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

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December 12, 2009
Gates Africa Meeting

Motivation

- International borders can affect trade flows and price dispersion
- Border effects found in high-income countries
- In West Africa, intra-national market segmentation may be more pronounced
  - Limited infrastructure (roads, distances)
  - Corruption and transaction costs
  - Countries comprised of ethno-linguistic groups corresponding to different regions within country

Niger and Nigeria

This Paper

- Goal: Assess the extent to which borders impose costs that segment markets between Niger and Nigeria
  - Determine the impact of the Niger–Nigeria border on price dispersion for agricultural products
  - Identify the mechanisms that can mitigate or exacerbate border effects
- Three datasets

Preview of Findings

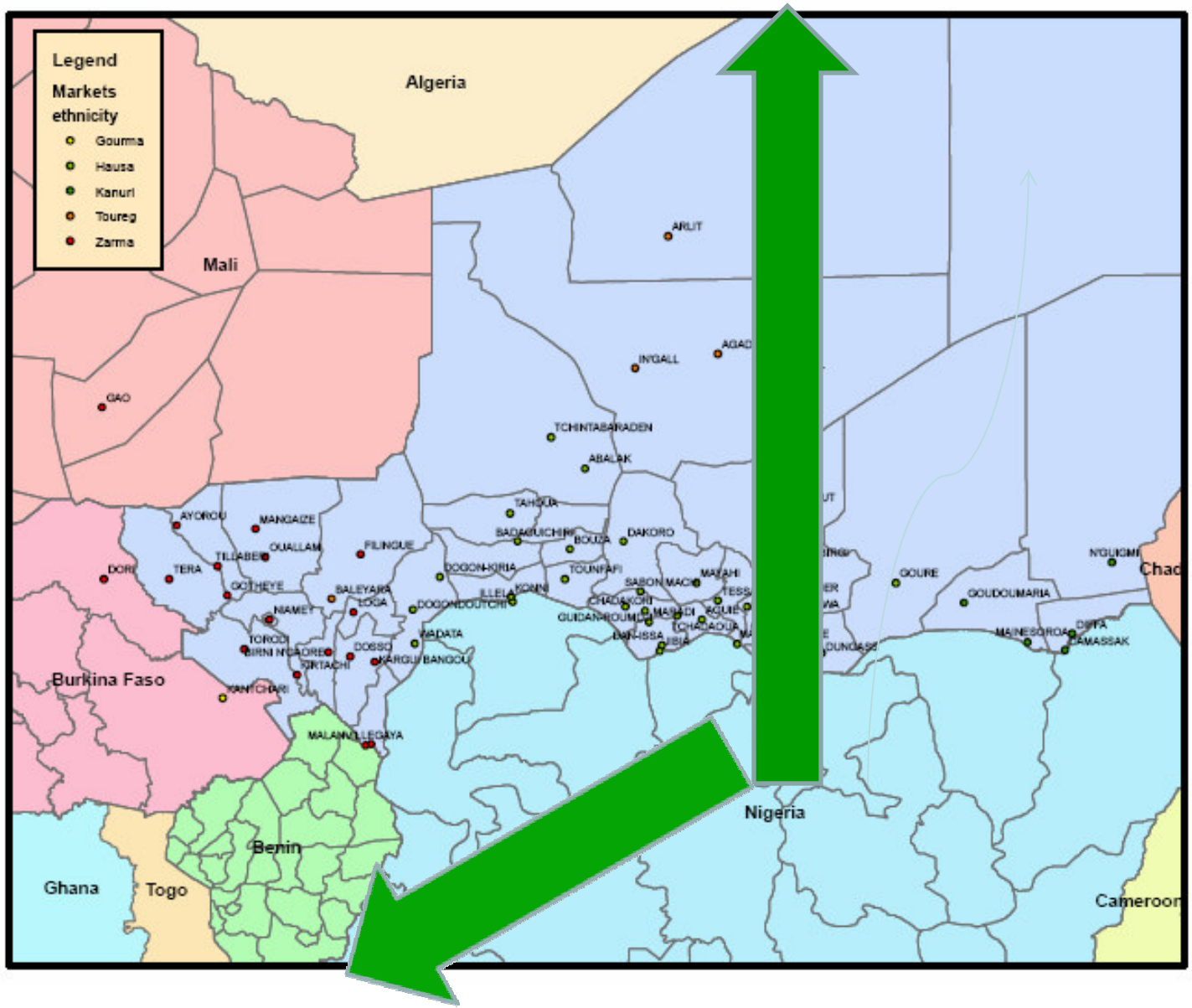
- International borders matter, but they don't deter trade in the Niger-Nigeria sub-region.
  - Common ethnicity across borders appears to reduce the international border effect

- There is a statistically significant border effect along ethnic lines *within* Niger.
  - Differences regarding the role of women and the importance of social networks for providing credit

Borders and Agricultural Trade

- Borders were drawn to reflect interests of colonial powers.
  - Berlin Conference (1884/5) starts "scramble for Africa"
  - 1890 – French (expanding from Senegal and Algeria) and British (expanding north from southern Nigeria) established Niger's southern border.
  - Borders passed through political, ethnic, and economic groupings

Borders and Agricultural Trade



Commodity Markets in Niger and Nigeria

Background on Borders and Trade in West Africa

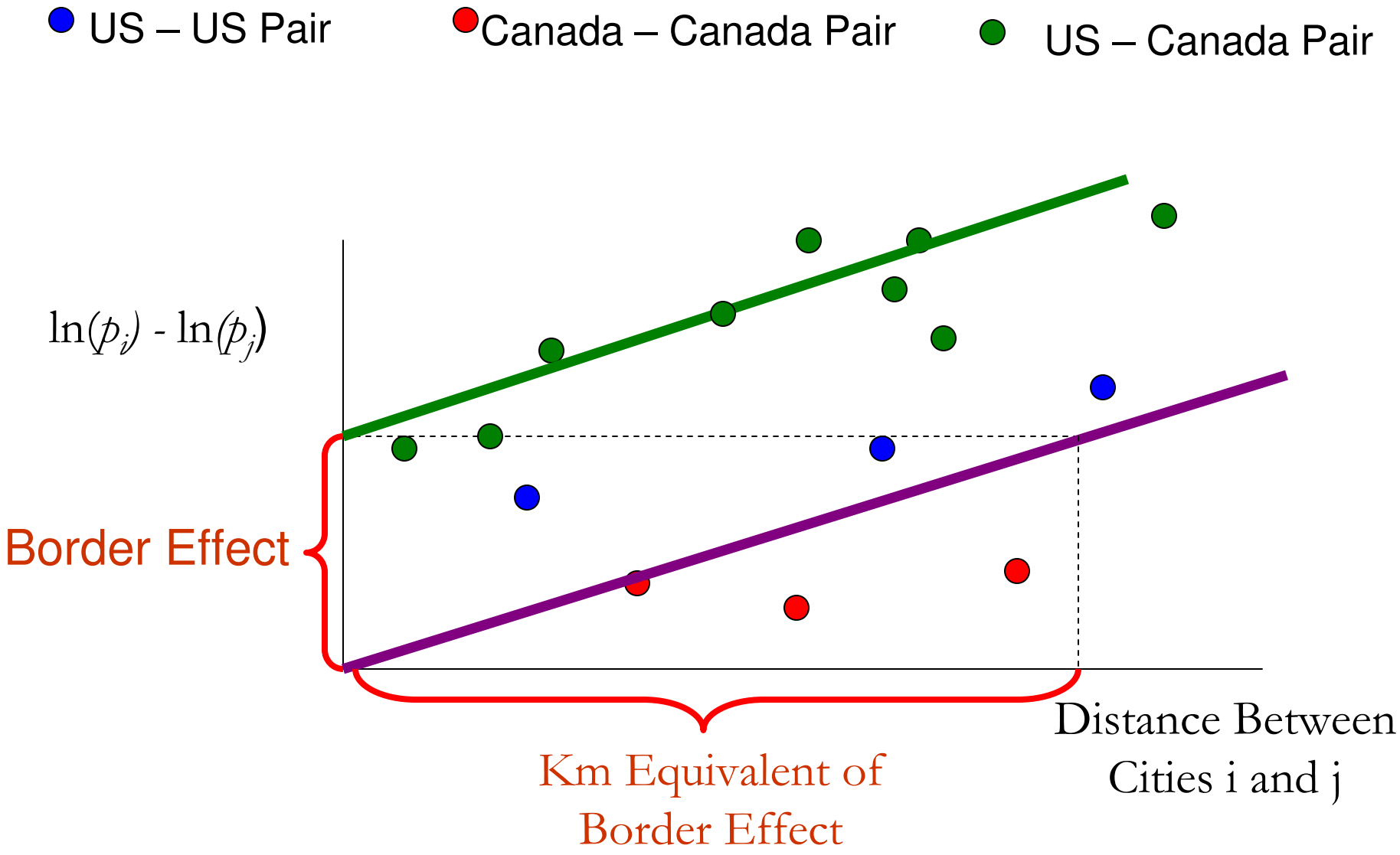
- West African Economic and Monetary Union (UEMOA)
  - Customs and monetary union in 1994
  - Common external tariff (CET) in 1998
- Economic Community of West African States (ECOWAS)
  - Created in 2001
  - Harmonize their import tariffs with UEMOA CET in 2007
- Niger-Nigeria Joint Commission (1971)

Related Research

- Engel & Rogers *AER* 1996,
- Prices in US and Canadian Cities, Parsley and Wei *JIE* 2001, Prices in Japan and US.
- Ceglowski, *CJE* 2003, Intra-national price comparisons in Canada.
- Gorodnichenko and Tesar, *AEJ-Macro* 2009
- Gopinath, Gourinchas, Hsieh, and Li, 2009, RDD approach for supermarket prices in western US & Canada.

