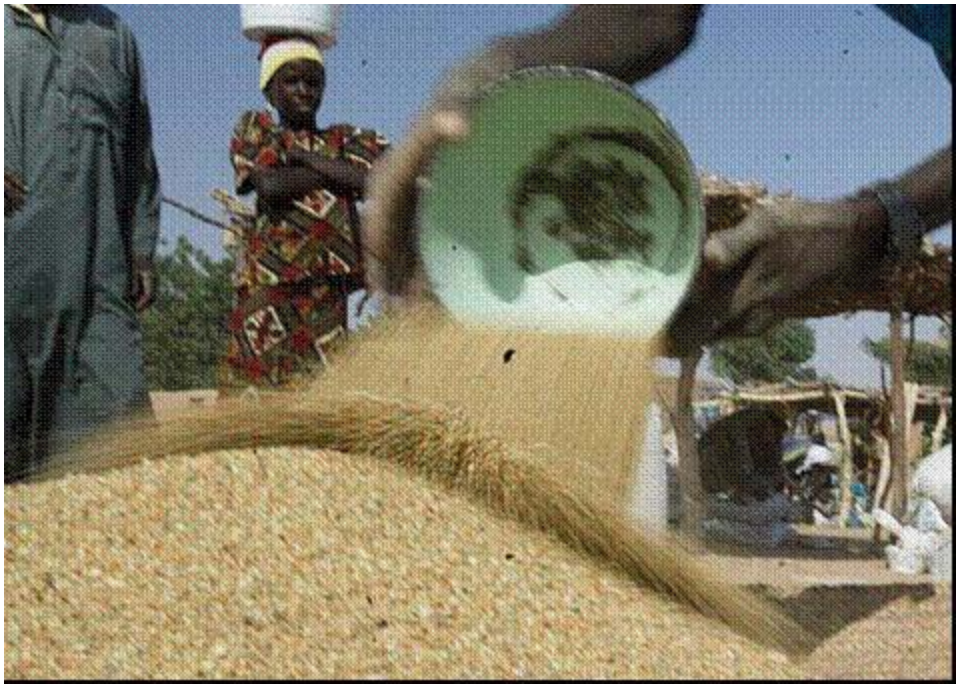
"Information from Markets Near and Far": Mobile Phones and Grain Markets in Niger



