The Visible Hand(set): Mobile Phones and Market Performance in South Indian Fisheries

The Micro and Mackerel Economics of Information

Robert Jensen

Is There a Role for IT in Development?

- Lots of software engineers getting rich….

  …but what about the other 99.999999 % ?????

- Many critics say, why IT when there are basic needs like nutrition, health care and education?
  - Even Bill Gates!
  - Certainly, anti-virus software no substitute for vaccines!

- But, they may be selling IT short, by missing what IT can do: make markets work.

The Importance of Agricultural Output Markets

- Significant proportion of the world's poor are in agriculture, fisheries or forestry.
  - Farmers, fishermen, etc.
  - Wage workers
- Consumers

→The functioning of markets for such products important for well-being of the poor.

Markets

- Coordinate numerous, dispersed producers and consumers.
- Price coordinates allocation of goods. Not enough eggs→price goes up and more are delivered.
- First Fundamental Theorem of Welfare Economics
- ‘Law of One Price’
- Rely on assumption agents can see prices.

Information & Market Functioning

- Stigler, Econs of Information: Implications Costly Search→Price dispersion
- Esp. where communications infrastructure is poor & markets dispersed, rural areas of poor countries.
- Without price, no reason assume efficient.
- Consumers/producers/intermeds don’t adjust to scarcity.
- Price dispersion reflects inefficiency. Improved info. could enhance market efficiency & help the poor.

Table 1. Prices and Excess Supply and Demand in 15 Beach Sardine Markets

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Hosabethe	6.2	0	0	4.3	0	0
Aarikkadi	4.0	0	0	5.9	0	0
Kasaba	0.0	0	4	5.9	0	0
Kanhangad	9.9	15	0	0.0	0	9
Thaikadappuram	0.0	0	11	6.1	0	0
Kannur District						
Puthiangadi	9.8	12	0	5.0	0	0
Neerkadavu	6.9	0	0	7.7	0	0
Ayikkara	8.4	1	0	0.0	0	13
Thalassery	4.3	0	0	5.7	0	0
New Mahe	6.2	0	0	0.0	0	5
Kozhikode District						
Chombala	8.7	2	0	1.9	0	0
Badagara	9.7	11	0	5.2	0	0
Quilandi	7.2	0	0	0.0	0	8
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Most of the poor need markets...

and markets need information.

But information is often lacking...

So maybe IT can help.

But we need evidence, not anecdotes!

This Project

- In Kerala, state in south India, fishing is:
  - A huge industry (1 million+ directly employed)
  - Important component of diet (70+% consume *daily*)
- 1997, cell phones available--big take-up by fishermen, traders. Market information.
- What is the impact on market functioning, LOP, profits and consumer prices/welfare.

Model: Two Stage Market Competition

- Fishermen from different towns choose among markets for selling their catch;
- Spatial correlation in catches, →supply caught near each town varies daily. Demand Saturation.
- As cost of acquiring price info declines, additional fishermen purchase this info, and use it to seek out the highest price for their catch.
- In equilib, the flow of supply from markets with low prices to markets with higher prices reduces dispersion.

Why is there waste and price variation in Kerala's fish markets?

- Why not go to other markets when have high catch?
- High transport costs and uncertainty.
- Plus, constraints:
  - Market open only a few hours (supply chain)
  - Can visit 1 market per day (distance)
  - fish can't be resold on land (distance, roads, cost)
  - can't store overnight
  - no contracting or futures market

THEOREM. For each Ψ, there is a subgame perfect Nash equilibrium such that,

(i) the equilibrium is symmetric across the two markets;

(ii) there is a function with such that fishermen in either market with catch x or above purchase the search technology and those with catch less than x do not;

(iii) the price dispersion between the markets when one zone is in state H and the other is in state L is weakly decreasing in Ψ. (prices identical if zones in the same state).

Increased Information

Results/Predictions

- More even supply across markets
- Price gaps close (to less than transport cost)
- Less waste
- Prices less volatile (still aggregate shocks)

  …but (daily) fishermen incomes more volatile
- Price level effect indeterminate
  - Shape of demand curve
  - Waste
  - Changes in strategic consumption behavior

Other causes price dispersion

Increased Information

Enables fishermen to check prices at several markets before selling.

‘*Fish prices…can vary widely among the 17 landing spots around Cochin. Before mobile phones, deciding which would offer the best price was sheer guesswork.’*

‘*On a recent day, [we] turned down an offer of 3,000 Rs for [our] catch in favor of a 12,000 Rs bid elsewhere.’*

– Captain P.A. ‘Joy’ Clarence, captain of the St. Xavier, quoted in newspaper.