Engel & Rogers Methodology

Border effect as km-equivalent



Gorodnichenko & Tesar (2009)

- Engel & Rogers method overstates role of border if differences in price volatility in the two countries. (e.g. Parsley and Wei US-Japan border effect is 43,000 trillion miles)
- Price dispersion between the two countries exists because low-volatility Canadians trading with high-volatility Americans.
- Border effect under-identified: Cannot have dummy variables for US-US pairs, Canada-Canada pairs and border (i.e. US-Canada) pairs due to multicollinearity.

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Empirical Strategy

- Part I: Regression-based estimates of the border effect across market pairs within and across countries.

- Part II: Regression Discontinuity Design: As distance to the border shrinks to zero, is there a price change at the border?

Data Sets

- Market-Level Panel Data on prices, costs, other characteristics
- Market Locations and Distances between markets (road and Euclidean)
- Trader and farmer-level datasets

Market-Level Panel Dataset

- Monthly prices for agricultural products in 65 markets in Niger and northern Nigeria between 1999-2007
- Market-level rainfall statistics
- Monthly gasoline prices
- Urban status
- Date of mobile phone coverage in each market
- Monthly CFA-Naira exchange rates

Data on Market Locations and Distances

- GIS (latitude and longitude location) of each market
- Road and Euclidean distances between each set of market pairs

Trader-Level Data

- Panel survey of markets, traders and farmers collected between 2005-2007 across 6 regions of Niger and in cross-border markets
  - Traders' demographic characteristics and marketing behavior
  - Number of traders operating per market
  - Market-level institutional characteristics

- Ethnolinguistic mapping of villages by SIL/Niger (1998)

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

Observables	Unconditional Mean (Northern) Niger Mean (s.d.)	Nigeria Mean (s.d.)	Difference in Mean Unconditional s.e.
Panel A. Market Pair Level Data			
Distance between markets (km)	375.29(207)	369(271)	5.38(65)
Road Quality between markets	.37(.49)	.6(.52)	-.22(.16)
Cell Phone Coverage (2007)	.89(.32)	.6(.52)	.29*(.16)
Transport Costs between Markets (CFA/kg)	12.35(6.72)	12.19(6.67)	.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)	.8(.447)	'-.21(.21)
Zarma	.29(.464)	0	.29***(.096)
Kanuri	.08(.27)	.2 (.447)	-.12(.19)
Road Quality to Market	.71(.46)	.75(.5)	.041(.25)
Market Size	105.08(90)	176.75(149)	'-71.66(69)
Cell Phone Coverage (2007)	.95(.020)	.8(.447)	.158(.19)
Drought between 1999-2007	.027(.162)	.025(.156)	.002(.007)
Urban center(>=35,000)	.35(.49)	0.8 (.45)	.45*(.21)

Empirical Strategy

$$|\ln(p_{i,t}/p_{j,t})| = \beta_1 d_{ij} + \beta_2 B_{ij} + \Sigma\beta_x X_{ij,t} + a_i + a_j + \varepsilon_{ijt}$$

- d_{ij} is the distance between markets i and j
- B_{ij} is a dummy variable for the presence of an international border between two markets
- $X_{ij,t}$ is a vector of other exogenous covariates
- θ_t is time fixed effects
- a_i and a_j are market-specific fixed effects
- Use dyadic standard errors

The International Border Effect

Table 2. Average International Border Effect

	Millet					
Dependent variable: $\|\ln(P_{it}/P_{jt})\|$	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Niger-Nigeria border	.021*** (.003)	.025*** (.003)	.025*** (.003)	.032*** (.007)	.018*** (.002)	.024*** (.003)
Niger Market Pair			.007 (.008)			
Nigeria Market Pair				-.007 (.008)		
Inter-ethnic						.014*** (.003)
Inter-ethnic*border						.019*** (.007)
Constant	.141*** (.005)	.095*** (.003)	.052*** (.006)	.095*** (.003)	.038*** (.006)	.097*** (.003)
Other covariates	No	Yes	Yes	Yes	Yes	Yes
Market-Specific Fixed Effects	No	No	Yes	No	Yes	No
Monthly time dummy	Yes	Yes	Yes	Yes	Yes	Yes
# of observations	23760	23760	23760	23760	23760	23760
Dyadic s.e.	0.005	0.005	0.005	0.005	0.006	0.006
R^2	0.0109	0.0505	0.1609	0.0831	0.2956	0.086
Joint effect (different) ethnicity						.034*** (.007)
Joint effect border						.044*** (.007)

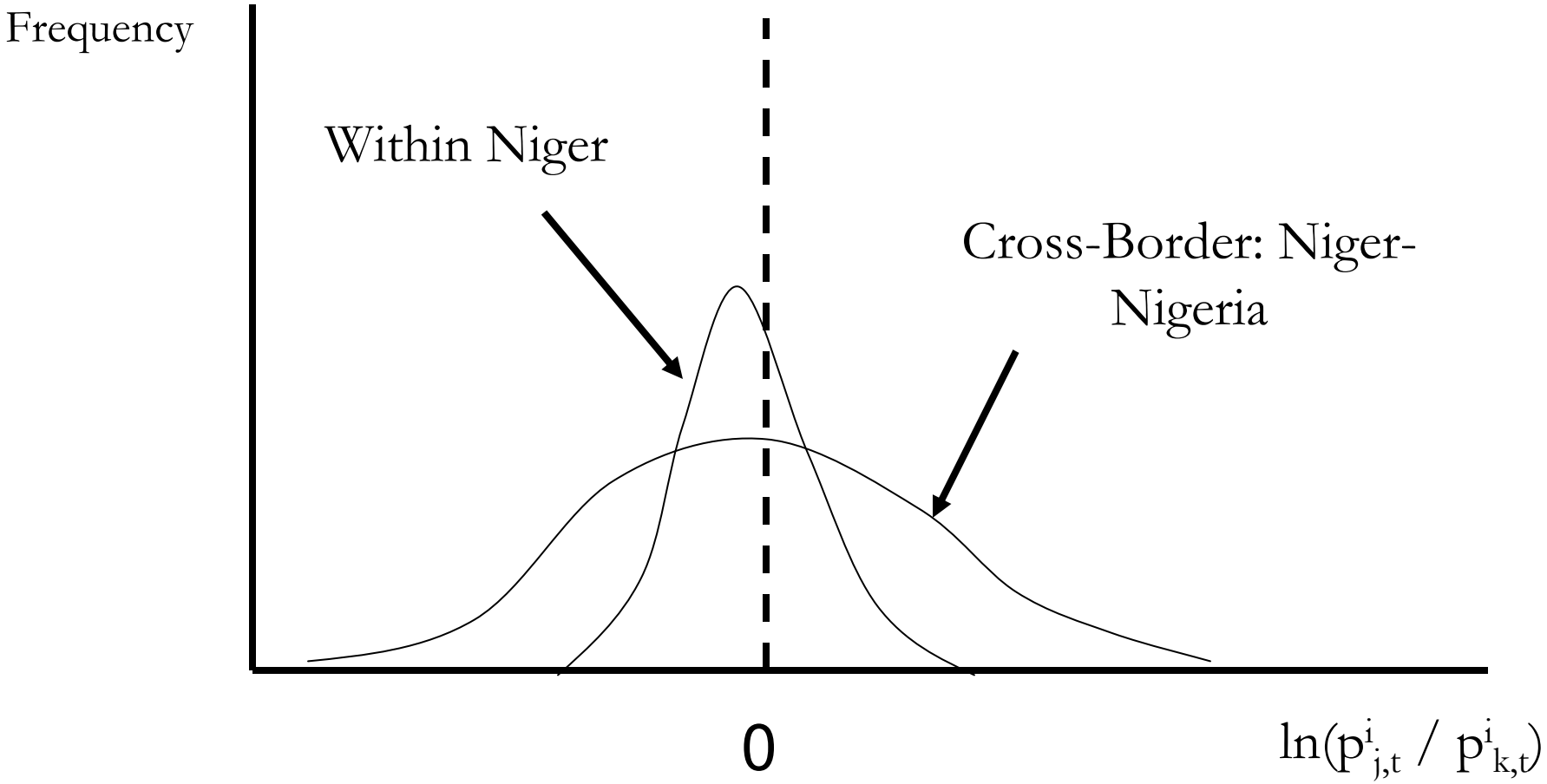
Km-equivalent border effect is only 5 km

