hsieh, and Li (2009) and implement the RD approach by estimating the following equation:

$$\ln p_{jt}^{i} = \alpha + \gamma N_j + \theta D_j + \delta D_j \times N_j + \beta X_j + \varepsilon_i \quad (5)$$

where p_{jt}^{i} is the price of a particular good in market j at time t, N_j is a dummy variable equal to 1 if market j is in Niger and 0 if it is in Nigeria, D_j is the distance from market j to the international border, with $D_j < 0$ for markets within Nigeria and $D_j > 0$ for markets within Niger, and X_j is a vector of variables that affect supply or demand characteristics in market j, such as urban status, drought or cell phone coverage. We also include the latitude and longitude of market j in some specifications as proxies for unobservable characteristics of market j that vary smoothly over space and have a continuous local impact on price. In this specification, the border effect is measured by the coefficient on the border dummy variable, γ, which is an estimate of the conditional discontinuity in prices as the distance from the border approaches zero. We estimate the equation using a local linear regression framework, restricting the regression sample to markets within a certain distance (bandwidth) of the border (Imbens and Lemieux 2008, Imbens and Kayanaraman 2009).[12]

We check the validity of the assumption that the observed characteristics are a continuous function of the distance from the border in the final column of Table 1. The statistics in this column represent the equality of means for binary market-level covariates on either side of the international border. We fail to find evidence of a statistically significant difference for most market-level covariates, including market size, the frequency of drought, road quality, transport costs and the ethnic composition of markets. The notable

[12] An important difference in using the RD approach to estimate the presence of the border effect as compared with the traditional treatment effects literature is dimensionality: while a test score or income is one-dimensional, geography is two-dimensional variable. Consequently, while Detroit, Seattle and Vancouver are all close to the US-Canada border, it is more meaningful to compare prices between Seattle and Vancouver than between Detroit and Vancouver. This dimensionality problem can be addressed by using a bandwidth that takes into consideration not only the distance to the border, but also the distance to other markets.

exceptions are urban status and the Zarma ethnic group, although the difference in urban status is only significant at the 10 percent level.[13]

We begin the regression discontinuity analysis with plots of the log of prices for millet, sorghum and cowpeas as a function of distance from either side of the Niger-Nigeria border, for all markets within a 50-km radius of the international border, in Figures 4(a), 4(b), and 4(c), respectively. The discontinuity in the outcome at the border is evident compared to the variation in the data.[14] A formal RD analysis, following Hahn, Todd, and Van der Klaauw (2001), results in a significant border effect, with coefficients ranging from 15-20 percent, depending upon whether the analysis is for millet, sorghum, or cowpeas. The significance of these results, and their relatively modest magnitudes, are consistent with the regression results presented above. The coefficients are similar when estimated with and without controls, thereby diminishing concerns that omitted variables might result in biased estimates of the border effect. Thus, the results of this analysis are consistent with the graphical analysis and the regression analysis presented above.

4. Price Dispersion Across Ethnic Regions in Niger

In recent times, there has been a growing interest within economics in the role that ethnic or cultural diversity can play in explaining socio-economic outcomes. A number of empirical studies have found that ethnic diversity is associated with lower growth rates (Easterly and Levine 1997), more corruption (Mauro 1995), lower contributions to local public goods (Alesina, Baqir and Easterly, 1999) and lower participation in groups and associations (Alesina and La Ferrara 2000). Consequently, it is also plausible that ethnic diversity could create "internal borders" to trade and hence market segmentation.

The process through which borders were established in West Africa resulted in multiple ethnic groups within Niger, as noted above. We focus on the ethnic "border" between the Hausa and Zarma regions of Niger. We use both secondary and primary data on the ethnic composition of geographic

[13] A more robust analysis of the potential overlap problem is a comparison of the difference in means with the standard deviation. Comparing the difference in average means with the standard deviations, the dataset is well-balanced; the difference in means between Niger and Nigeria groups is never more than 0.30 standard deviations for any covariate. The exceptions are for Zarma and the urban status variables. However, our analysis of the international border effect only uses limited observations of "Zarma" markets in Niger.
[14] We also find that this is true when plotting the log of prices by each marketing year, from 1999 to 2007, though we do not present these results in the paper.

locations within Niger (DHS 2000, RGPH 2001) to identify internal borders by assessing the degree of ethnic diversity (ethno-linguistic fractionalization, ELF) across locations. This ethnic Hausa/Zarma border is identified as a coordinate (latitude and longitude) that borders two geographic locations with a low degree of ELF (ie, a strong majority of Hausa or majority of Zarma), but which itself has a high degree of ELF. [15]

We use this information to analyze the effect of an intra-Niger ethnic border using the three methods employed above to study the effects of the Niger – Nigeria border on price dispersion. We begin with a graphical analysis. Figures 5(a)-5(c) show the kernel distributions of the ε_{jkt} of a specification like equation (1) but with the data for the Hausa and Zarma regions of Niger. In this case, the distinction is made between Hausa-Hausa market pairs, Zarma-Zarma market pairs and cross-ethnic-border pairs that include one location in the Hausa region and the other in the Zarma region. These kernel distributions suggests that the underlying price dispersions for millet, sorghum, and cowpeas in each region are similar but, unlike the kernel distributions for Niger-Nigeria market pairs, the distribution of price dispersion between Zarma and Hausa markets seems markedly different than the distributions for intra-Hausa and intra-Zarma market pairs. This suggests that the internal Hausa-Zarma border could have larger economic consequences within Niger than Nigerian border does for price dispersion between the two countries.