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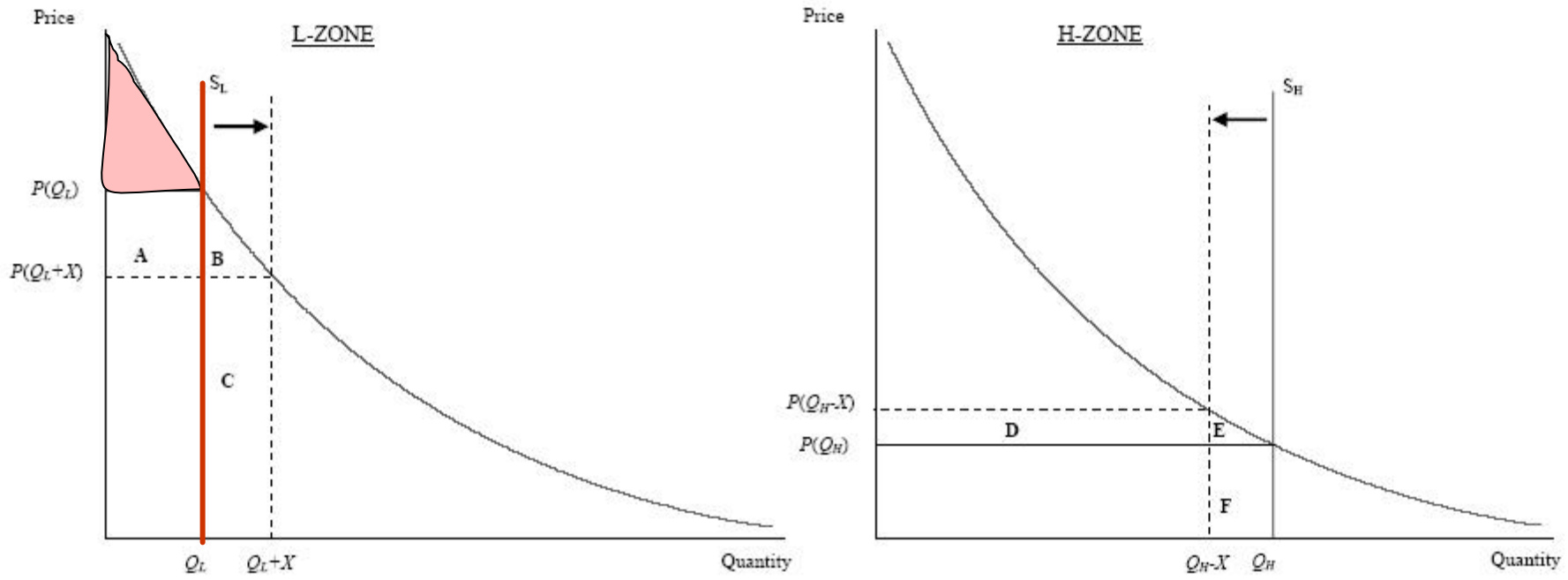
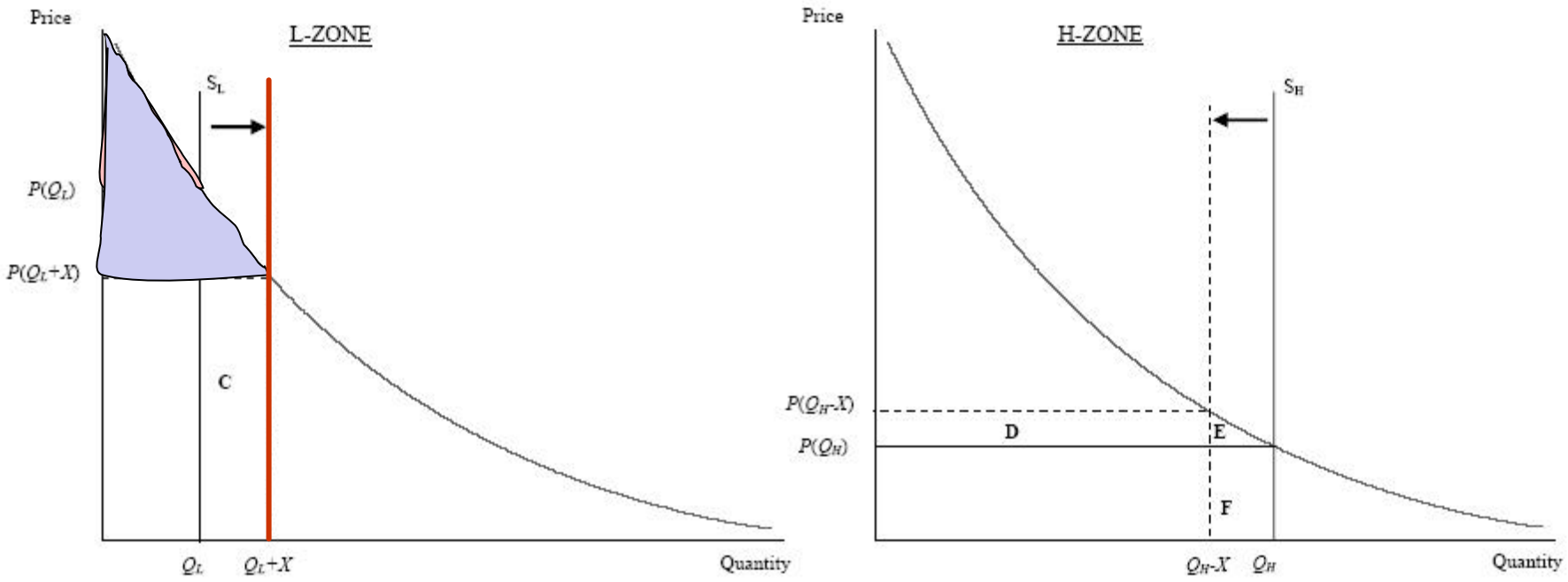


FIGURE I. CHANGES IN WELFARE ASSOCIATED WITH ARBITRAGE

Without arbitrage:

Consumers:



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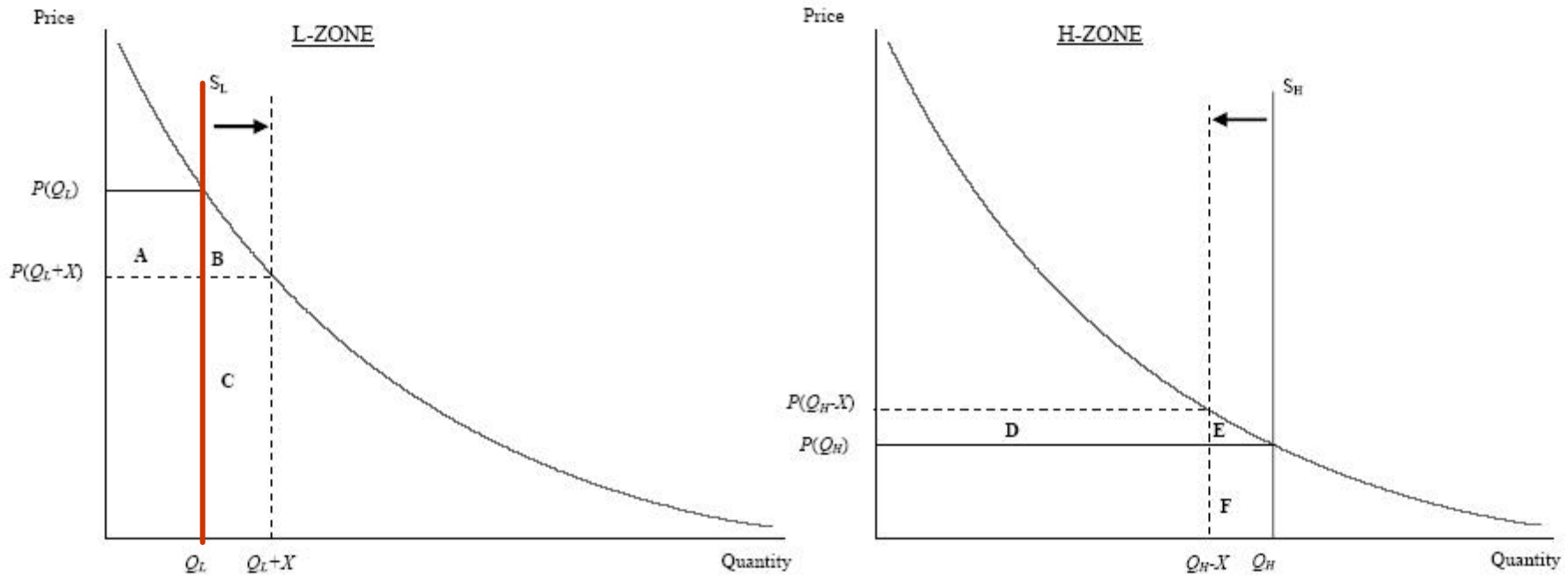