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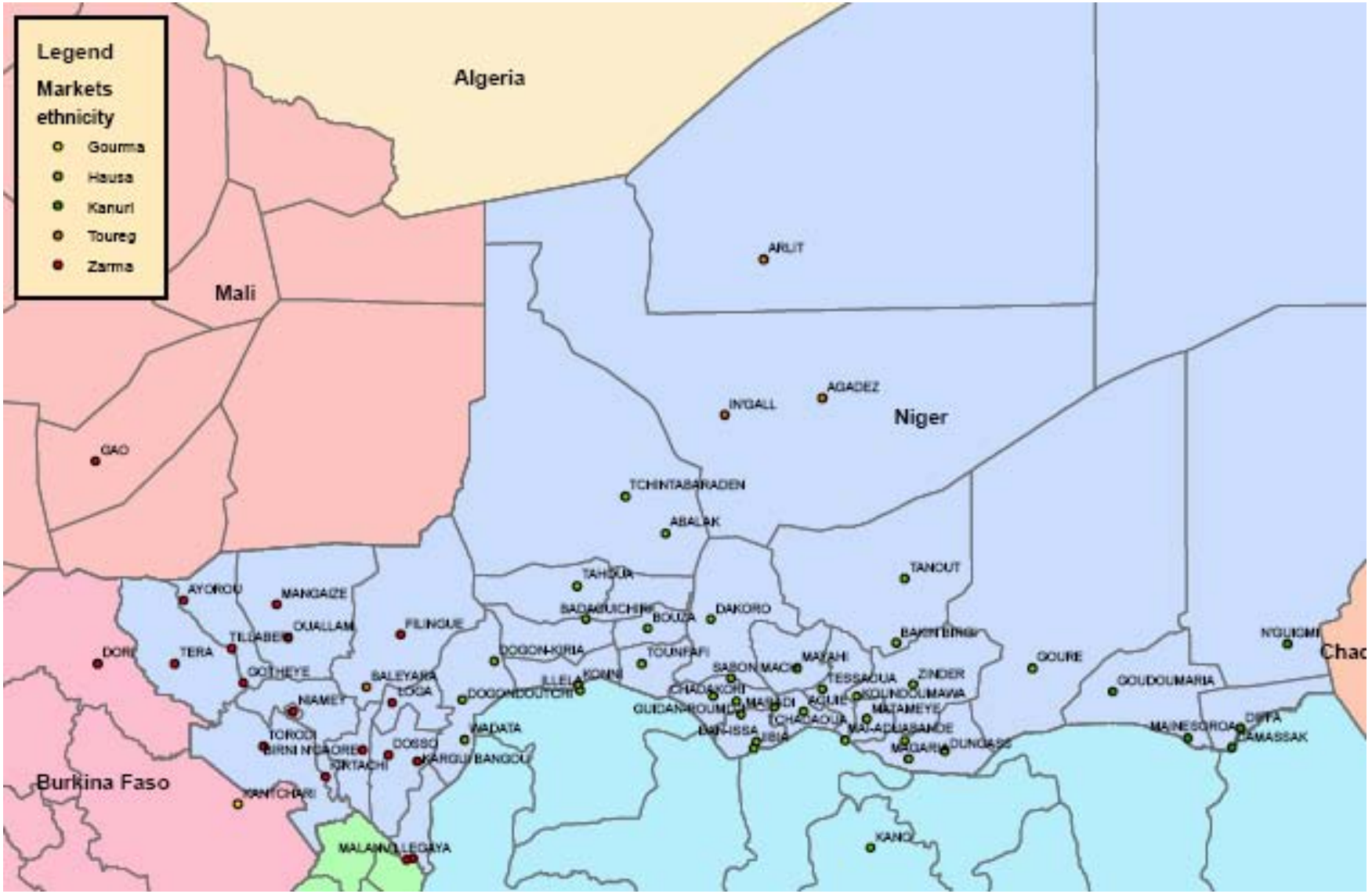
Motivation

- Costly information can make it difficult for market agents to engage in optimal arbitrage

- Excess price dispersion for homogeneous goods is a common occurrence in developed and developing countries (Stigler, *JPE* 1961, Brown and Goolsbee, *JPE* 2002, Jensen, *QJE* 2007)

Motivation

Motivation


Legend
Markets
ethnicity
Gourma
Hausa
Kanuri
Touareg
Zarma
Algeria
Mali
Niger
Burkina Faso
ARLIT
AGADEZ
INGALL
GAO
TCHINTABARADEN
ABALAK
TAHOUA
TANOUT
AYOROU
MANGAIZE
OUALLAM
FILINGUE
TILLABERI
DORI
TERA
GOTHEYE
SALEYAKA
LOGA
NIAMEY
TORODI
BIRNI N'GAORE
DOSSO
KIRTACHI
KARGUI BANGOU
KANTCHARI
MALANVILLE
GAYA
WADATA
DOGON-KIRIA
DOGONDOUTCHI
ILLELA
KORNI
BOUZA
DAKORO
BADAMUCHIRI
TOUNFAFI
SABON MACHI
CHADAKORI
GUIDAN-ROUMJI
MARADI
TCHADAOUA
BAN-ISSA
IBIA
MAYAHI
TESSAOUA
AGUIE
ZINDER
KOUNDOUMAWA
MATAMEYE
MAI-ADUASSANDE
MAGARIA
DUNGASS
BAKIN BINGI
GOURE
GOUDOUMARIA
NGUIGMI
Chad
MAINE SOROA
DIFFA
DAMASSAK
KANO

Motivation

65 km~3 hours

Zinder
(Thursday)

Bakin Birgi
(Monday)

20 km~1 hour

Tanout
(Friday)

Motivation

65 km~2 min

Zinder
(Thursday)

Bakin Birgi
(Monday)

20 km~1 hour

Tanout
(Friday)

750 km~2 min

Niamey
(Sunday)

Motivation

"[With a cell phone], in record time, I have all sorts of information from markets near and far…"

Grain trader in Magaria, Niger

"[Now] I know the price for US$2, rather than traveling (to the market), which costs US$20."