Regression estimates confirm this impression. Table 3 shows the regression estimates of equation (3) for each commodity although, in this case, the sample only includes data from the Hausa and Zarma regions of Niger and "border" represents the intra-Niger division between these regions. These regression results show that this internal border is associated with a positive and statistically significant increase in price dispersion for each commodity. Column 1 of each panel shows that the internal (Zarma-Hausa) border is associated with a 2.5 percent increase in price dispersion for sorghum, which is similar to the international border, but a 5 percent increase in price dispersion across millet and cowpea markets, which is much larger than the effect of the Niger – Nigeria border. The results for sorghum and millet are robust to the inclusion of country-specific fixed effects for intra-Hausa (Column 2) and intra-Zarma (Column 3) market pairs, but is

[15] The measure of ethnic diversity used almost universally in the empirical literature is the index of ethno-linguistic fractionalization (ELF), which is a decreasing transformation of the Herfindahl concentration index. In particular, if we consider a society composed of $K \geq 2$ different ethnic groups and let p_k indicate the share of group k in the total population, the resulting value of the ELF index is given by $1 - \sum(p_k)^2$

sensitive to inclusion of intra-Hausa or intra-Zarma market pairs for cowpeas. This is consistent with the visual inspection of the kernel distributions in Figure 5(c), which suggested that the underlying price dispersion for cowpeas differed considerably in intra-Hausa and intra-Zarma regions.

Finally, we undertake a regression discontinuity analysis of the effects of the internal border. This analysis is distinguished from the RD analysis of the international border, however, because the latter involves a "sharp" RD design since the international border is well-defined, and markets are clearly in either Niger or Nigeria, while the internal ethnic border in Niger is "fuzzy" since the probability of treatment (i.e. switching from a Hausa market to a Zarma market as one travels west) increases discontinuously, but not completely. In other words, crossing from east to west across the 3.5 degree longitude line increases the probability of a market being dominated by the Zarma ethnic group, but does not fully ensure that the market is populated solely by people in the Zarma ethnic group.

Table 4 shows the equality of means for binary market-level covariates on either side of the internal border. We fail to find evidence of a statistically significant difference for most market-level covariates, including market size, the frequency of drought, road quality, distance between markets and urban status. The notable exception is cell phone coverage, with a strongly statistically significant difference between the two groups. We formally test for discontinuity in market size, one of the only continuous covariates in the sample, and find that we cannot reject the null of no discontinuity in the market size at the internal border using multiple bandwidths.

Figures 6(a)- 6(c) plot the outcome of interest, the log of prices, against the continuous forcing variable in the model, distance to the internal border within Niger. We add lowess smoothed plots for the below- and above-threshold subsamples in order to allow for a discontinuity at the border. We construct this graph for all markets within a 250-km radius of the internal border. The discontinuity in the outcome at the threshold is evident compared to the variation in the data for millet and cowpeas, but not so for sorghum, consistent with the regression results. Indeed, when we perform a formal RD analysis, we find evidence of significance for the coefficient on the border effect for all three commodities, but a lesser magnitude for

sorghum. These plots also suggest that the internal discontinuity is higher than the international discontinuity, but additional analyses and robustness checks are needed.

5. Conclusion

This paper provides some initial evidence of the magnitude and statistical significance of international borders on price dispersion in West Africa. The results suggest that an international border effect exists between Niger and Nigeria, but that the magnitude of this effect is much smaller than that found in industrialized countries. The results are robust to a variety of specifications, including kernel distributions, regression-based estimates and RD results.

These results suggest that perhaps existing regional economic commissions have been somewhat successful in promoting cross-border trade, even among different currency unions. However, whether the limited border effect is due to regional economic policies or the strength of longstanding trade routes between ethnic groups – namely the Hausa of Northern Nigeria and Niger – is difficult to untangle. Recognizing the manner in which national borders in West Africa included, in a single nation, diverse ethnicities, there exists some evidence of an internal border along ethnic lines within Niger. It is not clear whether these effects are due to current social cleavages, longstanding policies or social networks that have been used to replace missing markets in Niger, namely in the area of credit and insurance. There is some evidence that information technology, namely cell phones, mitigate the international border effect, but have less of an impact on internal borders.

Bibliography

Aker, Jenny C. (2008), Does Digital Divide or Provide? The Impact of Cell Phones on Grain Markets in Niger. BREAD Working Paper, May 2008.

Alesina, Alberto, William Easterly, and Janina Matuszeski. 2009. "Artificial States" *Journal of the European Economic Association*, (forthcoming).

Anene, J. C. (1970), *The International Boundaries of Nigeria 1885-1960* (New York: The Humanities Press).

Araujo-Bonjean, Catherine, Magali Aubert, and Jonhy Egg (2008), "Commerce du Mil en Afrique de l'Ouest: Les Frontières Abolies? » Paper prepared for CERDI Conference on "Intégration des Marchés et Sécurité Alimentaire dans les Pays en Développement, 3-4 November, Université d'Auvergne, Clermont-Fd, France

Azam, Jean-Paul (2007), *Trade, Exchange Rate and Growth in Sub-Saharan Africa* Cambridge, UK: Cambridge University Press.

Campell, Donald T. (1969), "Reforms as Experiments," *American Psychologist* 24: 409 – 429.

Ceglowski, Janet, 2003, "The Law of One Price: Intranational Evidence for Canada," *Canadian Journal of Economics*, vol. 36, no. 2, pp. 373 – 400.

Charlick, Robert 1991, *Niger: Personal Rule and Survival in the Sahel*, Westview Press: Boulder, Colorado.

Collins, D. J. (1974), "The Clandestine Movement of Groundnuts Across the Nigeria-Niger Border," Canadian Journal of African Studies 10(2): 259-76.

Crucini, Mario, Mototsugu Shintani, and Takayuki Tsuruga. 2008. "The Law-of-One-Price Without the Border: The Role of Geography Versus Sticky Prices," Mimeo, Vanderbilt University.

Crucini, Mario, Chris Telmer and Marios Zachariadis, 2005. "Price Dispersion : The Role of Borders, Distance and Location." mimeo, Vanderbilt Unviersity.

Daubrée, C. (1994), *Marchés Parallèles et Equilibres Economiques: Expériences Africaines*. Paris: L'Harmattan.

Charles Engel and John Rogers, "How Wide is the Border?" *American Economic Review*, Dec. 1996, vol. 86, no. 5, pp. 1112 – 1125.

Feyrer, James, "Trade and Growth – Exploiting the Time Series Dimension," mimeo, Dartmouth College Economics Department, December 2008.

Jeffrey Frankel and David Romer, "Does Trade Cause Growth?" *American Economic Review*, vol. 89, no. 3, 1999, pp. 379 – 399.