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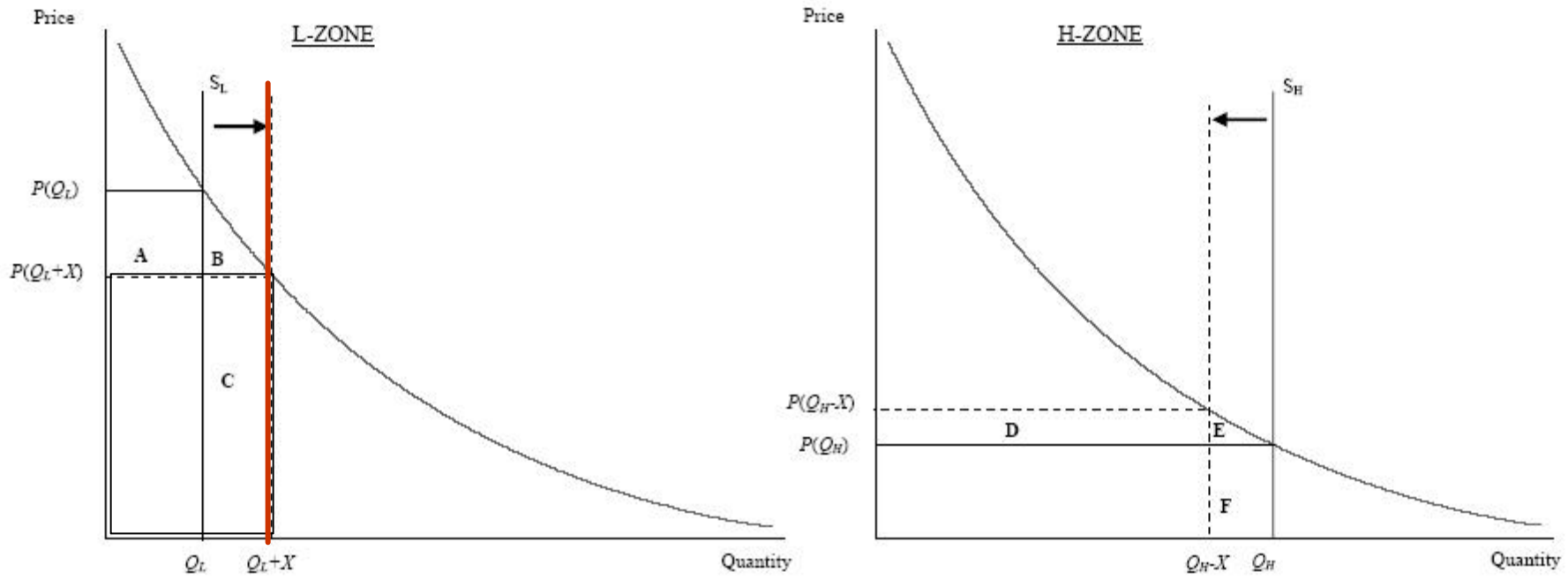

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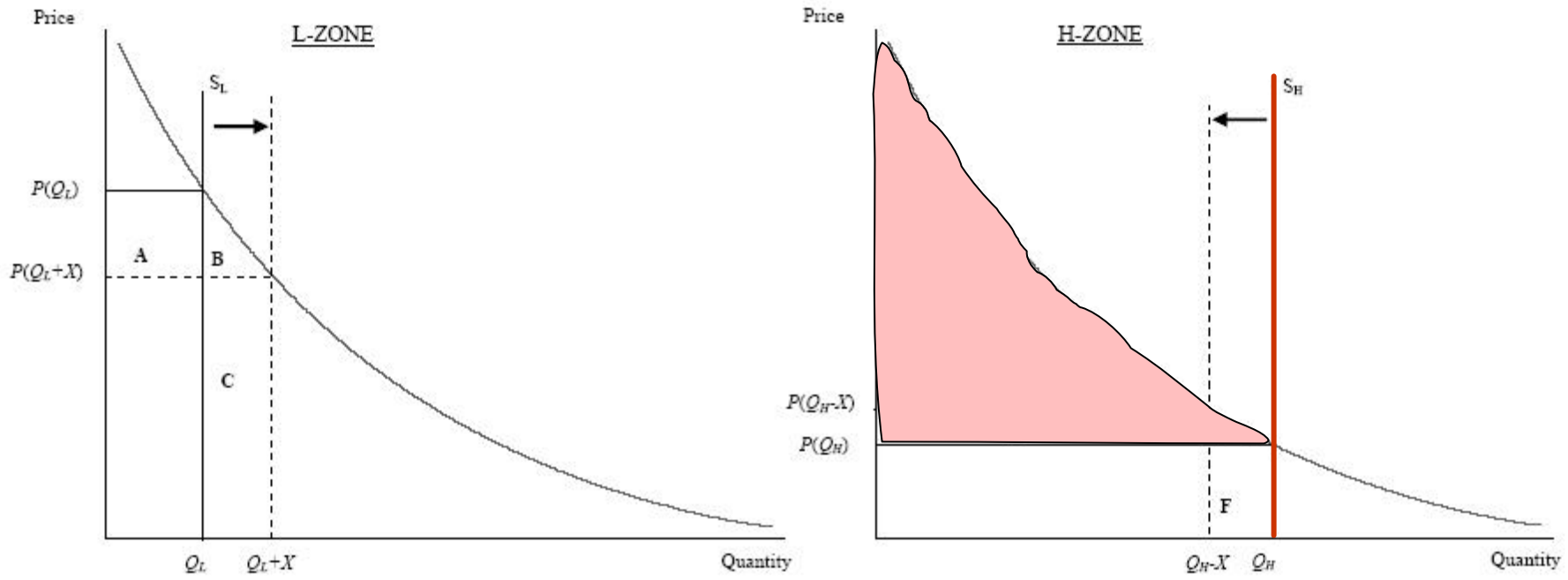
Consumers: A+B