Grain trader in Zinder, Niger

Motivation

- **Goal:** Assess the impact of a new search technology on grain market performance in Niger
  - Develop a simple model of trader search
  - Exploit the quasi-experimental rollout of cell phone towers to measure their impact on grain price dispersion
  - Investigate alternative hypotheses and mechanisms

- **Two Datasets**
  - Market-level time series (monthly) panel 1999-2006
  - Unique trader panel collected between 2005-2007

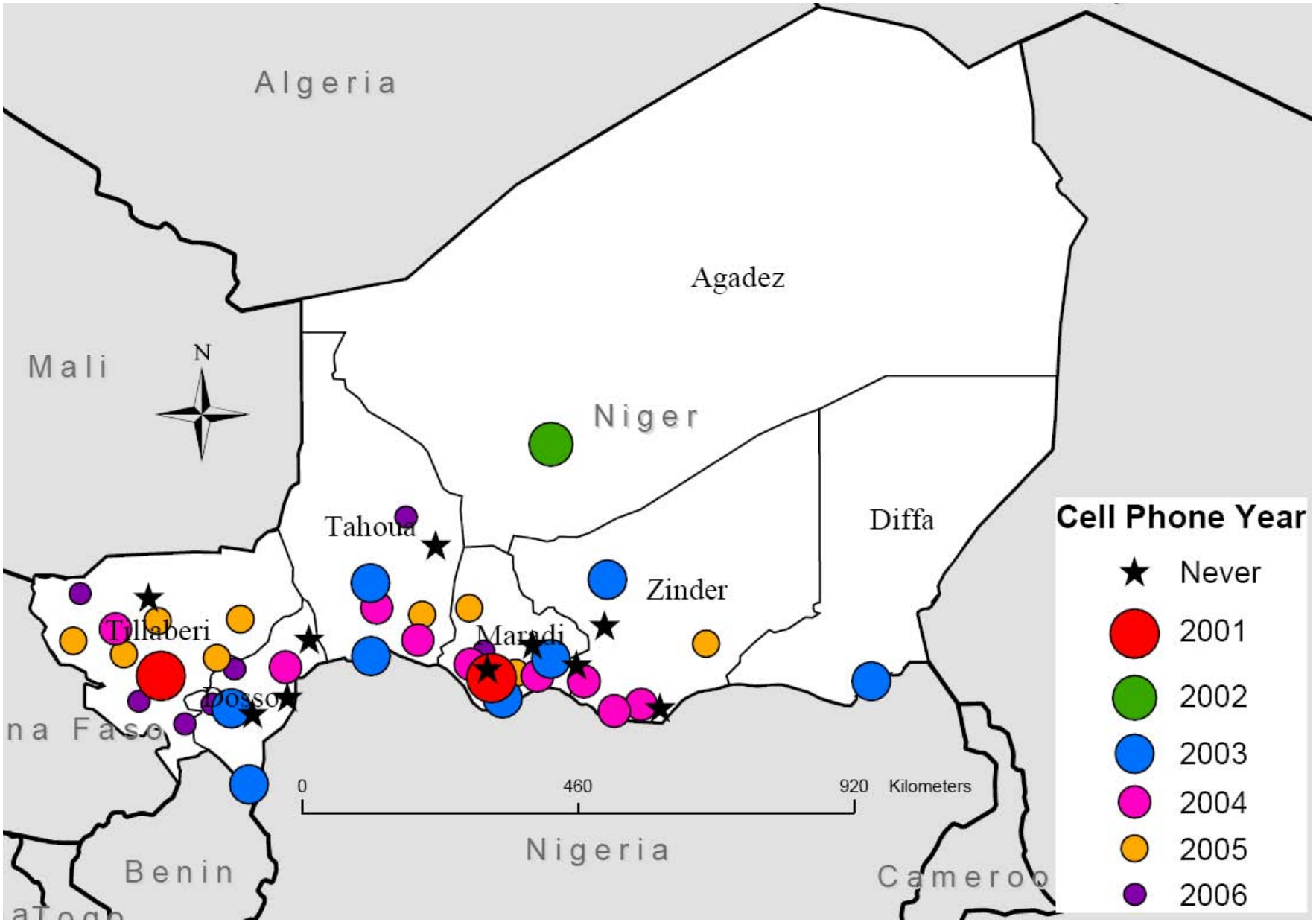
Preview of Findings

- The introduction of cell phones is associated with a decrease in price dispersion across grain markets
  - The effect is stronger for isolated markets and those with poor quality roads, and as a higher percentage of markets receive cell phone coverage
- Traders in cell phone markets search more and sell in a larger number of markets
- Cell phones are associated with welfare gains for traders and consumers

Cell Phone Rollout

- Between 2001-2006, cell phone towers were phased-in throughout the country
- Cell phone companies (Celtel, Sahelcom, Telecel) intended to provide universal coverage by 2009
- There were two criteria to prioritize the rollout:
  - Whether the town was an urban center
  - Whether the town was located near a border (Benin, Burkina Faso, Mali and Nigeria)

Cell Phone Coverage by Market and Year, 2006



Linking the Model to the Data

- Cell phones require an initial fixed cost but reduce the per-search cost as compared to personal travel
  - 50 percent reduction in traders' (marginal) search costs

- Therefore, the introduction of cell phones will:
  - #1. Increase traders' reservation prices (unobserved)
  - #2. Increase the number of markets over which traders search
  - #3. Reduce dispersion of millet prices across markets

First Dataset: Market-Level Panel

- Monthly cereal prices in 42 domestic and cross-border markets between 1999-2006
- Department-level rainfall and cereal production
- Trade flows (directions) between key markets
- Monthly gasoline prices
- Estimated transport costs between markets
- Village and town population and urban status