Threats to Identification

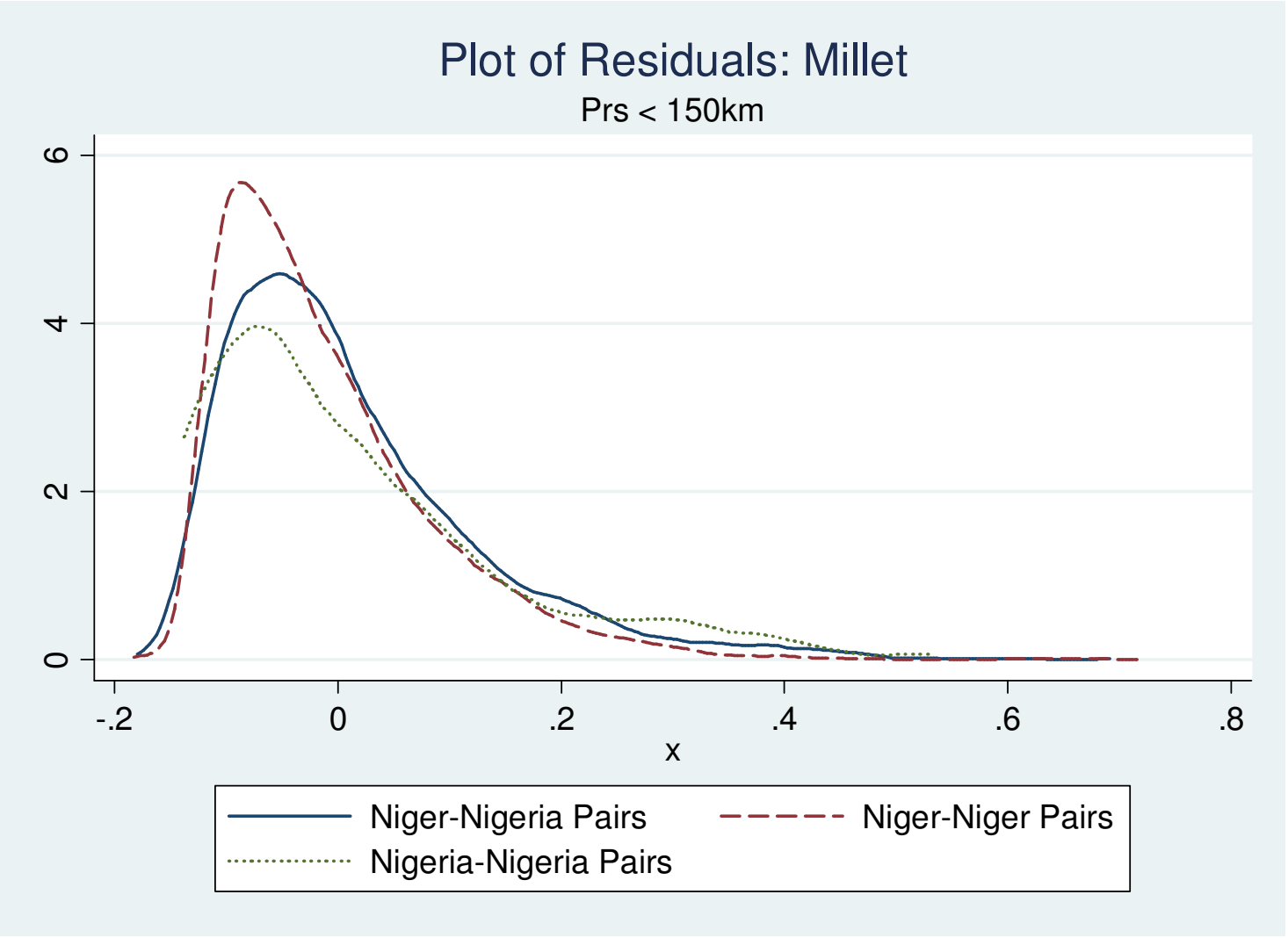
- Different price volatilities in each country
- Market segmentation
- Endogeneity of border effect

Different price volatilities

Plot of ε_{ijt} from regressions



Millet


Plot of Residuals: Millet
Prs < 150km
0
2
4
6
-.2
0
.2
.4
.6
.8
x
Niger-Nigeria Pairs
Niger-Niger Pairs
Nigeria-Nigeria Pairs

Threats to Identification

- Different price volatilities in each country
- Market segmentation
- Endogeneity of border effect

Is There Trade Across the Border?

Table 6: Difference in Trader-Level Characteristics between Niger and northern Nigeria

	Niger		Nigeria		Coefficient	S.e.
	Mean	s.d.	Mean	s.d.		
Trading Behavior						
Number of markets followed	4.35	3.90	5.29	2.21	-0.93	0.84
Number of market contacts	4.24	3.89	5.00	5.59	-0.76	2.12
Number of purchase and sales markets	4.36	2.85	5.38	1.92	-1.01	0.68
Trade in cross-border markets within a 50-km radius	0.27	0.22	0.55	0.07	-0.28**	0.05
Quantity traded in 2005/2006	12936	59696	10025	14106	-2911	36096

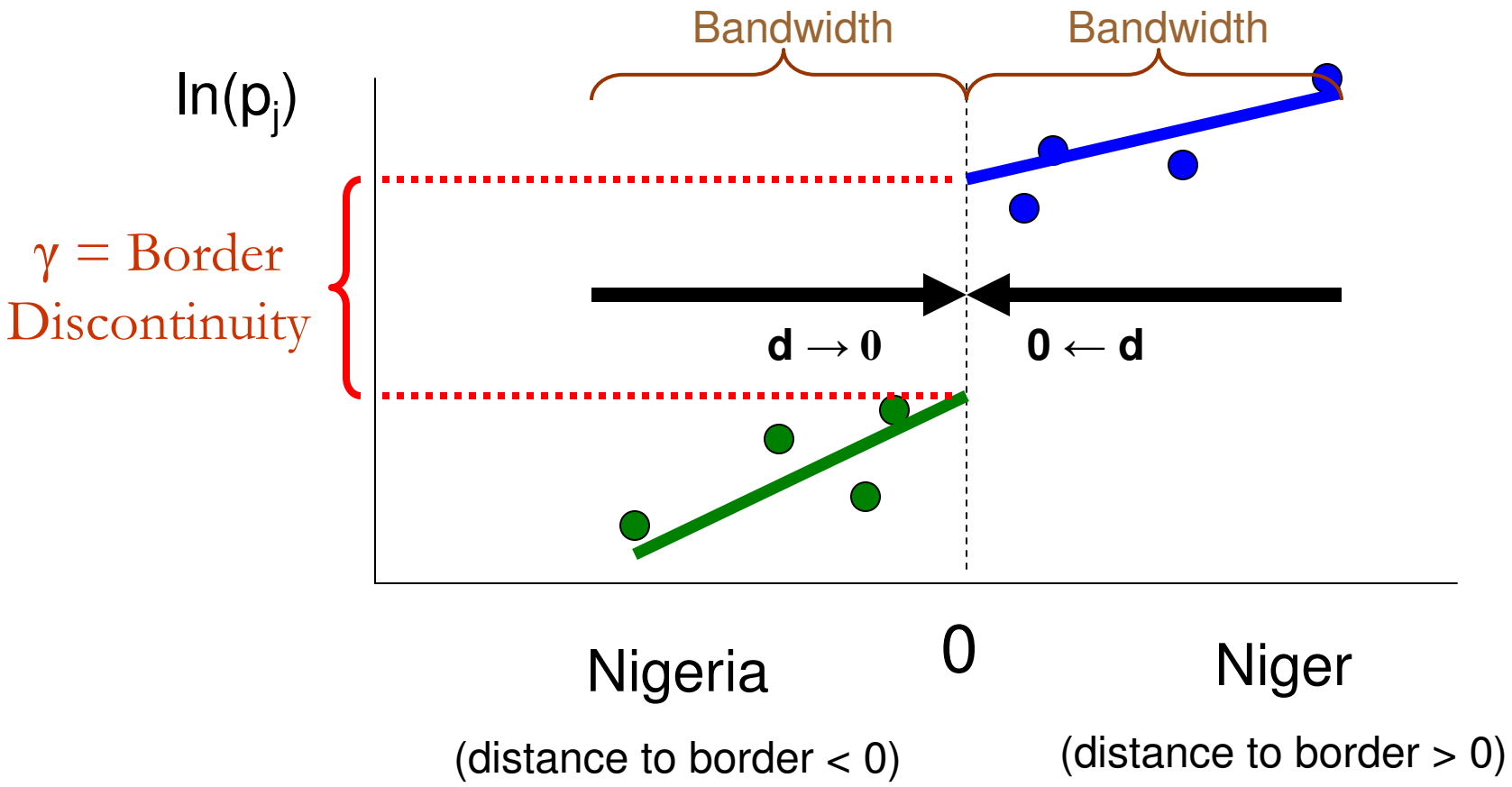
Notes: Data from the Niger trader survey and secondary sources collected by Aker. N=415 traders, 37 markets. Huber-White robust standard errors are in parentheses. * is significant at the 10% level, ** significant at the 5% level, *** is significant at the 1% level.

Threats to Identification

- Different price volatilities in each country
- Market segmentation
- Endogeneity of border effect

Regression Discontinuity

1. Is there a discontinuity in prices across the border?
2. Does Distance to the border matter?
3. Is the discontinuity related to other factors?
4. What is the relevant range for comparison?