Producers: C-A

Net Change B+C

Transfer A



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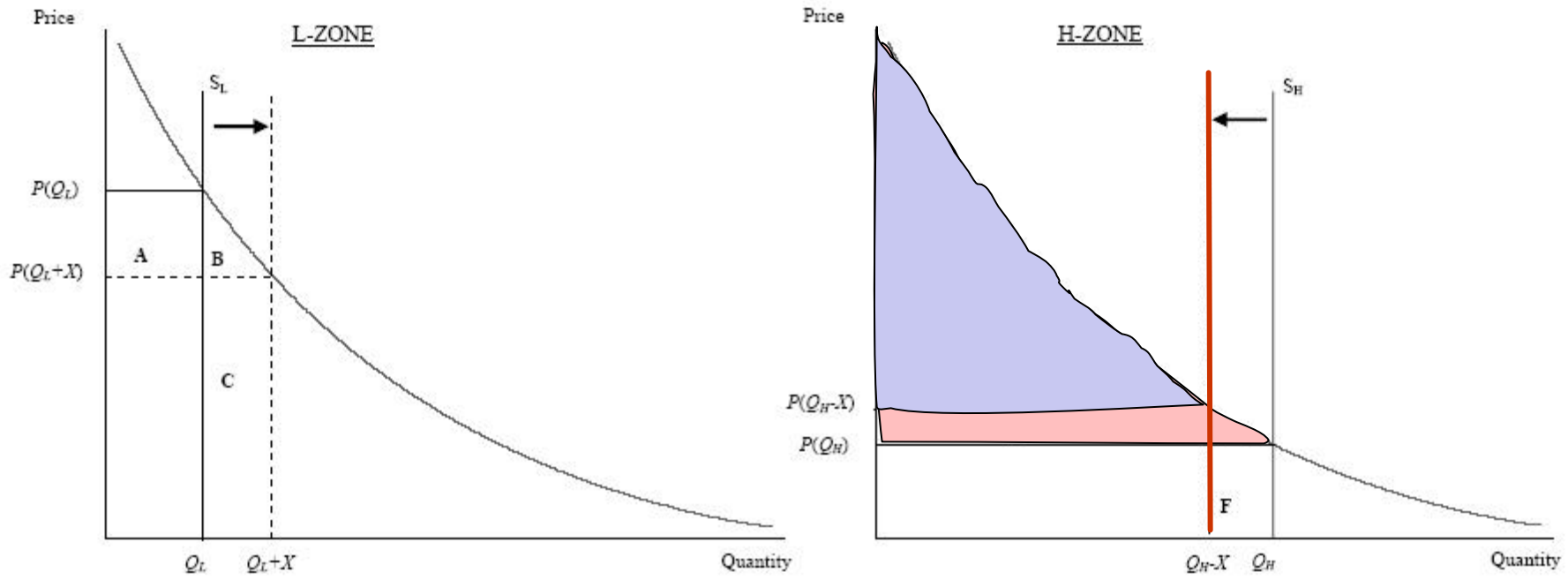

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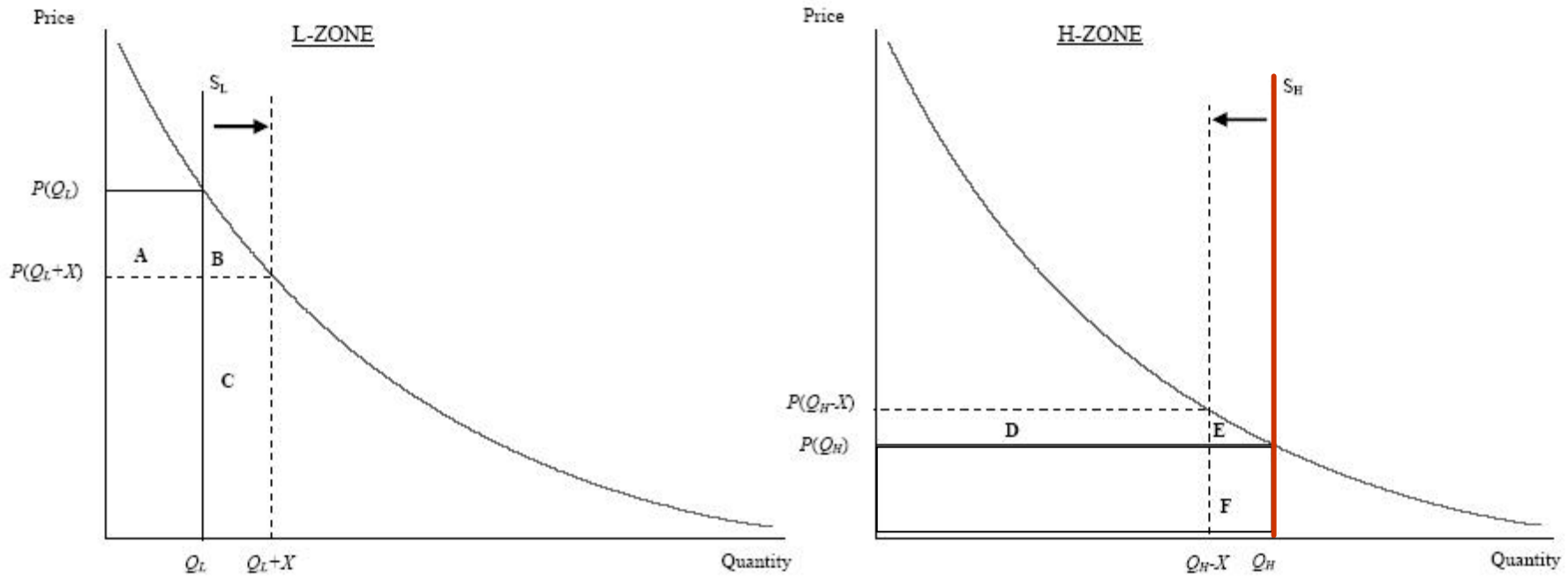