Gopinath, Gita, Pierre-Olivier Gorinchas, Chang-Tai Hseih, and Nicholas Li, 2008, "Estimating the Border Effect:: Some New Evidence," mimeo.

Gorodnichenko, Yuriy, and Linda Tesar, 2008, "Border Effect or Country Effect? Seattle May Not Be So Far from Vancouver After All," *American Economic Journal: Macroeconomics*, Vol. 1, no. 1, January 2009, pp. 219 – 241.

Hahn, Jinyong, Petra Todd and Wilbert van der Klaaw. "Identification of Treatment Effects by Regression Discontinuity Design." *Econometrica*, 2001,

Hashim, Yahaya and Kate Meager. 1999. Cross-Border Trade and the Parallel Currency Market: Trade and Finance in the Context of Structural Adjustment. A Case Study from Kano, Nigeria.

Holmes, T.J. (1998), "The effects of state policies on the location of industry: Evidence from state borders", *Journal of Political Economy* 106:667—705.

Imbens, Guido and Thomas Lemieux. Regression Discontinuity Designs: A Guide to Practice. *Journal of Econometrics* 142(2): 615–35.

Imbens, Guido and Karthik Kalyanaraman. 2009. "Optimal Bandwidth Choice for the Regression Discontinuity Estimator." NBER Working Paper 14726, Cambridge, MA: NBER.

Limao, Nuno and Anthony J. Venables (2001), "Infrastructure, Geographical Disadvantage, Transport Costs, and Trade," *World Bank Economic Review* 15(3): 451-79.

Lovejoy, P. 1980. *Caravans of Kola: The Hausa Kola Trade, 1700-1900*. Zaria: Ahmadu Bello University Press.

Nichols, Austin. 2007. "Causal Inference with Observational Data."

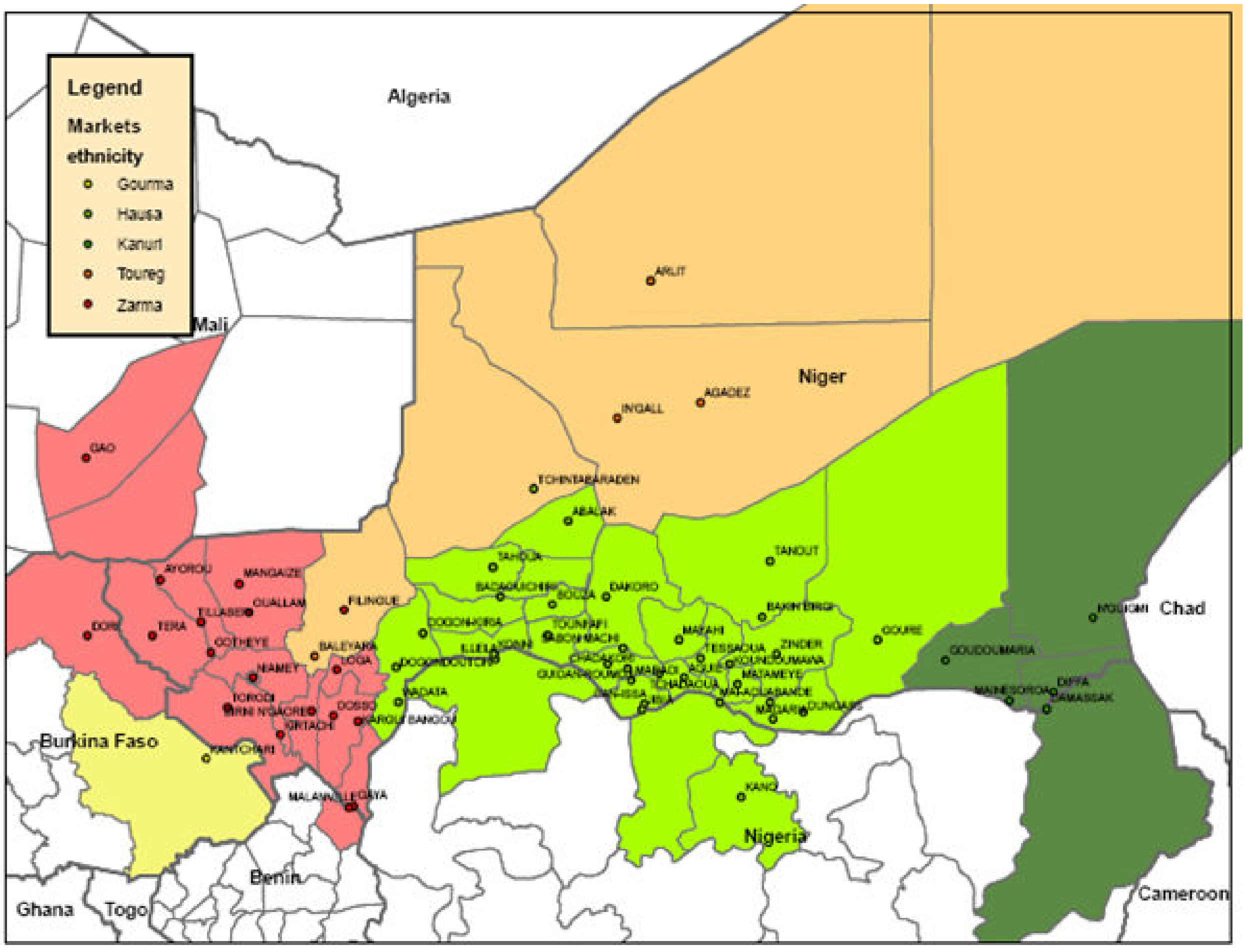
Obstfeld, Maurice and Kenneth Rogoff. 2000. "The Six Major Puzzles in International Macroeconomics: Is There a Common Cause?" NBER Working Paper 7777, NBER Inc.

Oyejide, T. A., E. O. Ogunkola and A. Bankole (2005), "Import Prohibition as a Trade Policy Instrument: The Nigerian Experience," In P. Gallagher, P. Low and A. Stoler, eds, *Managing the Challenges of WTO Participation: 45 Case Studies*. Cambridge, UK: Cambridge University Press.