- Road distances, road quality and estimated travel times (time-invariant)
- Criteria used by cell phone companies for cell phone rollout
- Date of cell phone entry in each market

Second Dataset: Trader Panel

- Panel survey of traders, farmers, market resource persons and transporters collected between 2005-2007
- 415 traders across 35 markets in 6 regions of Niger
- Census of grain markets and grain traders on each market
- Detailed data on traders' operations, with retrospective questions for 2004/2005

Summary Statistics

Panel A: Trader-Level Characteristics	**Sample Mean (s.d.)**	**# of obs**
Ethnicity (Hausa ethnic group)	0.65	395
Age	45.71(12.2)	395
Gender(male=0, female=1)	0.11(.32)	395
Education (0=elementary or above, 1=no education)	0.62(.48)	395
Trader type (retailers)	0.53	395
Years' of Experience	16.0(10.2)	395
Trade in agricultural output products only	0.98(.02)	395
Changed "principal market" since he/she became a trader	.10(.31)	395
Number of days of storage	7.14(9.8)	395
Own cell phone	.29(.45)	395
Own means of transport (donkey cart, light transport)	.11(.32)	395
Panel B. Market-Level Characteristics		
Number of traders	137(99.6)	35
Road quality (1=paved road, 0=otherwise)	.71(.45)	35
New paved road in past 5 years	.15(.37)	35
Located in an urban center (>35,000 people)	.39(.48)	35

Empirical Strategy

- Part I: Assess the impact of the introduction of cell phones on grain market performance

- Part II: Estimate the mechanisms behind the market-level (treatment) effect

Empirical Strategy: Part I

- Assess the impact of the introduction of cell phones on grain price dispersion across markets
  - "Treatment" defined as a cell phone tower, not adoption
  - Use market-level time-series panel dataset
- Exploit the quasi-experimental nature of the rollout of cell phone towers
  - Pooled and yearly difference-in-differences estimation
  - Treatment effect heterogeneity over time and space
- Robustness checks
  - Control for potential bias of the estimates
  - Check consistency of standard errors using non-parametric permutation tests and dyadic-corrected standard errors
  - Test for alternative explanations