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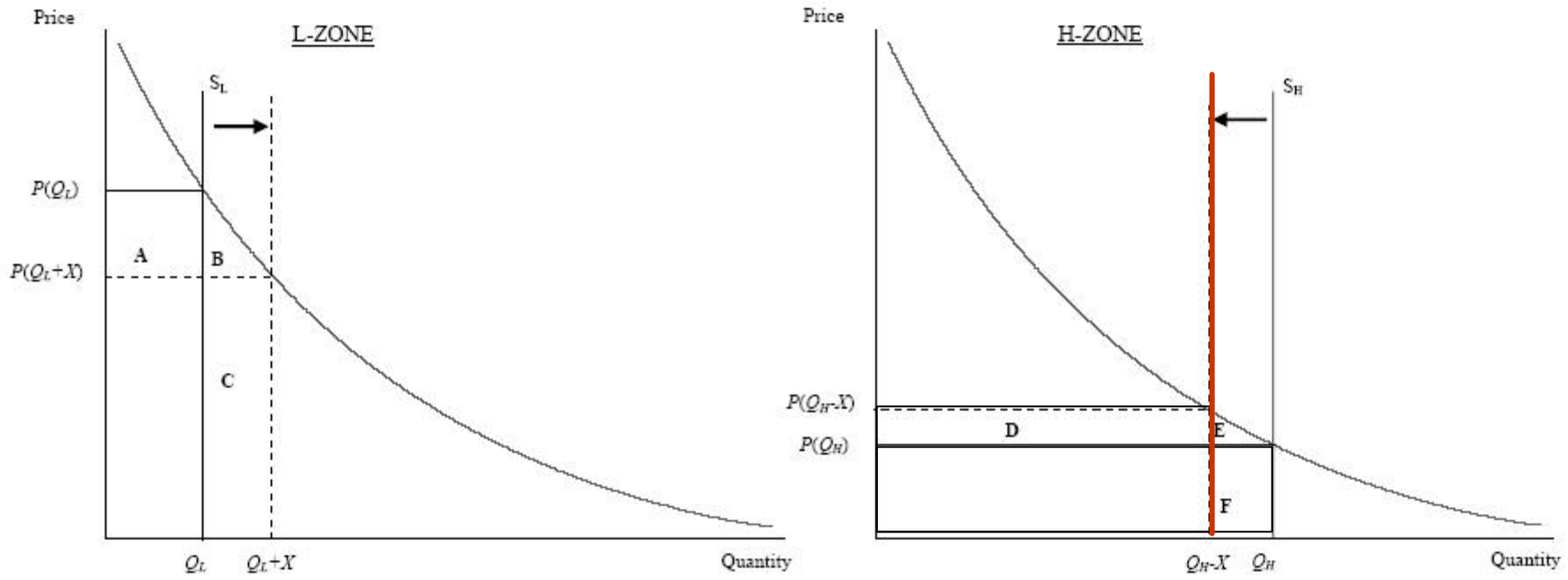

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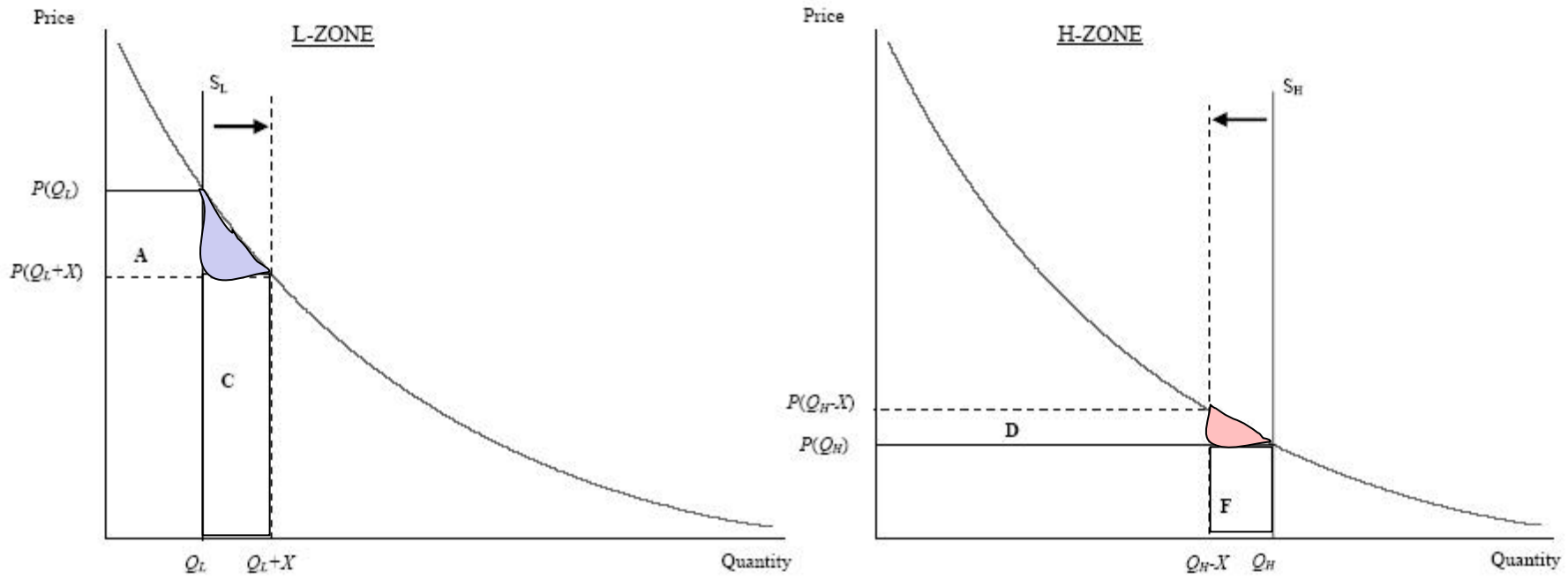