Parsley, David, and Shang-Jin Wei. 2001. "Explaining the Border Effect: The Role of Exchange Rate Variability, Shipping Costs, and Geography," *Journal of International Economics*, vol. 55, pp. 87 – 105.

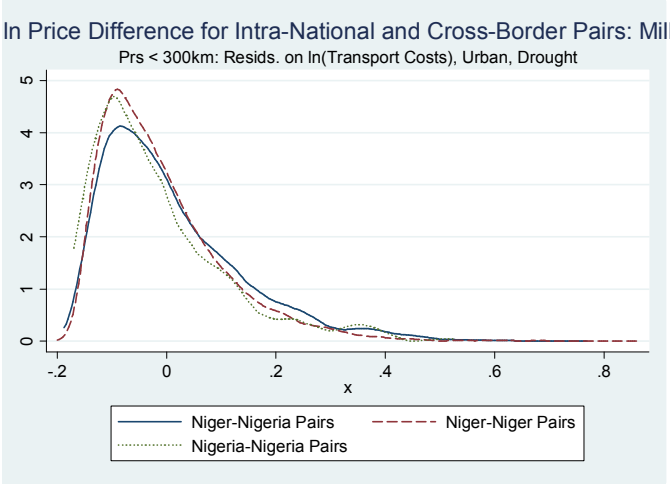
Thistlewaite, Donald L, and Donald T. Campbell (1960), "Regression Discontinuity Analysis: An Alternative to the Ex Post Facto Experiment," *Journal of Educational Psychology* 51: 309 – 17.

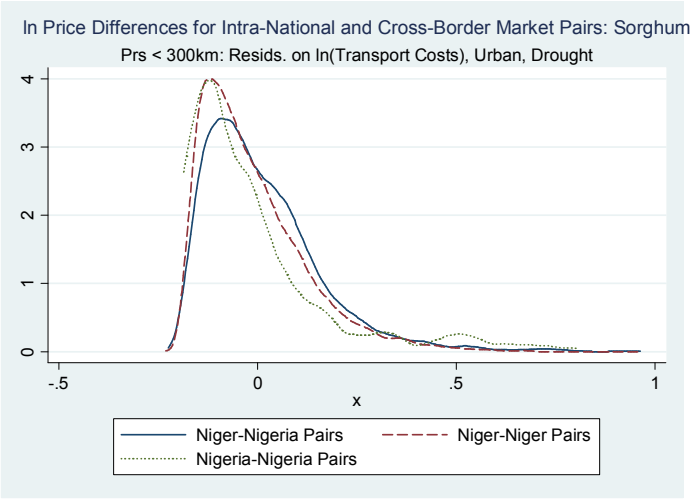
Figure 1. International Borders and Ethnic Groups in Niger and northern Nigeria

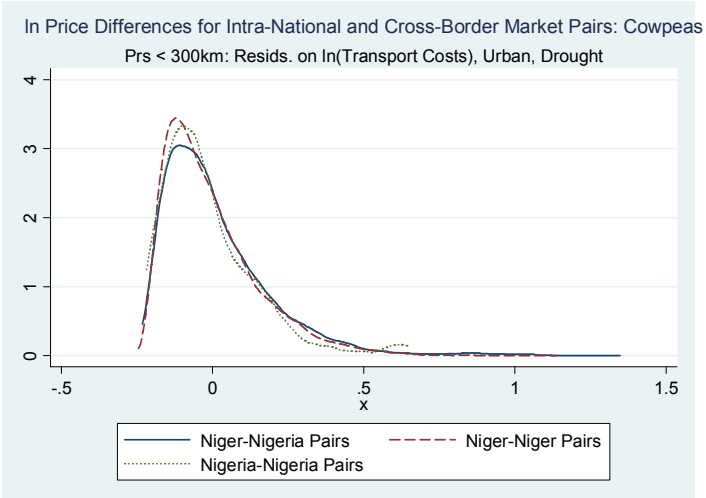


Notes: A map of the ethnic and international borders for Benin, Burkina Faso, Mali, Niger and Nigeria. Created from the authors' household and trader-level data collected between 2005-2007, as well as secondary data for markets in Burkina Faso and Mali.

Figures 2(a)-2(c). Kernel Distributions of Millet, Sorghum and Cowpeas for Niger and Nigeria, 1999-2006







Figures 3(a)-3(c). Kernel Distributions for Niger-Nigeria Market Pairs by Year, 1999-2001