Regression Discontinuity

- Is there a discontinuous change in price with respect to distance to the border?
- Price at time *t*, of good *i* in market *j*:

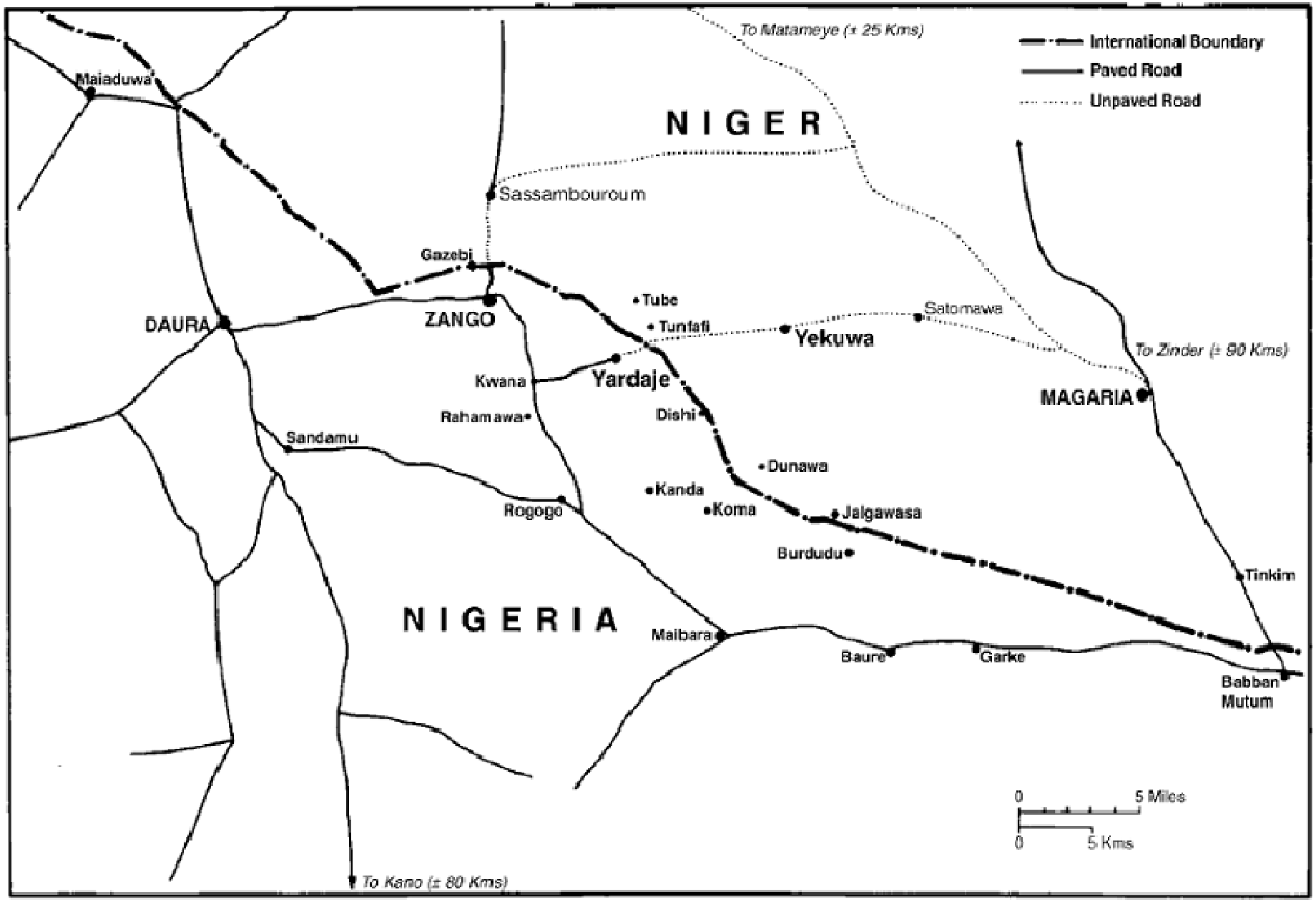
$$\ln(p^i_{j,t}) = \alpha^i + \gamma^i N_j + \theta^i D_j + \delta D_j * N_j + \beta X_j + \varepsilon^i_j$$

N_j=1 if market in Niger, 0 if in Nigeria

D_j is distance of market *j* from the border, >0 for markets within Niger and <0 for cross-border markets

X_j other market-specific variables

Local linear regression


To Matameye (± 25 Kms)
International Boundary
Paved Road
Unpaved Road
NIGER
Maiaduwa
Sassambouroum
Gazebi
Tube
ZANGO
DAURA
Tunfafi
Satomawa
Yekuwa
To Zinder (± 90 Kms)
Kwana
Yardaje
MAGARIA
Rahamawa
Dishi
Sandamu
Dunawa
Kanda
Koma
Jalgawasa
Rogogo
Burdudu
Tinkim
NIGERIA
Maibara
Baure
Garke
Babban
Mutum
0
5 Miles
0
5 Kms
To Kano (± 80 Kms)

Is the discontinuity related to other factors?

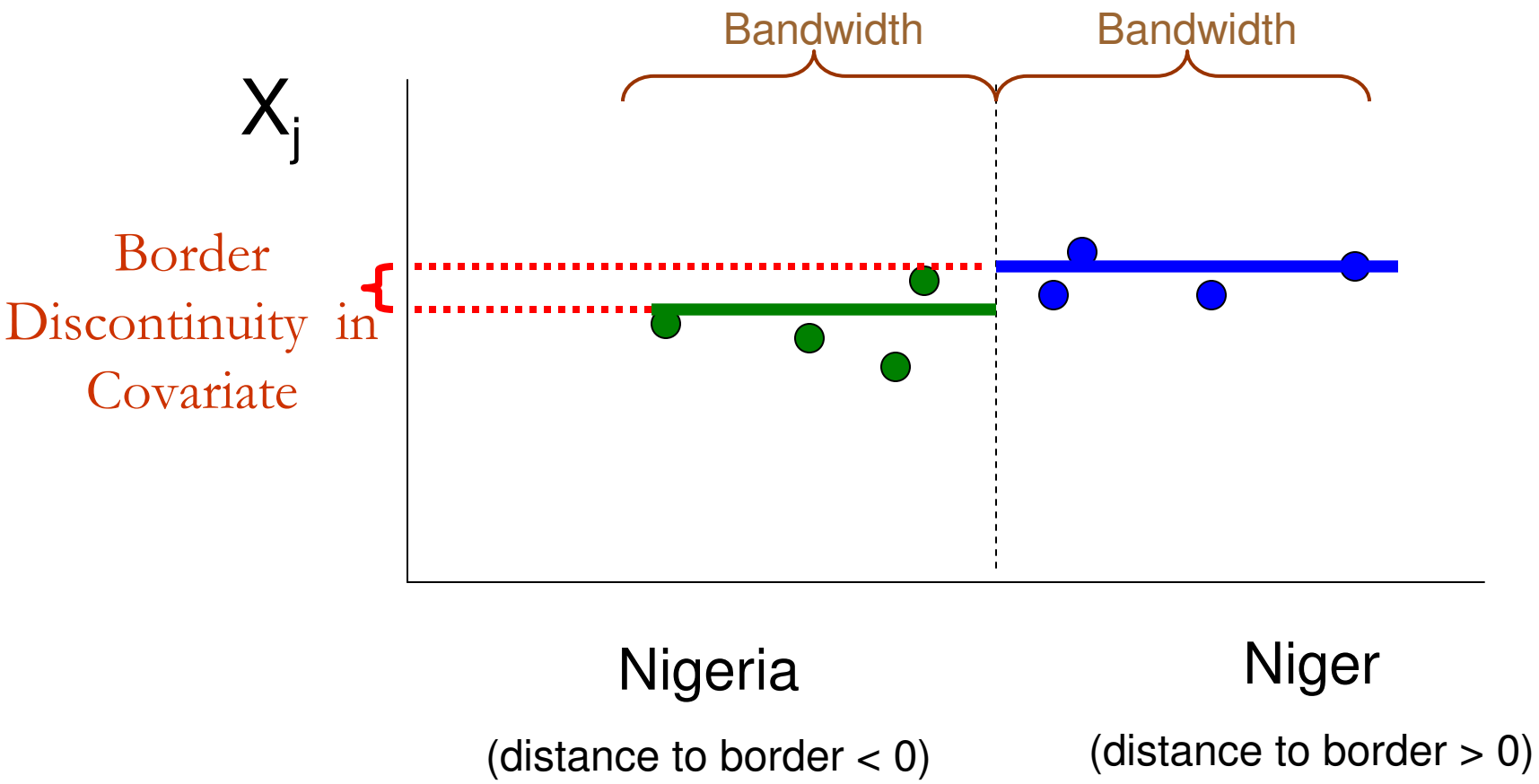
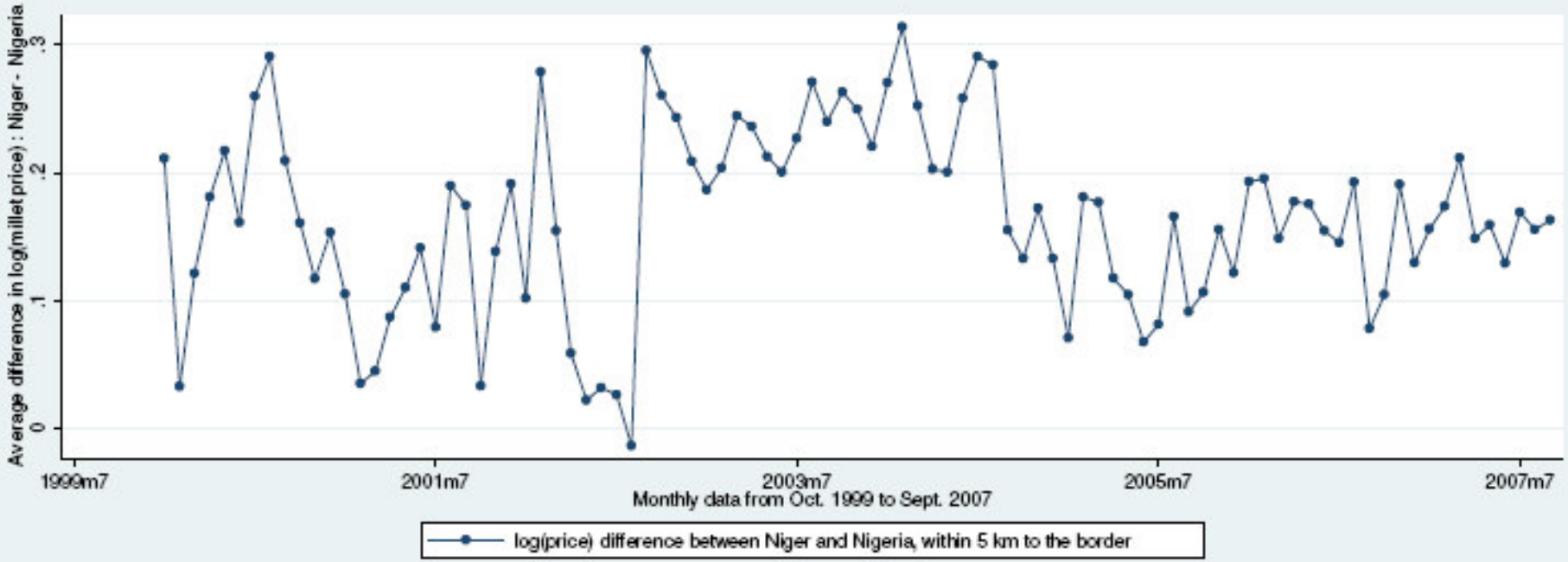
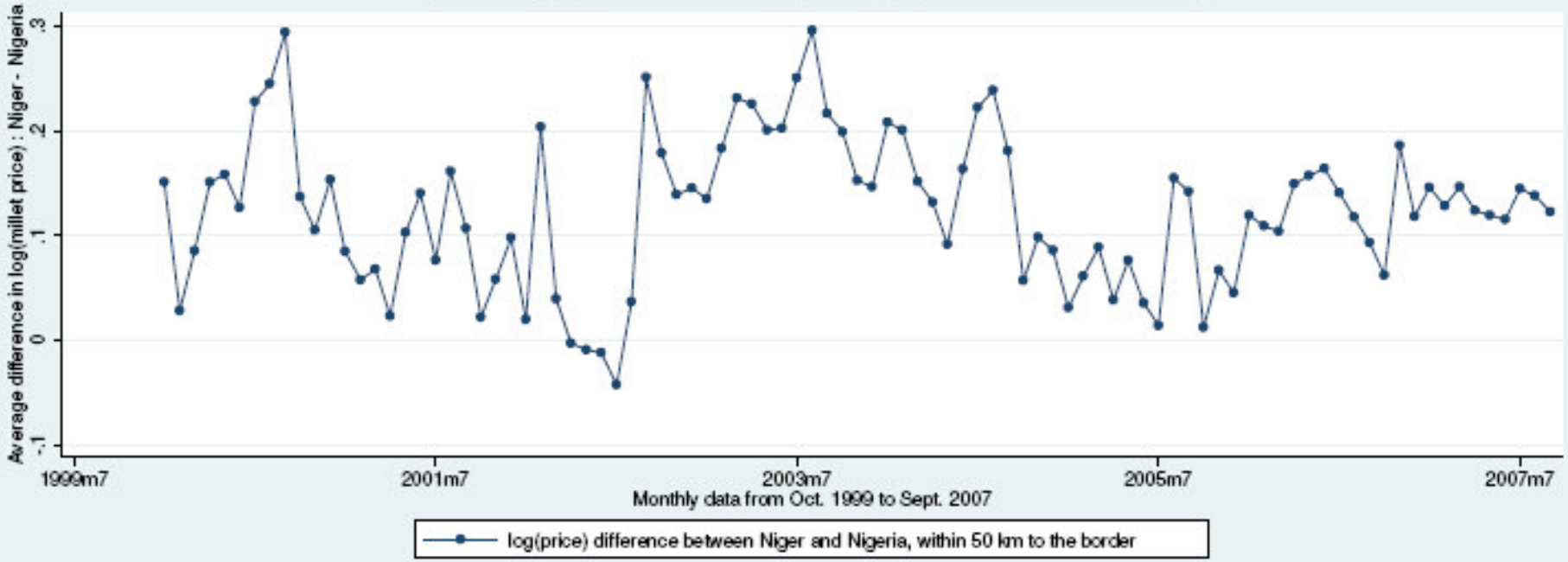