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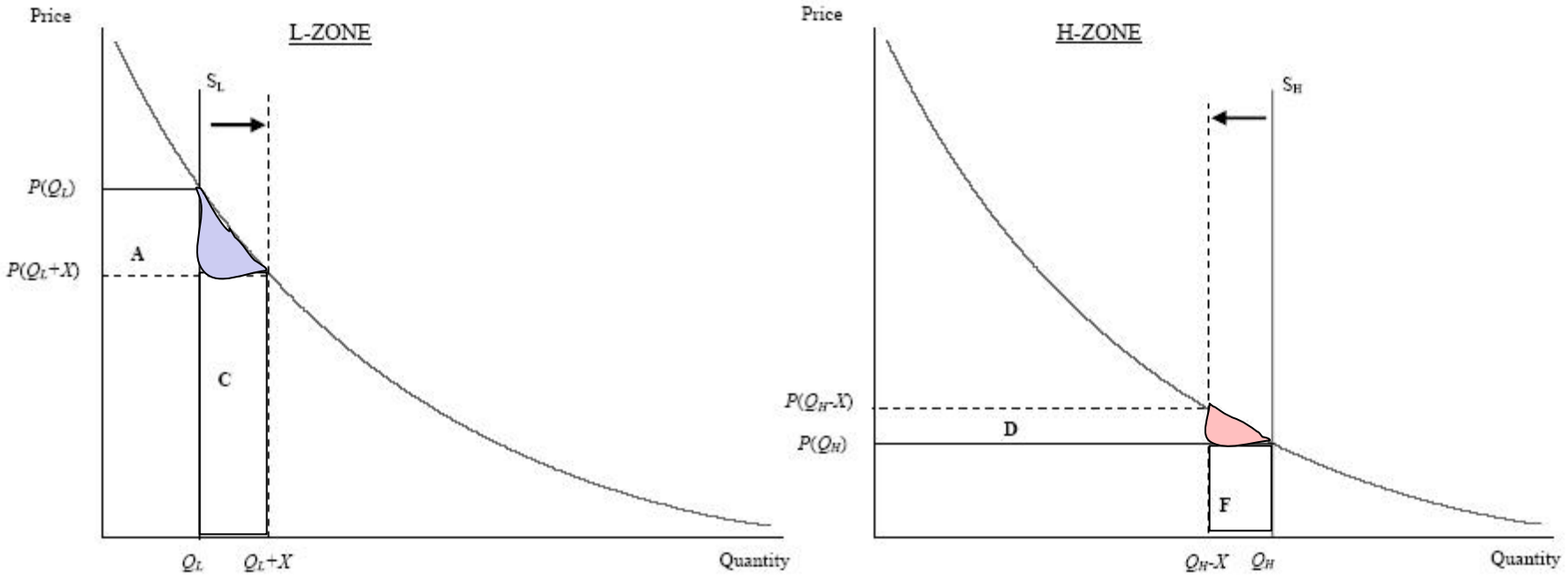

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$$\int_{Q_L}^{Q_L+x} P(Q)dQ - \int_{Q_H-x}^{Q_H} P(Q)dQ$$

Welfare Gains

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Well, then, do consumers lose at expense of producers or vice-versa?

It's possible. But not as easy as you think.

Also, less likely if reduced waste.

The Case of Kerala

- 590 km coastline (+rivers/backwaters)
- Hundreds of fishing villages, 1million+ fishermen
- 600 K tons annual fish production
- 70+% eat fish daily. Primary source protein.
- Sardines (small, cheap), mackerel, prawns, seer