Figure 3a

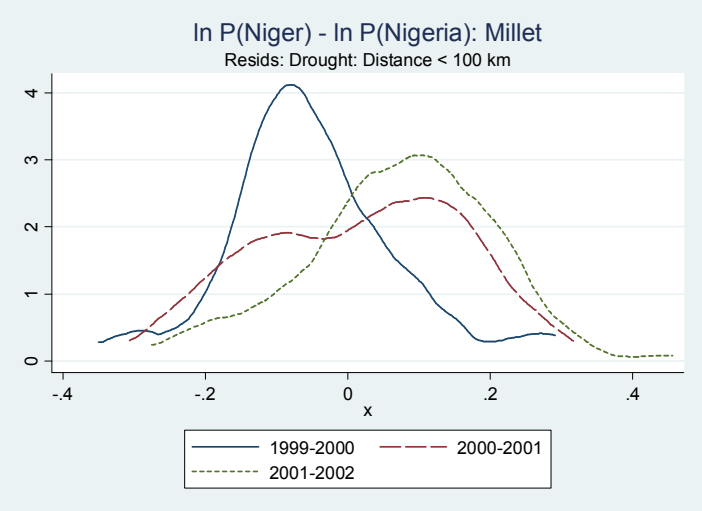


Figure 3b

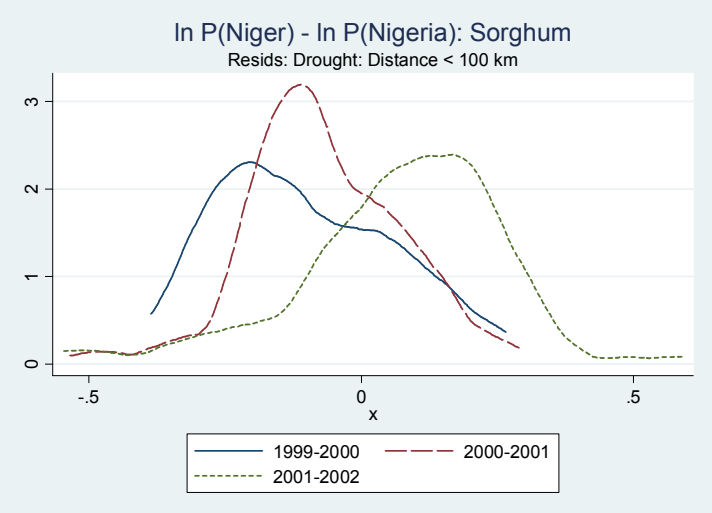
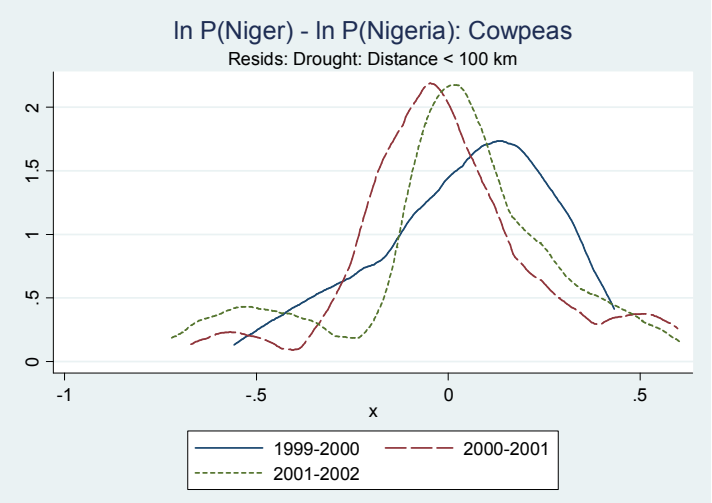


Figure 3c



Figures 4(a)-4(c). Price Discontinuity Across the Niger-Nigeria Border

Figure 4a. Millet

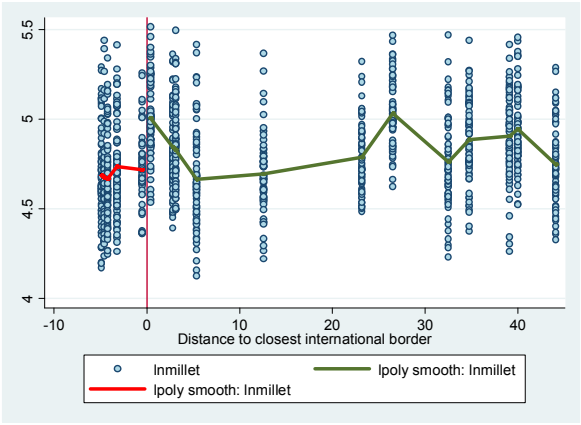


Figure 4b. Sorghum

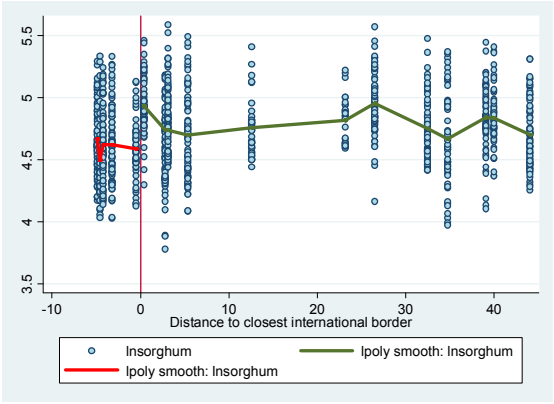
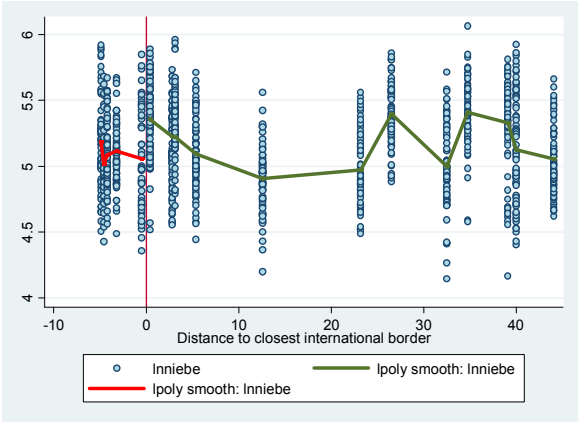