Table 5: Mean Difference (Niger - Nigeria)

	Within 5 km to the Niger-Nigeria border			
	Coefficient	Robust standard error	*t*-ratio	*p*-value
Market size	-138.92	75.74	-1.830	0.126
Urban status	-0.417	0.411	-1.010	0.358
Road quality	-0.083	0.411	-0.200	0.847
Gas/kg	0.000	4.411	0.000	1.000
Cellphone coverage	0.320	0.035	8.400	0.000
Drought status	-0.010	0.012	-0.850	0.390
Number of police cont	-0.167	0.693	-0.240	0.816
Sample size		960		
	Within 50 km to the Niger-Nigeria border			
	Coefficient	Robust standard error	*t*-ratio	*p*-value
Market size	-84.977	73.277	-1.160	0.267
Urban status	-0.295	0.283	-1.040	0.316
Road quality	-0.205	0.283	-0.720	0.483
Gas/kg	0.000	3.370	0.000	1.000
Cellphone coverage	0.219	0.024	9.160	0.000
Drought status	-0.006	0.010	-0.560	0.575
Number of police cont	-0.286	0.664	-0.430	0.677
Sample size		1,920		


Average difference in log(millet price) : Niger - Nigeria
0
.1
.2
.3
1999m7
2001m7
2003m7
2005m7
2007m7
Monthly data from Oct. 1999 to Sept. 2007
log(price) difference between Niger and Nigeria, within 5 km to the border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0
.1
.2
.3
1999m7
2001m7
2003m7
2005m7
2007m7
Monthly data from Oct. 1999 to Sept. 2007
log(price) difference between Niger and Nigeria, within 50 km to the border

Table 3. RDD Regressions of Niger-Nigeria Border Effect on Millet Price

	5 km to Border				50 km to Border			
	1	2	3	4	5	6	7	8
International border	.255***	.306***	.257***	.232***	.065	.140***	.141***	.215***
	(.009)	(.031)	(.022)	(.020)	(.079)	(.070)	(.076)	(.031)
Distance to Border	.012***	.004	.013***	.013***	.012***	.001	.004	.014**
	(.002)	(.005)	(.004)	(.007)	(.001)	(.004)	(.003)	(.004)
Border*Distance	-.080***	-.068***	-.079***	-.044*	'-.012	'-.001	'-.003	-.015***
	(.002)	(.008)	(.004)	(.019)	(.002)	(.005)	(.004)	(.004)
Hausa				-.013				.002
				(.018)				(.011)
Hausa*International Border				-.138				-.203***
				(.077)				(.032)
Constant	4.73***	4.50***	4.73***	4.74***	4.73***	4.440522	4.71***	4.74***
	(.007)	(.114)	(.009)	(.011)	(.007)	.0652112	(.009)	(.040)
Other covariates	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Monthly fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Observations	588	588	588	588	1267	1267	1267	1267
R-squared	0.1765	0.9239	0.9239	0.8841	0.2519	0.0704	0.7322	0.8436
Joint effect border				.093*				.011
				(.07)				(.033)
Joint effect Hausa				'-.151*				-.200***
				(.072)				(.028)

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Standard errors are robust to market level clustering in the conditional variance-covariance matrix of the disturba

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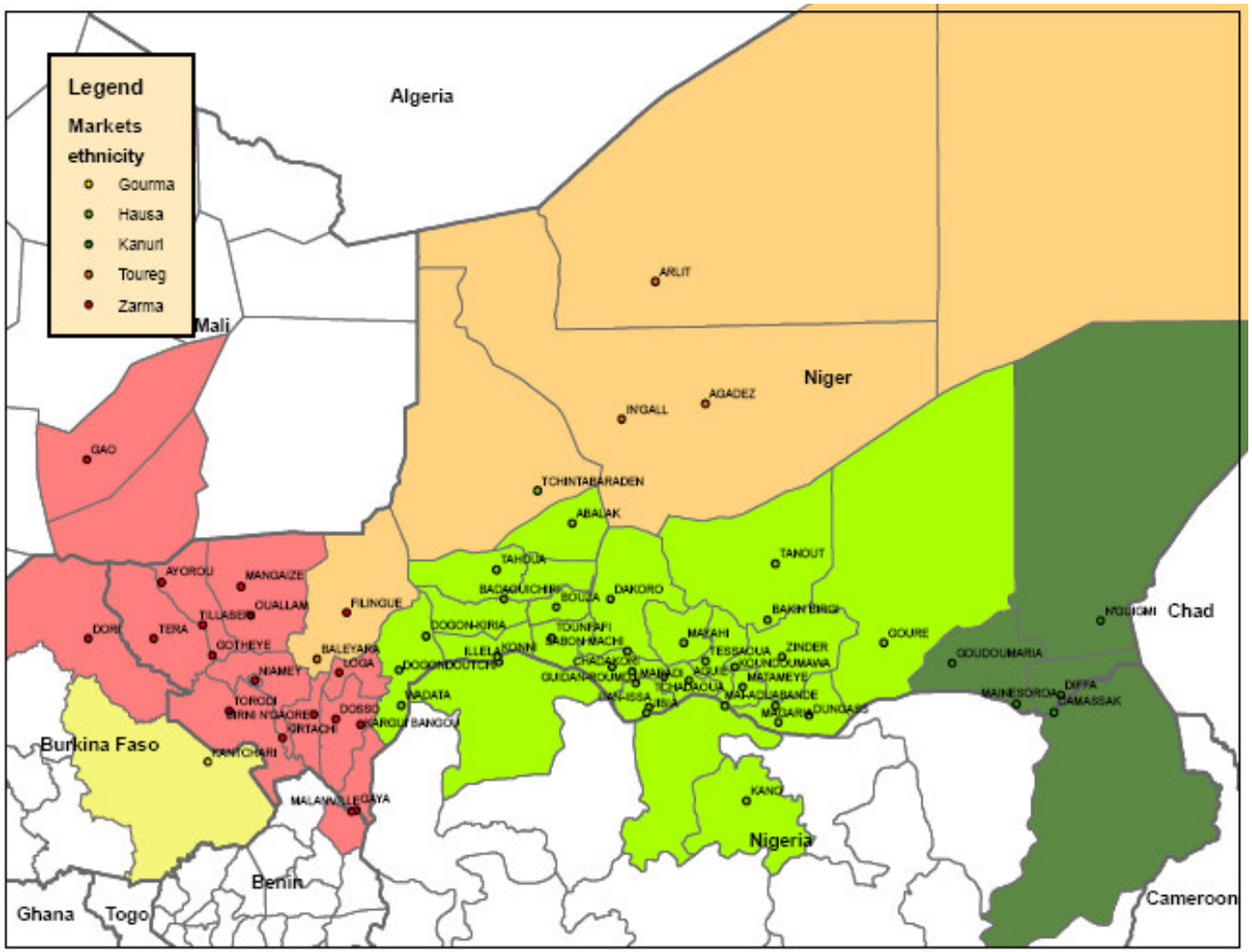
Ethnicity: Border or Barrier?