Estimating the Impact of Cell Phones at the Market Level

$$Y_{ij,t} = \alpha + \beta_2 cell_{ij,t} + \gamma Z_{ij,t} + a_{ij} + \theta_t + u_{ij,t}$$

$Y_{ij,t}$		absolute value of price difference between market *i* and market *j* at time *t**
$Cell_{ijt}$		1 if the market pair received cell phones in period *t*, 0 otherwise
$Z_{ij,t}$	$Transport_{ijt}$	per unit/per km fuel * distance
	$Drought_{ijt}$	markets *i* and *j* at time *t*
θ_t		time effects (monthly or yearly)
a_{ij}		market-pair specific effects
u_{ijt}		error with 0 conditional mean, $E[u_{ijt}/cell_{ijt}, Z_{ijt}, a_{ij}, \theta_t]=0$
t		time in months, $t=1\ldots84$
N		number of market pairs

*Alternative measures of price dispersion and the treatment variable are used

*Lagged dependent variable correcting for endogeneity using Arellano-Bond

Balance of Pre-Treatment Variables

Table 2. Comparison of Observables by Treated and Untreated Groups in Pre-Treatment Peri

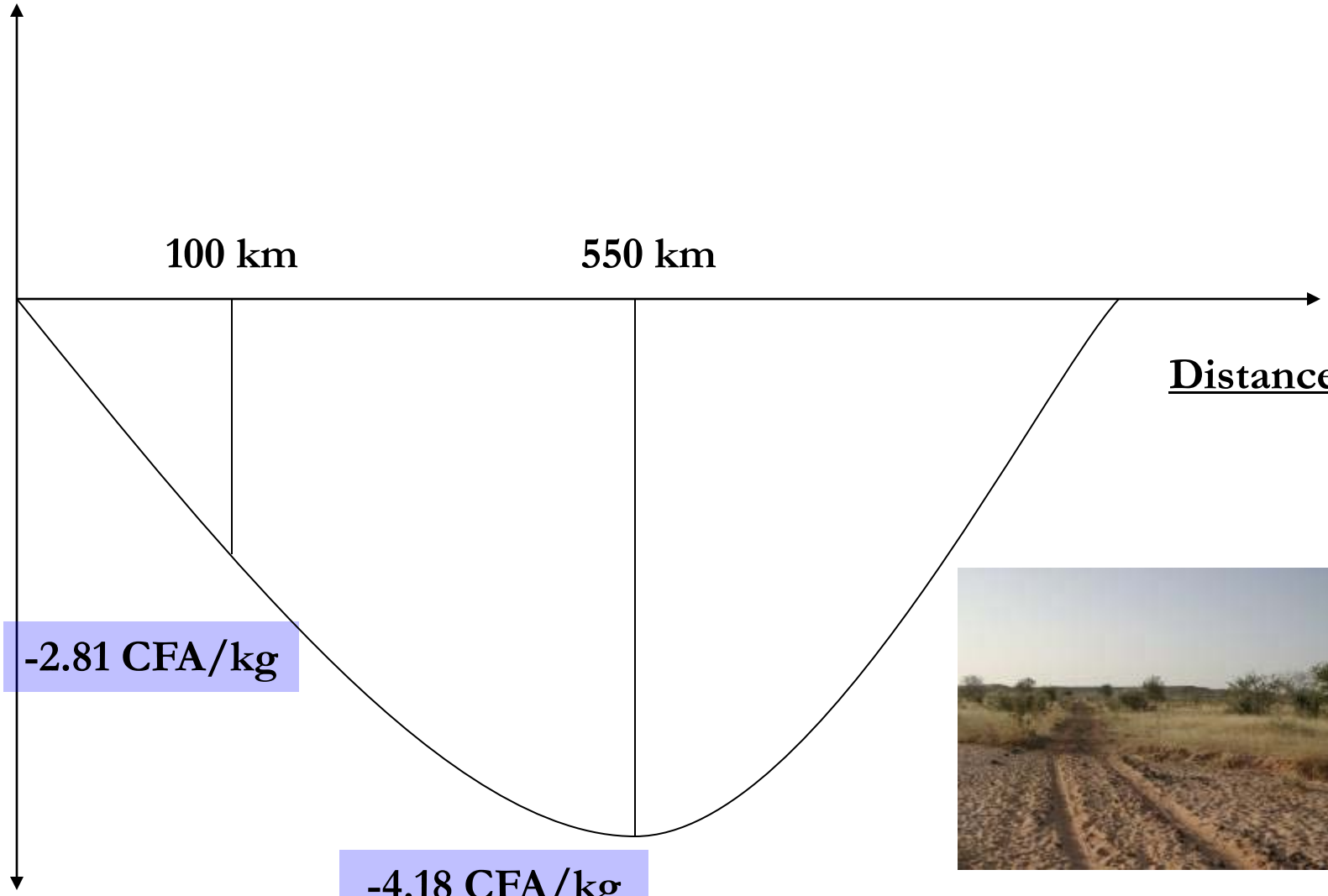
Pre-Treatment Observables	Unconditional Mean		Difference
	Cell Phone Mean (s.d.)	No Cell Phone Mean (s.d.)	Unconditional s.e.
Panel A. Market Pair Level Data			
Price dispersion between markets (CFA/kg)	20.72 (16.9)	22.14 (16.49)	-1.73 (1.92)
Distance between markets (km)	377.3 (217.5)	378.64 (227.65)	-.447 (24.8)
Road Quality between markets	0.418 (.493)	.318 (.465)	.100*(.052)
Drought in 1999 or 2000	.013(.114)	.019 (.137)	-.006(.004)
Urban center(>=35,000)	0.169 (.374)	0.000 (.001)	0.169***(.020)
Transport Costs between Markets (CFA/kg)	12.73 (6.89)	12.74 (7.12)	0.013 (.771)
Panel B. Market Level Data			
Road Quality to Market	0.629(.483)	.5(.5)	.129(.271)
Market Size	103.11(79.65)	101.75(45.5)	1.361(27.8)
Drought in 1999 or 2000	0.148(.355)	0.25(.435)	-.101(.134)
Urban center(>=35,000)	0.407(.491)	0(.00)	.407***(.096)