Figure 4c. Cowpeas



Figures 5(a)-5(c). Kernel Distributions for Zarma and Hausa Market Pairs

Figure 5a

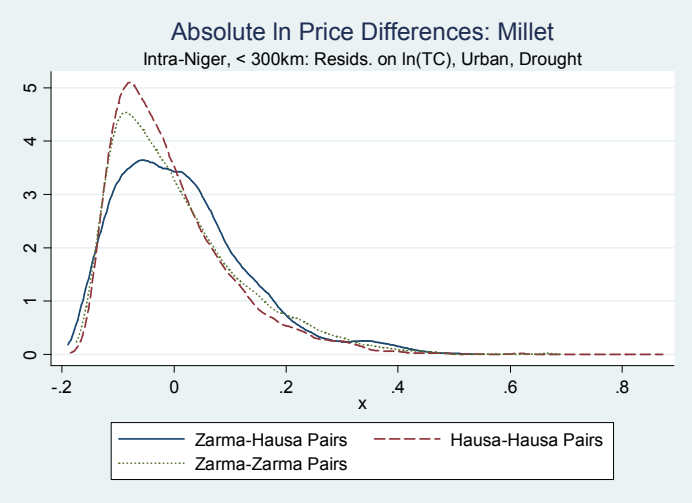


Figure 5b

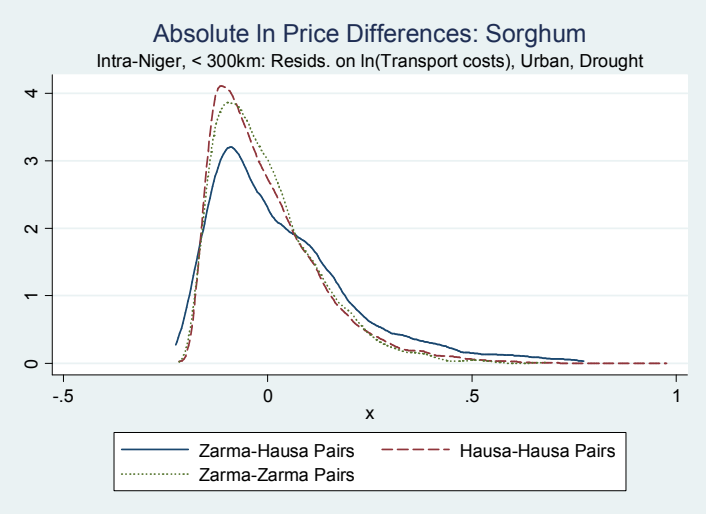
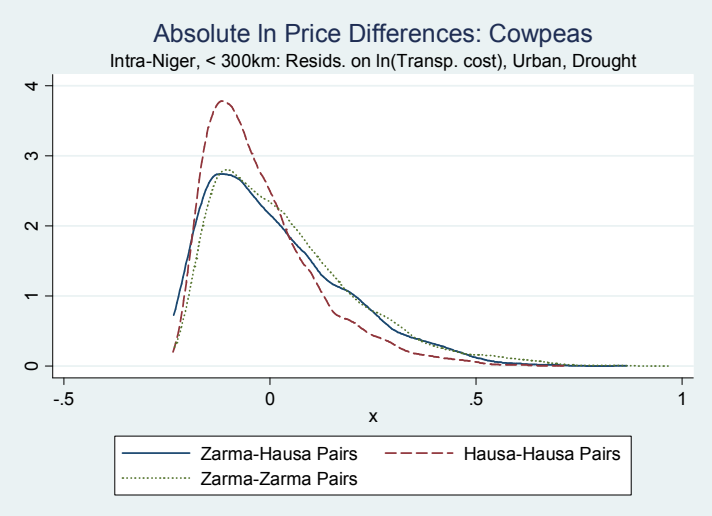


Figure 5c



Figures 6(a), 6(b), 6(c). Price Discontinuity across the Zarma-Hausa Border

Figure 6a. Millet

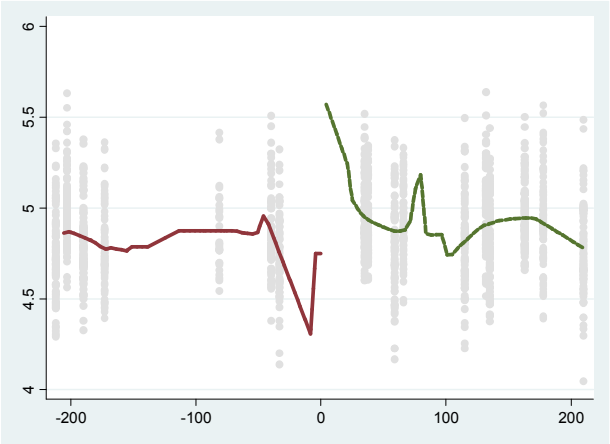


Figure 6b. Sorghum

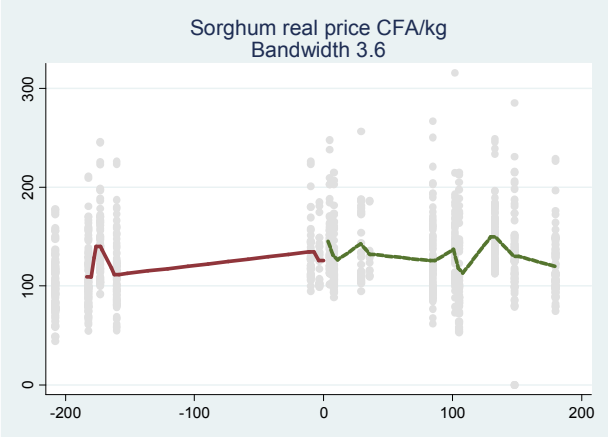


Figure 6c. Cowpea

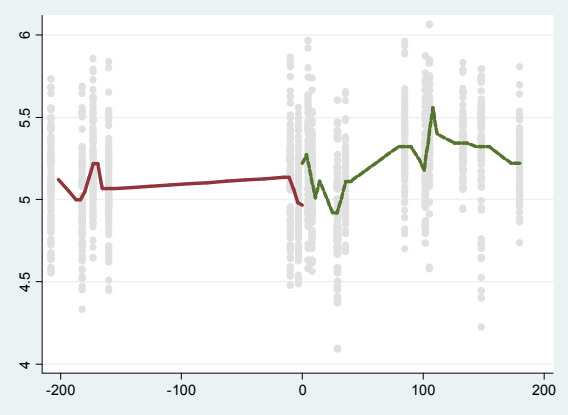


Table 1. Comparison of Observables by Country (Niger-Nigeria)

Observables	Unconditional Mean				Difference in Means
	Niger		Niger-Nigeria		Unconditional
	Mean (s.d.)	Obs	Mean (s.d.)	Obs	s.e.
Panel A. Market Pair Level Data					
Distance between markets (km)	375.29(207)	601	369(271)	10	5.38(65)
Road Quality between markets	.37(.49)	601	.6(.52)	10	-.22(.16)
Cell Phone Coverage (2007)	.89(.32)	601	.6(.52)	10	.29*(.16)
Transport Costs between Markets (CFA/kg)	12.35(6.72)	40704	12.19(6.67)	960	.16(.22)
Panel B. Market Level Data					
Millet Price level (CFA/kg)	124.33(33)		112.96(31)		11.60***(1.83)
Sorghum Price level (CFA/kg)	119(36)		104(34.8)		14.35***(2.04)
Cowpea Price Level (CFA/kg)	173(56)		176 (56)		-3.21(3.36)
Ethnic composition of traders					
Hausa	.58(.51)	29	.8(.447)	9	'-.21(.21)
Zarma	.29(.464)	29	0	9	.29***(.096)
Kanuri	.08(.27)	29	.2 (.447)	9	-.12(.19)
Road Quality to Market	.71(.46)	29	.75(.5)	9	.041(.25)
Market Size	105.08(90)	29	176.75(149)	9	'-71.66(69)
Cell Phone Coverage (2007)	.95(.020)	29	.8(.447)	9	.158(.19)
Drought between 1999-2007	.027(.162)	2780	.025(.156)	480	.002(.007)
Urban center(>=35,000)	.35(.49)	29	0.8 (.45)	9	.45*(.21)