The Case of Kerala

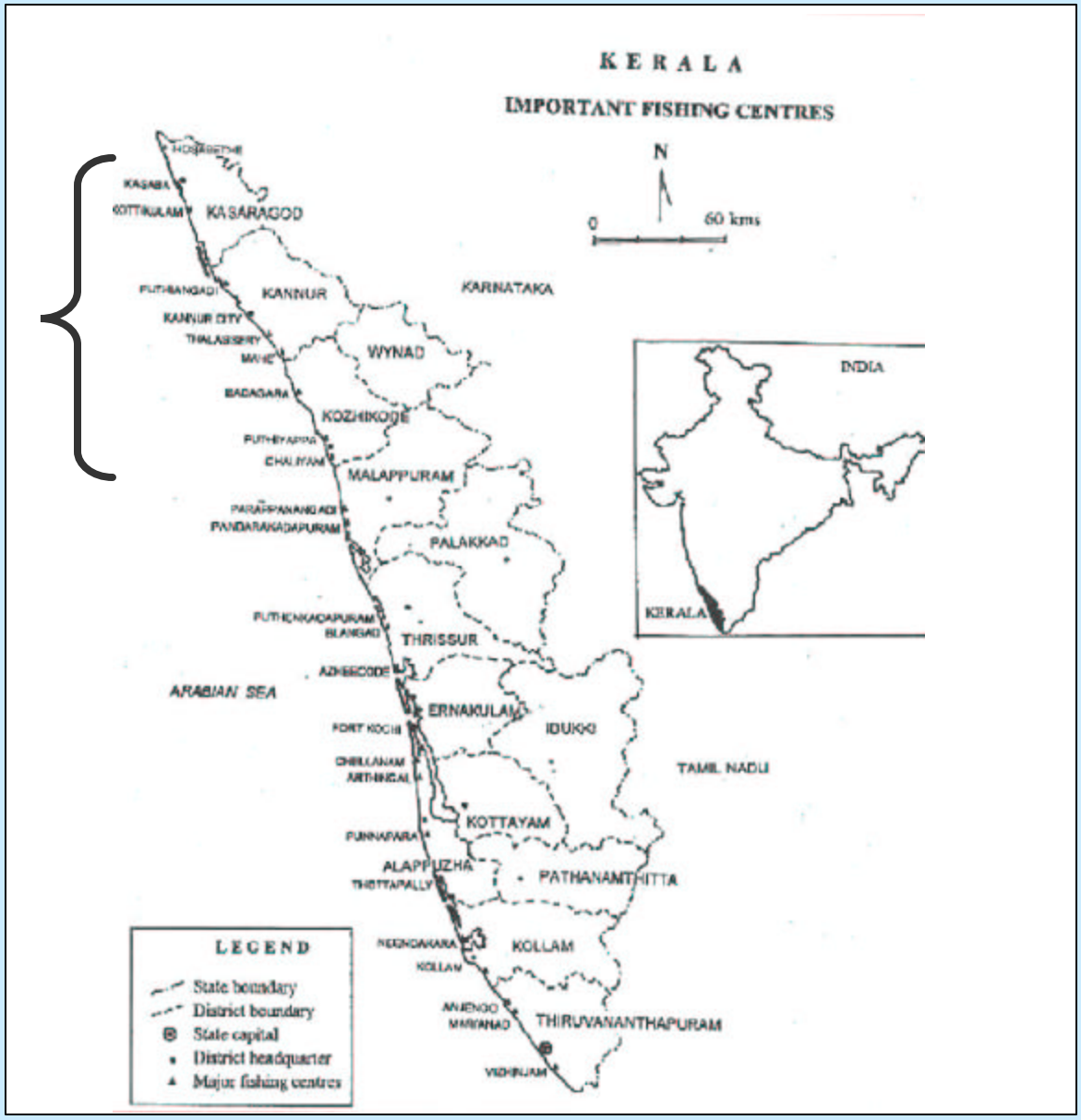
Fishing

- Wooden canoes, plywood or fiber glass boats
- Mostly outboard motors, 9-40HP.
- Gill net fishing, ring seine units
- 1-30 person crew, most 5 - 15. Joint ownership.

Marketing

- ~100-150 beach landings where sell fish, ~10km apart.
- Markets run largely from 5-8AM.
- Pre, Most fish sold via beach auction (English).
- Said to be competitive (buyers not collude (TN)).
- Little in way of interlinked transactions

Figure 1. Region of Study



Source: Reproduced from SIFFS (1999).

Three fishing regions

I. Small and medium scale. Sardines. Lots of phone use.

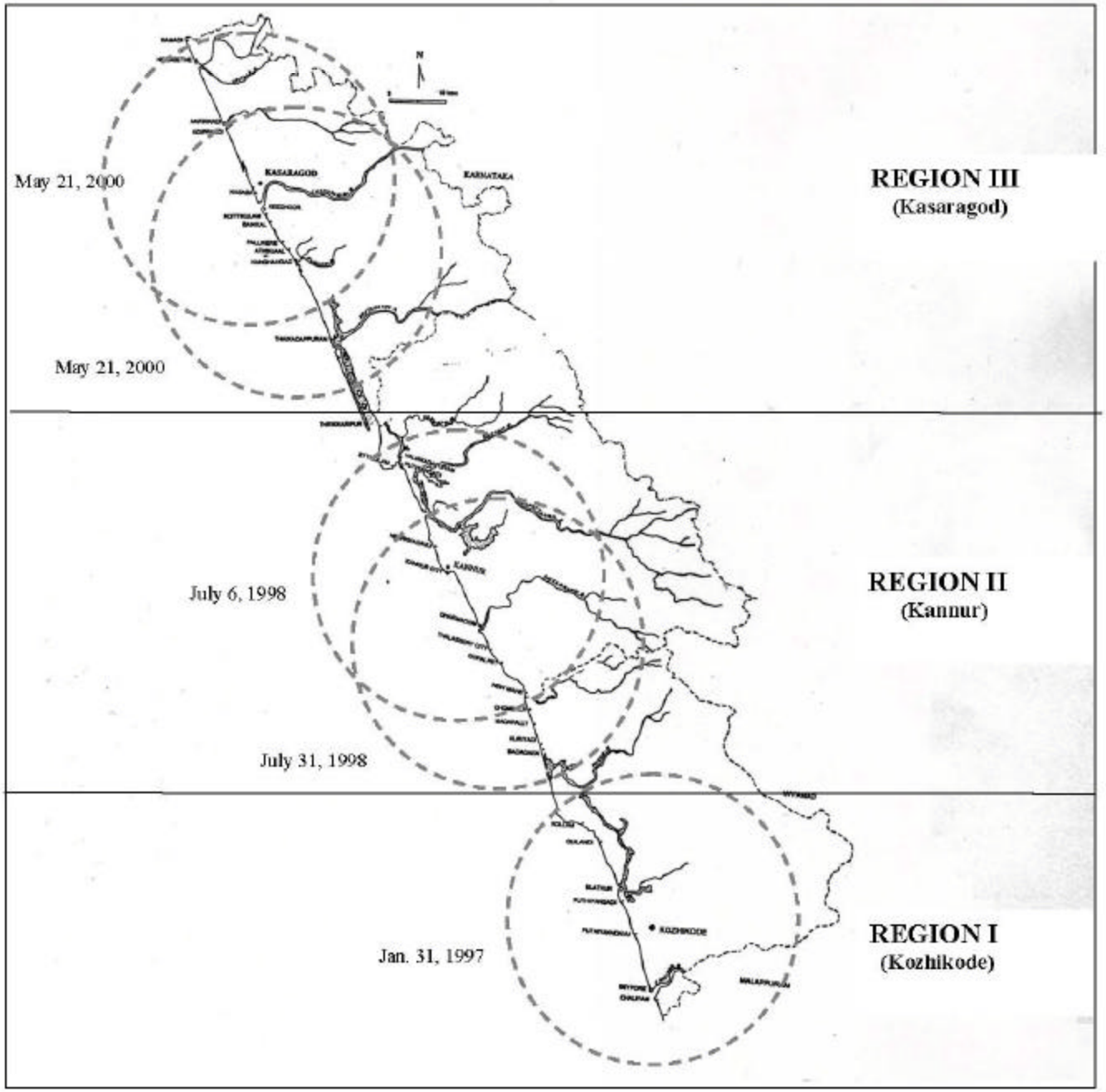
II. Large, commercial. Prawns, big fish. Export. Two-way radios long ago.