Average Effects of Cell Phones

- Cell phones are associated with a -1.42 to -4.7 CFA/kg reduction in price dispersion (6.5-22 reduction in price dispersion)

Dependent variable	**(1) P_{it}-P_{jt}**	**(3) P_{it}-P_{jt}**	**(4) CV**	**(5) P_{it}-P_{jt}**
Cell Phone Dummy (both treated)	-4.65*** (1.06)	-4.77*** (1.06)	-.039* (.020)	-1.42* (.863)
Common Time Trend	Yes	Yes	Yes	Yes
Group-specific time trend	No	Yes	Yes	Yes
Market-Pair Fixed effects	Yes	Yes	Yes	Yes
Yearly time dummy	Yes	Yes	Yes	Yes
Monthly time dummy	No	No	No	Yes
# of observations	27342	27342	2393	27342
R^2	0.0075	0.0075	0.0879	0.1003
Pre-treatment value for control groups	22.14	22.14	0.312	22.14

Heterogeneous Effects



Alternative Explanations and Mechanisms

- Hidden bias (conditional independence assumption)
- General equilibrium effects (SUTVA violation)
- Collusive behavior and entry and exit

Empirical Strategy: Part II

- Assess the impact of cell phones on traders' behavior
  - "Treatment" defined as a cell phone tower, not adoption
  - Use trader-level panel dataset
- Exploit the quasi-experimental nature of the rollout of cell phone towers
  - Pooled difference-in-differences estimation
- Robustness checks
  - Control for selection bias via matching and bounding the treatment effect

Estimating the Impact of Cell Phones on Traders' Behavior

$$Y_{ij,t} = \alpha + \beta_1 cell_{j,t} + \delta X_{ij,t} + \gamma Z_{j,t} + \theta_t + u_{ij,t}$$