- "Common ethnicity" (Hausa) minimizes the impact of the international border effect
  - The international border effect is reduced by 15 percent for millet and 20 percent for cowpeas

- Can different ethnic compositions across markets serve as a intra-national border?

Defining an Ethnic Border



Source: Trader and farmer panel surveys, 2005-2007

Defining an "Ethnic" Border

- Use demographic data on ethnic composition for villages from 1999 (SIL/Niger) and 2007
- Calculate the ethnolinguistic fractionalization (ELF) of each village in the sample
- Identify the villages with "high" ELF (ethnic diversity)
- Use this to mark the latitude and longitude points of the ethnic border
- Compare with trader and farmer survey data from 2005-2007

Regression Discontinuity

- Price at time *t*, of good *i* in market *j*:

$$\ln(p^i_{j,t}) = \alpha^i + \gamma^i H_j + \theta^i D_j + \beta X_j + \varepsilon^i_j$$

  - H_j=1 if market in Hausa area, 0 if in Zarma area
  - D_j is distance of market *j* from the border, >0 for markets in Hausa region and <0 for markets in Zarma region
  - X_j other market-specific variables
  - But, distance to border issue

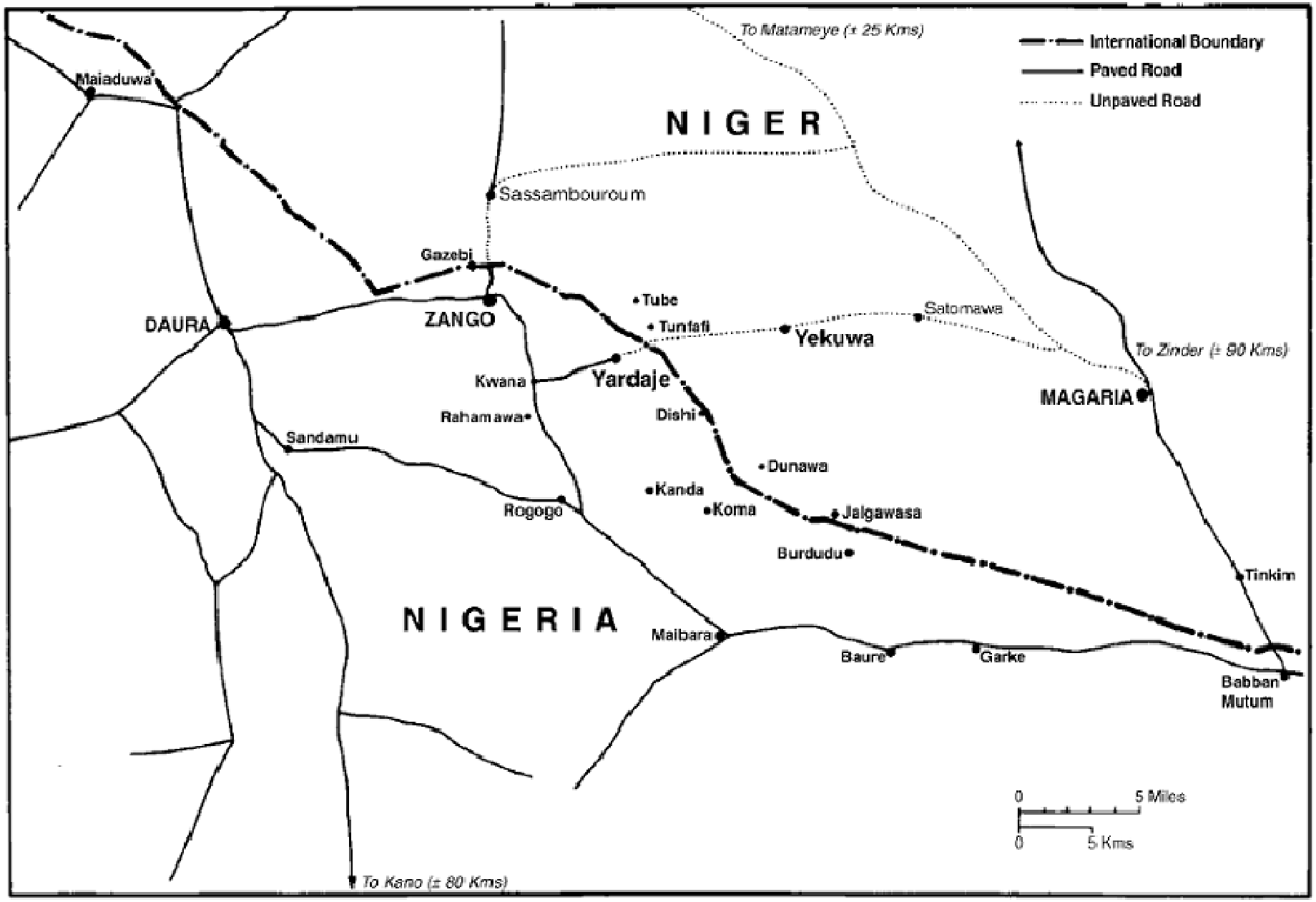

To Matameye (± 25 Kms)
International Boundary
Paved Road
Unpaved Road
NIGER
Maiaduwa
Sassambouroum
Gazebi
Tube
ZANGO
DAURA
Tunfafi
Satomawa
Yekuwa
To Zinder (± 90 Kms)
Kwana
Yardaje
MAGARIA
Rahamawa
Dishi
Sandamu
Dunawa
Kanda
Koma
Jalgawasa
Rogogo
Burdudu
Tinkim
NIGERIA
Maibara
Baure
Garke
Babban
Mutum
0
5 Miles
0
5 Kms
To Kano (± 80 Kms)

Table 7: Mean Difference (Zarma - Hausa)

	Within 50 km to the Hausa-Zarma border		
	Coefficient	*t*-ratio	*p*-value
Market size	28.50	2.11	0.17
Urban status	0.00	0.00	1.00
Road quality	0.00	0.00	1.00
Gas/kg	0.00	0.00	1.00
Cellphone coverage	0.09	1.84	0.07
Drought status	0.00	0.00	1.00
Police controls	-1.50	-2.45	0.25
Market tax (CFA/kg)	0.17	1.00	0.37
	Within 100 km to the Hausa-Zarma border		
	Coefficient	*t*-ratio	*p*-value
Market size	29.83	1.09	0.33
Urban status	-0.08	-0.20	0.85
Road quality	0.08	0.20	0.85
Gas/kg	0.00	0.00	1.00
Cellphone coverage	0.08	2.50	0.01
Drought status	0.00	0.00	1.00
Police controls	-0.83	-0.62	0.58
Market tax (CFA/kg)	0.10	0.71	0.51

Table 8. RD of Zarma-Hausa Border Effect on Log of Millet Price

	50 km to Border			
	(1)	(2)	(3)	(4)
Ethnic border	.282***	.289***	.252***	.480***
	(.082)	(.080)	(.064)	(.109)
Distance to Border	-.005***	-.005***	-.002***	-.005
	(.000)	(.000)	(.000)	(.004)
Border*Distance	.004***	.005***	.002*	-.017
	(.001)	(.001)	(.001)	(.011)
Distance squared				.000
				(.000)
Constant	4.79***	4.79***	4.79***	4.65***
	(.036)	(.044)	(.007)	(.022)
Other covariates	No	Yes	Yes	No
Monthly fixed effects	No	No	Yes	No
Observations	253	253	253	607
R-squared	0.055	0.0671	0.783	0.8019

Potential Mechanisms

- Higher transactions costs in Zarma regions
- Differential investment by colonial powers
- Unwillingness to trade across the "ethnic border"
- Linguistic costs to trade
- Gender differences among Hausa and Zarma markets (women's market participation)
- Credit among social networks

Potential Mechanisms

- Higher transactions costs in Zarma regions
- Differential investment by colonial powers
- Unwillingness to trade across the "ethnic border"
- Linguistic costs to trade
- Gender differences among Hausa and Zarma markets (women's market participation)
- Credit among social networks

Table 10: Difference in Trader-Level Characteristics between Hausa and Zarma Regions

	Zarma		Hausa		Coefficient	S.e.
	Mean	s.d.	Mean	s.d.		
Demographic Characteristics						
Years of Education	2.18	2.70	3.05	2.56	-0.88	0.60
Age	43.20	13.40	44.10	11.05	-0.91	2.78
Speak Hausa Language	0.20	0.40	1.00	0.00	-0.80***	0.06
Speak Zarma Language	0.70	0.48	0.00	0.00	0.70***	0.08
Gender	0.29	0.46	0.05	0.23	0.24***	0.08
Firm Characteristics						
Association Membership	0.33	0.48	0.47	0.51	-0.14	0.11
Years of Experience	11.48	8.22	15.20	9.38	-3.78*	1.99
Number of employees	3.44	5.10	4.00	3.11	-0.56	0.94
Have partners	0.29	0.46	0.24	0.49	0.06	0.11
Change original market	0.08	0.27	0.11	0.31	-0.03	0.07
Retailer	0.59	0.50	0.55	0.50	0.03	0.11
Have financial account	0.11	0.32	0.24	0.44	-0.13	0.09
Trading Behavior						
Number of markets followed	2.82	1.92	3.50	3.96	-0.68	0.71
Use mobile phone for trading	0.44	0.50	0.38	0.49	0.06	0.08
Number of market contacts	2.53	2.47	2.93	4.09	-0.40	0.88
Number of purchase and sales markets	3.51	1.96	4.53	2.88	-1.01*	0.56
Trade in markets within a 50-km radius	0.85	0.24	0.94	0.14	-0.09*	0.05
Take a loan	0.36	0.48	0.38	0.49	-0.02	0.10
Take a loan from a fellow trader	0.21	0.42	0.23	0.42	-0.01	0.09
Number of credit institutions	0.50	0.70	0.67	0.67	-0.02	0.10

Notes: Data from the Niger trader survey and secondary sources collected by Aker. N=415 traders, 35 markets. Huber-White robust standard errors are in parentheses. * is significant at the 10% level, ** significant at the 5% level, *** is significant at the 1% level.