Notes: Data from secondary sources and the the Niger trader survey collected by the authors. In Panel A, "Niger" market pairs are pairs where both markets are located in Niger (within 150 km of the Nigerian border), Niger-Nigeria market paris are cross-border. Huber-White robust standard errors clustered by market pair-month (Panel A) and by market-month (Panel B) are in parentheses.

* is significant at the 10% level, ** significant at the 5% level *** is significant at 1% level.
Prices are deflated by the Nigerien Consumer Price Index.

Table 2. Estimated International Border Effects

	Millet				Sorghum				Cowpea			
Dependent variable: |ln (Pit/Pjt)|	**(1)**	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**
	.026***	.026***	.026***	.030***	.023***	.021***	.024***	.024***	.029***	.029***	.029***	.044***
Niger-Nigeria border	(.002)	(.002)	(.002)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
	.045***	.045***	.045***	.045***	.036***	.036***	.036***	.036***	.063***	.063***	.063***	.063***
Transport Costs	(.002)	(.002)	(.002)	(.002)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
	.004	.004	.004	.004	.046***	.045***	.045***	.046***	-.040***	-.040***	-.040***	-.036***
Drought Dummy	(.007)	(.007)	(.007)	(.007)	(.011)	(.011)	(.011)	(.011)	(.009)	(.009)	(.009)	(.009)
	-.009***	-.009***	-.009***	-.009***	-.008***	-.008***	-.008***	-.008***	-.009***	-.009***	-.009***	-.011***
Urban status	(.001)	(.001)	(.001)	(.001)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
		.002				.001						
Niger Market		(.008)				(.011)						
			-.002				-.001				-.006	
Nigeria Market			(.008)				(.011)				(.010)	
				-.0005				-.015***				-.019***
Cell Phone Coverage				(.002)				(.003)				(.003)
				-.011**				.008				-.033***
Border*Cell Phone Coverage				(.004)				(.005)				(.006)
Constant												
Market-Pair Fixed effects	No	No	No	No	No	No	No	No	No	No	No	No
Monthly time dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of observations	21460	21460	21460	21460	15662	15662	15662	15662	20421	20421	20421	20421
# of cross-sectional observations												
R^2	0.0797	0.0797	0.0897	0.0801	0.108	0.1081	0.1081	0.1091	0.1036	0.1036	0.1036	0.1079
				-.021***				'-.007				-.051***
Joint Effect of Cell Phones and Interaction				(.008)				(.005)				(.006)
				-.011**				.016				-.065***
Joint Effect of Border and Interaction				(.004)				(.011)				(.012)

Notes: Data from the Niger trader survey and secondary sources collected by the author. For market pairs, cell phone dummy =1 in period *t* when both markets have cell phone coverage, 0 otherwise. Drought dummy=1 in period *t* when one market in a pair has rainfall less than or equal to 2 standard deviations below its average rainfall level during the rainy season, or 15 consecutive days without rainfall during the rainy season, 0 otherwise. Urban status =1 if one market in a pair is an urban center (>=35,000 people), 0 if both or neither are urban centers. Huber-White robust standard errors clustered by market pair-month (price difference) are in parentheses. * is significant at the 10% level, ** significant at the 5% level, *** is significant at the 1% level. All prices are deflated by the Nigerien Consumer Price Index (CPI).

Table 3. Estimated Internal Border Effects

	Millet				Sorghum				Cowpea			
Dependent variable: |ln (Pit/Pjt)|	**(1)**	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**
	.056***	.061***	.043***	.052***	.026***	.024***	.037***	.026***	.047***	.060***	.018***	.037***
Hausa-Zarma Border	(.006)	(.006)	(.006)	(.007)	(.003)	(.003)	(.004)	(.003)	(.006)	(.006)	(.01)	(.01)
	.041***	.040***	.040***	.040***	.053***	.052***	.052***	.052***	.060***	.060***	.060***	.060***
Transport Costs	(.003)	(.003)	(.003)	(.003)	(.002)	(.002)	(.002)	(.002)	(.003)	(.003)	(.003)	(.003)
	.009	.011	.011	.009	.022**	.022**	.022**	.022**	-.024**	-.023**	-.023**	-.024**
Drought Dummy	(.011)	(.010)	(.010)	(.011)	(.010)	(.010)	(.010)	(.010)	(.011)	(.011)	(.011)	(.011)
	-.006***	-.006***	-.006***	-.006***	.009***	.009***	.009***	.009***	-.007**	-.007**	-.007**	-.006**
Urban status	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.003)	(.002)
		-.018***				.012***				-.041***		
Hausa Market		(.002)				(.003)				(.003)		
			.018***				.012***				.041***	
Zarma Market			(.002)				(.003)				(.003)	
				-.012***				-.017***				-.044***
Cell Phone Coverage				(.003)				(.003)				(.004)
				.019				.004				.052***
Border*Cell Phone Coverage				(.016)				(.005)				(.014)
Constant												
Market-Pair Fixed effects	No	No	No	No	No	No	No	No	No	No	No	No
Monthly time dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of observations												
# of cross-sectional observations	10829	10829	10829	10829	26262	26262	26262	26262	13195	13195	13195	13195
R^2	0.0873	0.0935	0.0935	0.0844	0.2362	0.2362	0.2362	0.2371	0.1176	0.1329	0.1329	0.1248
				.007				-.013***				.007
Joint Effect of Cell Phones and Interaction				(.016)				(.004)				(.014)
				.071***				.029***				.090***
Joint Effect of Border and Interaction				(.014)				(.004)				(.012)

Notes: Data from the Niger trader survey and secondary sources collected by the author. For market pairs, cell phone dummy =1 in period *t* when both markets have cell phone coverage, 0 otherwise. Drought dummy=1 in period *t* when one market in a pair has rainfall less than or equal to 2 standard deviations below its average rainfall level during the rainy season, or 15 consecutive days without rainfall during the rainy season, 0 otherwise. Urban status =1 if one market in a pair is an urban center (>=35,000 people), 0 if both or neither are urban centers. Huber-White robust standard errors clustered by market pair-month (price difference) are in parentheses. * is significant at the 10% level, ** significant at the 5% level, *** is significant at the 1% level. All prices are deflated by the Nigerien Consumer Price Index (CPI).