$Y_{ij,t}$	outcome of trader *i* in market *j* at time *t* (number of markets searched, number of market contacts, number of sales markets)
$Cell_{ijt}$	variable =1 if the market received cell phones in period *t*, 0 otherwise
X_{ijt}	vector of exogenous regressors of trader *i* in market *j* at time *t*
Z_{ijt}	vector of exogenous regressors of market *j* at time *t*
θ_t	time effects (year)
u_{ijt}	error with 0 conditional mean, $E[u_{ijt} \mid Z_{ijt}, X_{ijt}, a_i, a_j, \theta_t]=0$
t	time in years, t=2004/2005, 2005/2006
N	number of traders, N=395

Self-Selection into Cell Phone Markets

- Concern about potential selection into cell phone markets
  - Differences in traders' behavior might be the result of pre-treatment characteristics that caused traders to "self-select" into a cell phone market
- Traders' self-selection into cell phone markets seems unlikely:
  - Number of traders per market did not vary (significantly) between 2004-2007 (period of cell phone expansion)
  - Only 10 percent of traders surveyed have changed their "principal market" since they began trading

Trader-Level Outcomes

	OLS Estimate		Poisson Estimate		Probit Estimate	Nearest Neighbor	
Dependent variable:	**Coeff (s.e.)**	**%Δ**	**Coeff (s.e.)**	**Coeff (adj s.e.)**	**Coeff (df/dx) (s.e.)**	**Coeff (s.e.)**	**%Δ**
# of Markets Searched	.91** (.46)	26.26%	.22** (.11)	.22** (.05)		.91** (.47)	26.49%
# of people consulted for market information	1.5*** (.50)	39.95%	.33*** (.11)	.33** (.08)		1.7*** (.71)	45.14%
Use personal contacts to obtain market information	.07*** (.02)	7.99%			.61*** (.09)	.07* (.04)	7.57%
Change sales markets (Yes=1, 0=No)	.08 (.06)	57.14%			.08* (.05)	.09* (.05)	64.29%
# of Sales Markets	1.02** (.71)	25.37%	.22** (.09)	.22*** (.02)		1.13* (.70)	28.04%

Search in .91 more markets

Sell in one more market

Bounding the Treatment Effect

Dependent variable:	(1) Untrimmed ATE	(2) "Best case" Bound	(3) "Worst Case" Bound
# of Markets Searched	.83**(.42)	.99**(.41)	.83**(.42)
# of people consulted for market information	1.4**(.7)	1.6**(.62)	1.4**(.7)
Use personal contacts to obtain market information	.06***(.03)	.06**(.02)	.06**(.03)
Change sales markets	.06**(.03)	.08**(.04)	.05*(.03)
# of Purchase and Sales Markets	.80*(.46)	.95**(.31)	.67*(.31)

Means comparison

Trim distribution of traders in cell phone markets with lower outcome values

Summary

- Cell phones are associated with a 6.5-22 percent decrease in price dispersion across markets
- The effect is larger for markets located farther apart and linked by poor quality roads
- The effect is also stronger over time, suggesting that cell phones are more useful as there are more network users
- The mechanism appears to be a change in traders' search behavior

Summary

- The findings *suggest* welfare improvements from the introduction of cell phones (lower consumer prices, higher traders' profits)
  - Traders' profits could decrease (zero profits) in the long-term
- However, how the gain is shared among farmers, traders and consumers is ambiguous
- Therefore, welfare estimates of farmers are needed…but not trivial!

Policy Implications

- It's the "I", not the "T" in information technology
  - Information alone is important for market performance and can reduce transaction costs, especially for remote areas

- But…cell phones provide information in a way that is "desirable" (timely, accurate)
  - Information technology should be central to the debate on existing (market) information systems in sub-Saharan Africa

Policy Implications

- Information provision is *necessary* but not *sufficient* for functioning markets
  - Investments in other factors that affect transaction costs (road quality, access to credit) are necessary

- Public-private partnerships can be useful for IT solutions in development
  - Cell phone expansion is happening without policy interventions or subsidies…but what about the market structure and pricing?
  - Opportunities for cell phone and development projects