Table 10: Difference in Trader-Level Characteristics between Hausa and Zarma Regions

	Zarma		Hausa		Coefficient	S.e.
	Mean	s.d.	Mean	s.d.		
Demographic Characteristics						
Years of Education	2.18	2.70	3.05	2.56	-0.88	0.60
Age	43.20	13.40	44.10	11.05	-0.91	2.78
Speak Hausa Language	0.20	0.40	1.00	0.00	-0.80***	0.06
Speak Zarma Language	0.70	0.48	0.00	0.00	0.70***	0.08
Gender	0.29	0.46	0.05	0.23	0.24***	0.08
Firm Characteristics						
Association Membership	0.33	0.48	0.47	0.51	-0.14	0.11
Years of Experience	11.48	8.22	15.20	9.38	-3.78*	1.99
Number of employees	3.44	5.10	4.00	3.11	-0.56	0.94
Have partners	0.29	0.46	0.24	0.49	0.06	0.11
Change original market	0.08	0.27	0.11	0.31	-0.03	0.07
Retailer	0.59	0.50	0.55	0.50	0.03	0.11
Have financial account	0.11	0.32	0.24	0.44	-0.13	0.09
Trading Behavior						
Number of markets followed	2.82	1.92	3.50	3.96	-0.68	0.71
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Notes: Data from the Niger trader survey and secondary sources collected by Aker. N=415 traders, 35 markets. Huber-White robust standard errors are in parentheses. * is significant at the 10% level, ** significant at the 5% level, *** is significant at the 1% level.

Gender and Agricultural Trade (Correlations)

- Female traders are less likely to take a loan (in general) and are ***27 less likely to borrow from another trader***
- Female traders sell is ***2 fewer markets and consult 1.2 fewer people*** for market information
- Female traders have 1.5 years less schooling (mean is 3 years) and 4.5 years less experience

Conclusion

- International borders are statistically significant between Niger and Nigeria, but of smaller economic importance than in industrialized countries
  - Impact larger for semi-perishable commodity (cowpea)
  - Common ethnicities mitigate the impact of an international border effect
- There is an internal border along ethnic lines

Next Steps

- Disentangling the time element of the border effect (cowpeas)
- Understanding the credit constraints in the agricultural market – are social credit networks along ethnic lines?
- International border effect for agricultural trade between Niger and the CFA zone (Benin, Burkina Faso) as compared with the CFA-Naira (role of the exchange rate)