Table 4. Comparison of Observables by Ethnicity (Within Niger)

Observables	Unconditional Mean				Difference in Means
	Hausa		Zarma		Unconditional
	Mean (s.d.)	Obs	Mean (s.d.)	Obs	s.e.
Panel A. Market Pair Level Data					
Distance between markets (km)	234.08(134)	210	216.42(161)	68	17.66(21.54)
Road Quality between markets	.43(.49)	210	.41(.49)	68	.02(.07)
Cell Phone Coverage	.81(.39)	210	.98(.12)	68	-.17***(.03)
Transport Costs between Markets (CFA/kg)	8.08(4.34)	20160	7.54(5.06)	6528	.53***(.07)
Panel B. Market Level Data					
Millet Price level (CFA/kg)	123.23(30)	921	139.01(32)	744	-15.77***(1.56)
Sorghum Price level (CFA/kg)	112.84(32)	691	134.82(36)	635	-21.98***(1.90)
Cowpea Price Level (CFA/kg)	162.58(48.9	717	197.94(55)	908	-35.37***(2.60)
Road Quality to Market	.87(.35)	8	.6(.52)	10	.28(.21)
Market Size	107.63(86)	8	70.1(50)	10	37.53(34.43)
Cell Phone Coverage (2007)	.43(.50)	768	.35(.48)	960	.08***(.02)
Drought between 1999-2007	.031(.174)	768	.031(.174)	960	-.0000(.008)
Urban center(>=35,000)	.5(.53)	8	.4(.52)	10	.1(.25)

Notes: Data from secondary sources and the the Niger trader survey collected by the authors. In Panel A, "Hausa" market pairs are pairs where both markets are located in Hausa regions of Niger; "Zarma" market pairs are those pairs where both markets are located in the Zarma region of Niger. In Panel B, "Hausa" markets are markets with a majority of Hausa traders within Niger, and "Zarma" markets are markets with a majority of Zarma traders within Niger. Huber-White robust standard errors clustered by market pair-month (Panel A) and by market-month (Panel B) are in parentheses. * is significant at the 10% level, ** significant at the 5% level, *** is significant at the 1% level. Prices are deflated by the Nigerien Consumer Price Index. The Kolmogorov-Smirnov test tests for the equality of the distribution functions.

Table 4. Estimated Internal Border Effects

	Millet				Sorghum				Cowpea			
Dependent variable: |ln (Pit/Pjt)|	**(1)**	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**
Hausa-Zarma Border	.056*** (.006)	.061*** (.006)	.043*** (.006)	.052*** (.007)	.026*** (.003)	.024*** (.003)	.037*** (.004)	.026*** (.003)	.047*** (.006)	.060*** (.006)	.018*** (.01)	.037*** (.01)
Transport Costs	.041*** (.003)	.040*** (.003)	.040*** (.003)	.040*** (.003)	.053*** (.002)	.052*** (.002)	.052*** (.002)	.052*** (.002)	.060*** (.003)	.060*** (.003)	.060*** (.003)	.060*** (.003)
Drought Dummy	.009 (.011)	.011 (.010)	.011 (.010)	.009 (.011)	.022** (.010)	.022** (.010)	.022** (.010)	.022** (.010)	-.024** (.011)	-.023** (.011)	-.023** (.011)	-.024** (.011)
Urban status	-.006*** (.002)	-.006*** (.002)	-.006*** (.002)	-.006*** (.002)	.009*** (.002)	.009*** (.002)	.009*** (.002)	.009*** (.002)	-.007** (.002)	-.007** (.002)	-.007** (.003)	-.006** (.002)
Hausa Market		-.018*** (.002)				.012*** (.003)				-.041*** (.003)		
Zarma Market			.018*** (.002)				.012*** (.003)				.041*** (.003)	
Cell Phone Coverage				-.012*** (.003)				-.017*** (.003)				-.044*** (.004)
Border*Cell Phone Coverage				.019 (.016)				.004 (.005)				.052*** (.014)
Constant												
Market-Pair Fixed effects	No	No	No	No	No	No	No	No	No	No	No	No
Monthly time dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of observations												
# of cross-sectional observations	10829	10829	10829	10829	26262	26262	26262	26262	13195	13195	13195	13195
R^2	0.0873	0.0935	0.0935	0.0844	0.2362	0.2362	0.2362	0.2371	0.1176	0.1329	0.1329	0.1248
Joint Effect of Cell Phones and Interaction				.007 (.016)				-.013*** (.004)				.007 (.014)
Joint Effect of Border and Interaction				.071*** (.014)				.029*** (.004)				.090*** (.012)

Notes: Data from the Niger trader survey and secondary sources collected by the author. For market pairs, cell phone dummy =1 in period *t* when both markets have cell phone coverage, 0 otherwise. Drought dummy=1 in period *t* when one market in a pair has rainfall less than or equal to 2 standard deviations below its average rainfall level during the rainy season, or 15 consecutive days without rainfall during the rainy season, 0 otherwise. Urban status =1 if one market in a pair is an urban center (>=35,000 people), 0 if both or neither are urban centers. Huber-White robust standard errors clustered by market pair-month (price difference) are in parentheses. * is significant at the 10% level, ** significant at the 5% level, *** is significant at the 1% level. All prices are deflated by the Nigerien Consumer Price Index (CPI).