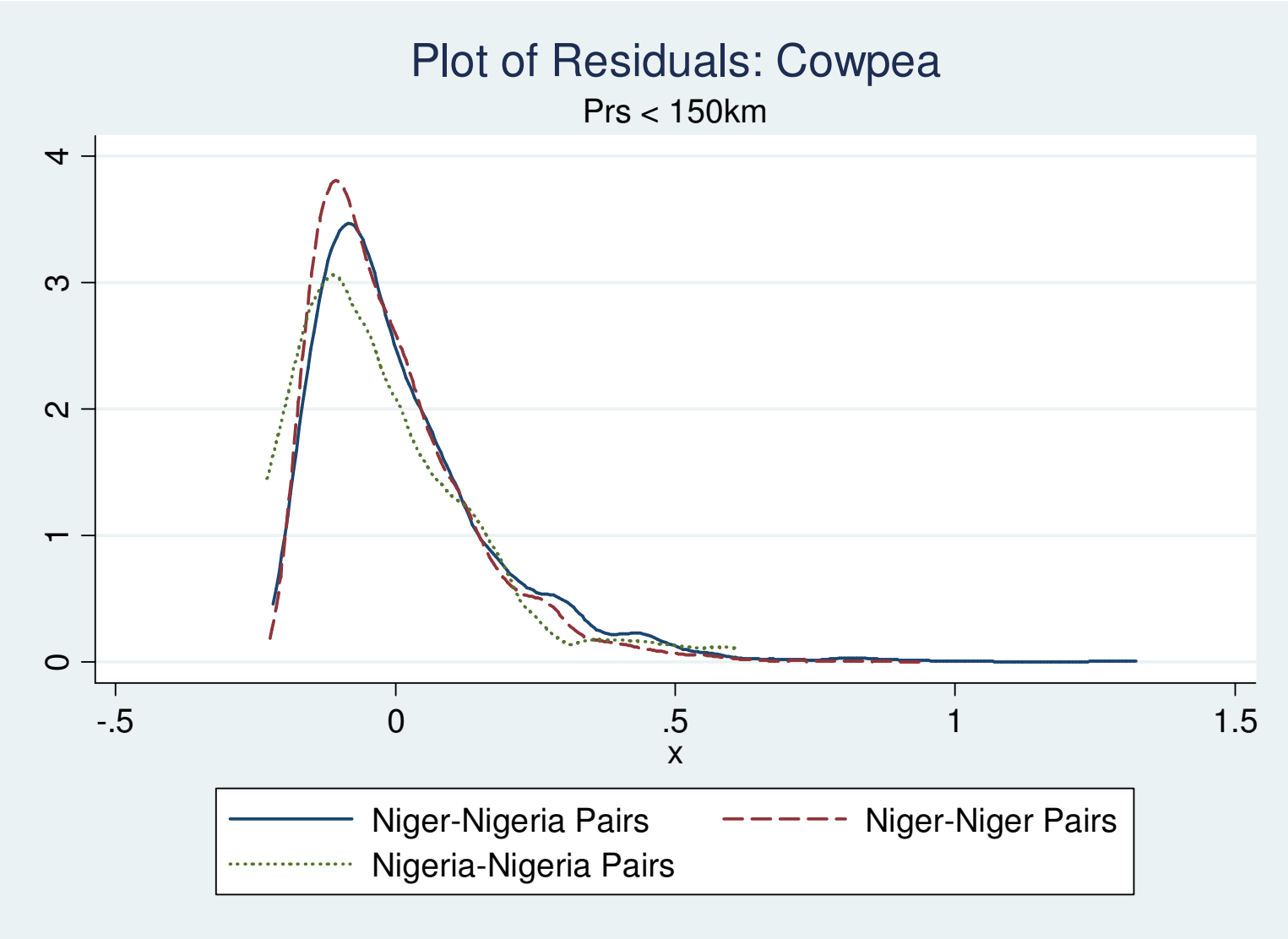
Extra Slides

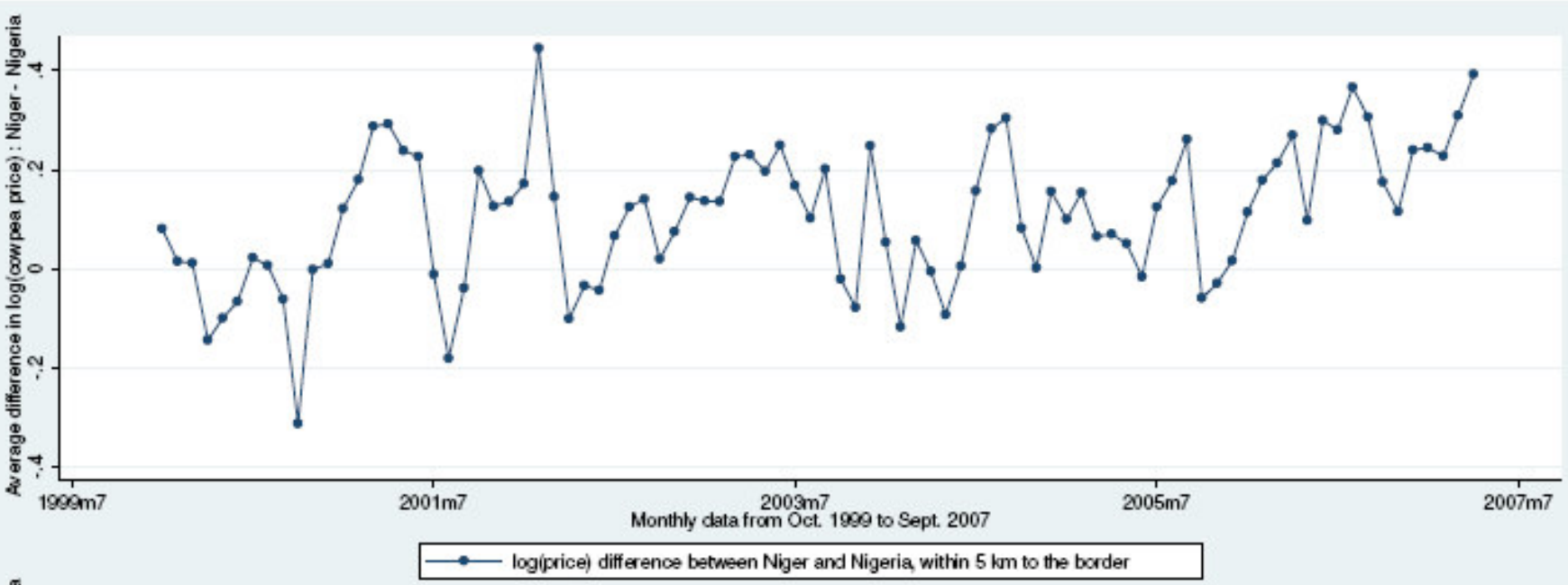
Kernel Distributions

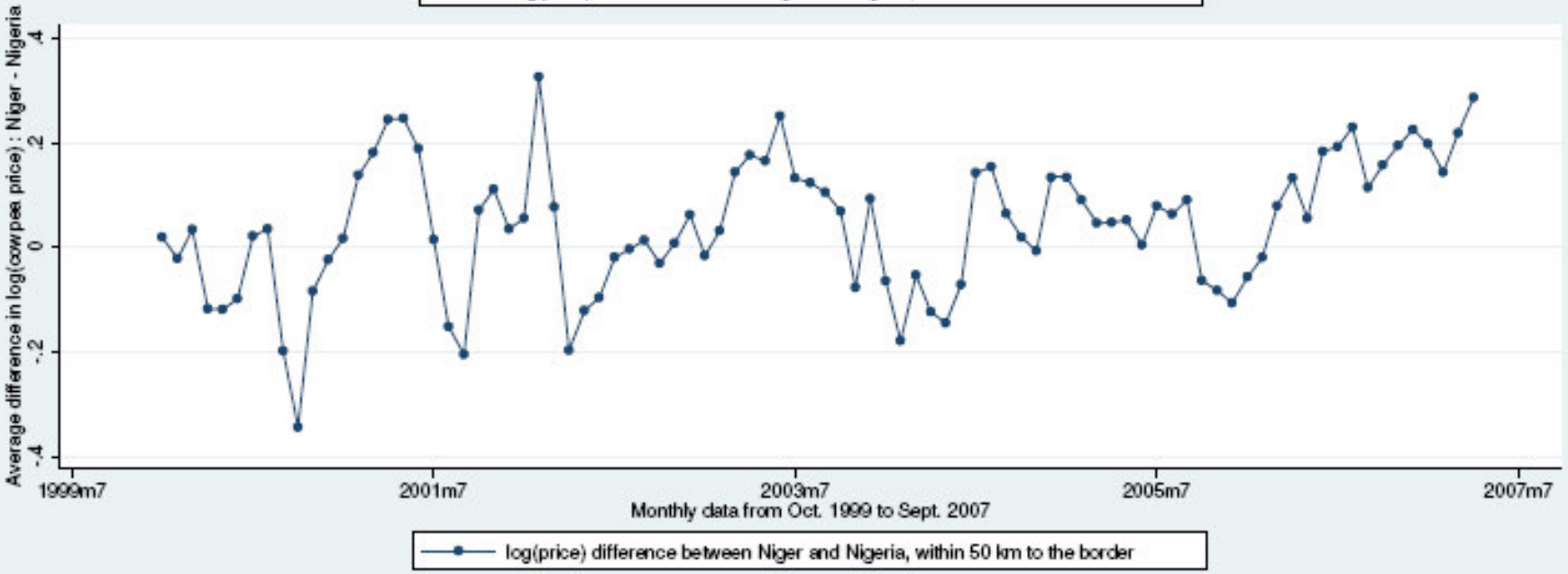
$$|\ln(p^i_{jt}/p^i_{kt})| = \beta_0 + \beta_1 \ln(TC_{jkt}) + \beta_2 urban_{jkt} + \beta_3 drought_{jkt} + \theta_t + a_{jk} + \varepsilon_{jkt}$$

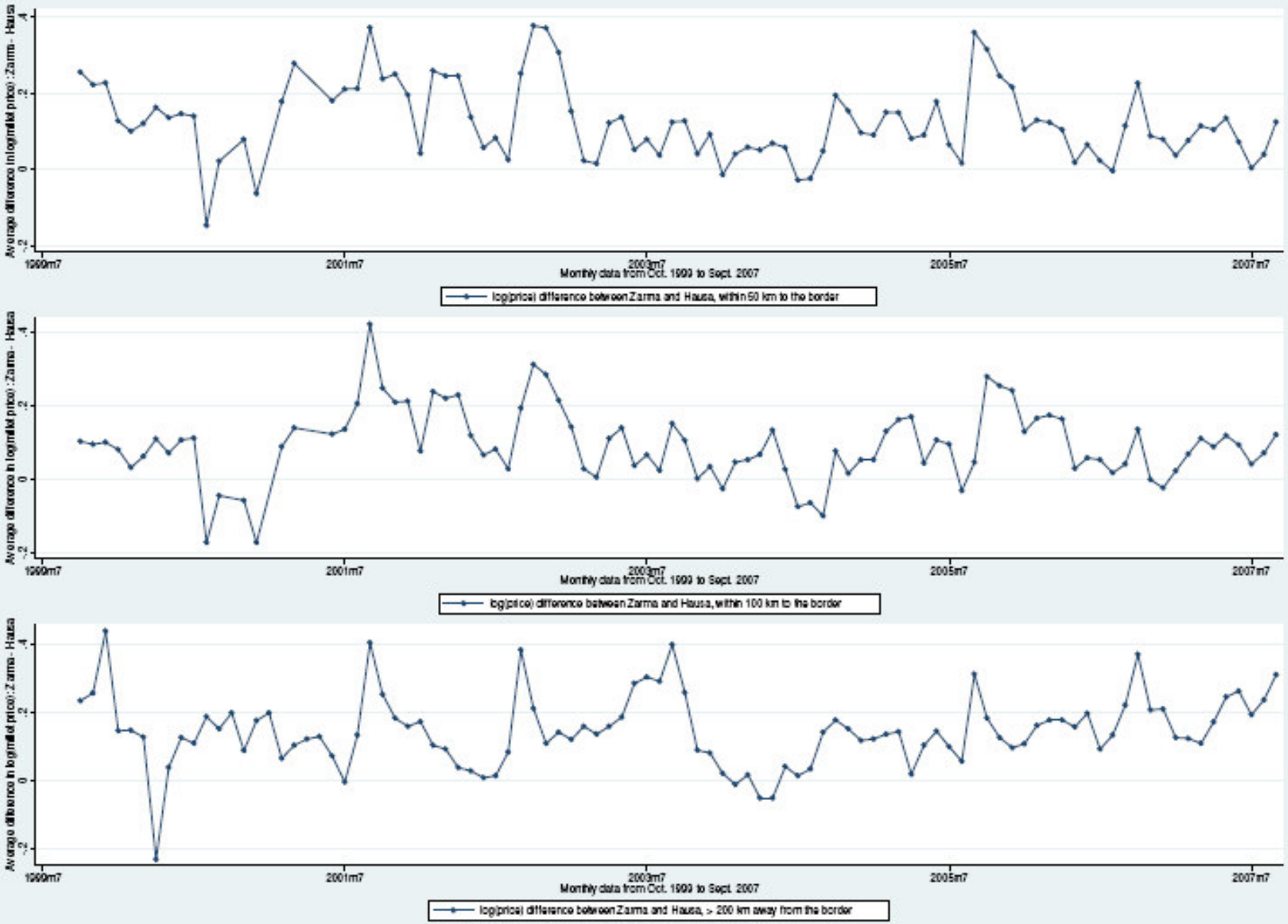
- p^i_{jt} is the price of good i in market j at time t
- p^i_{kt} is the price of good i in market k at time t
- TC_{jkt} is transport costs between markets j and k at time t
- $urban_{jkt}$ is an urban variable (1 if one market is greater than 35,000 people, 0 otherwsie)
- $drought_{jkt}$ is a dummy variable for drought at time t
- $a_{j,k}$ is market-pair fixed effect, used in some specifications

Cowpeas


Plot of Residuals: Cowpea
Prs < 150km
0
1
2
3
4
-.5
0
.5
1
1.5
x
Niger-Nigeria Pairs
Niger-Niger Pairs
Nigeria-Nigeria Pairs


Average difference in log(cowpea price) : Niger - Nigeria
-.4
-.2
0
.2
.4
1999m7
2001m7
2003m7
2005m7
2007m7
Monthly data from Oct. 1999 to Sept. 2007
log(price) difference between Niger and Nigeria, within 5 km to the border


Average difference in log(cowpea price) : Niger - Nigeria
-.4
-.2
0
.2
.4
1999m7
2001m7
2003m7
2005m7
2007m7
Monthly data from Oct. 1999 to Sept. 2007
log(price) difference between Niger and Nigeria, within 50 km to the border


Average difference in log(milled price): Zarma - Hausa
-.2
0
.2
.4
1999m7
2001m7
2003m7
2005m7
2007m7
Monthly data from Oct. 1999 to Sept. 2007
log(price) difference between Zarma and Hausa, within 50 km to the border
Average difference in log(milled price): Zarma - Hausa
-.2
0
.2
.4
1999m7
2001m7
2003m7
2005m7
2007m7
Monthly data from Oct. 1999 to Sept. 2007
log(price) difference between Zarma and Hausa, within 100 km to the border
Average difference in log(milled price): Zarma - Hausa
-.2
0
.2
.4
1999m7
2001m7
2003m7
2005m7
2007m7
Monthly data from Oct. 1999 to Sept. 2007
log(price) difference between Zarma and Hausa, > 200 km away from the border