III. Very small scale. Mack/sard. Few phone.

Empirical Strategy

- Mobile Phones introduced 1997. Staggered intro.
- By mid-2001 nearly entire coast covered.
- Towers built right along sea walls jutting out to sea. Typically cover ~25km to sea, also the distance at which most fishing is done (5-30km).

Figure 1. Spread of Mobile Phone Coverage, Kasaragod, Kannur and Kozhikode Districts



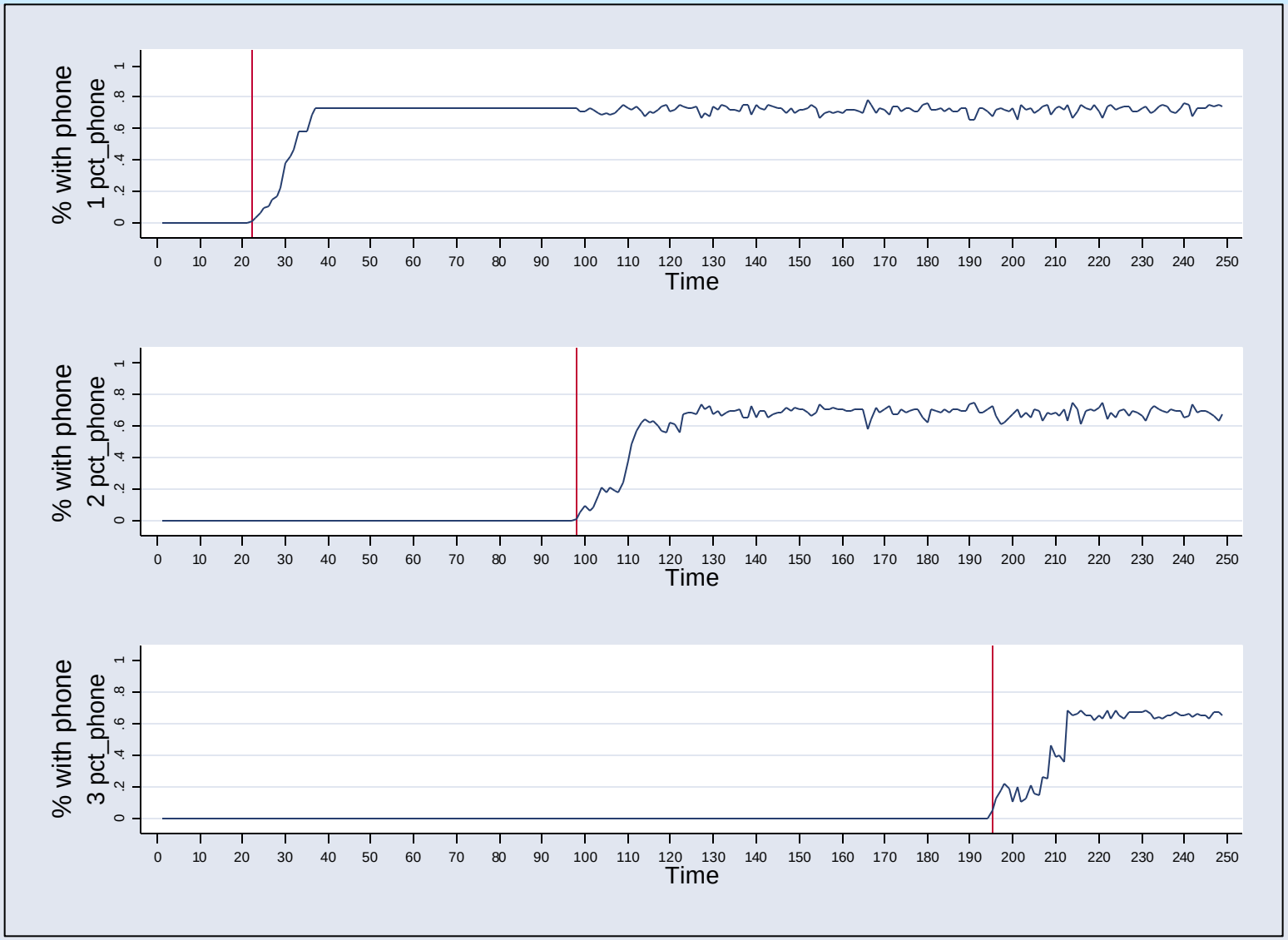
Data

- Beach Market Survey (N=15, ~15km apart, 225km)
  - 7-8AM, every Tuesday, Sept. 3, 1996 to May 29, 2001.
  - All transactions, prices, quantities, size, times, type of fish, mode of sale, dumping, weather, wind and sea conditions, fuel costs.

- Fisherman survey (weekly, N=15*20)
  - Where fished, amount caught, type caught, when caught, markets visited, where sold, when sold, size, waste, price received, fuel use, mode of sale.

- Fishing village survey (monthly, N=15)
- Consumer price survey (weekly, N=15)

High Adoption Rates



Large Changes in Fish Marketing

1996

2001

Large Changes in Fish Marketing

	Period 0 (Pre-phone)	Period 1 (Region I Has Phone)	Period 2 (Region II Has Phone)	Period 3 (Region III Has Phone)
% who sell in own zone				
Region I	1.00 (0.00)	.66 (.005)	.63 (.005)	.62 (.006)
Region II	1.00 (0.00)	1.00 (0.00)	.64 (.004)	.58 (.006)
Region III	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	.70 (.005)
% who sell in own region				
Region I	1.00 (0.00)	1.00 (0.00)	1.00 (.0004)	1.00 (.004)
Region II	1.00 (0.00)	1.00 (0.00)	.95 (.002)	.91 (.003)
Region III	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	.95 (.003)

Empirical Strategy

Compare changes in market performance relative to the staggered introduction of mobile phones.

Region I: Kozhikode (January 29, 1997)

Region II: Kannur (June 6, 1998) + Thalassery (July 31, 1998)

Region III: Kasaragod + Khanhangad (May 21, 2000)

Periods:

- 0 (weeks 1-21), no one has phones.
- 1 (weeks 22-97), region I has phones
- 2 (weeks 97-194) region II has phones
- 3 (weeks 195-248) region III has phones

Empirical Strategy

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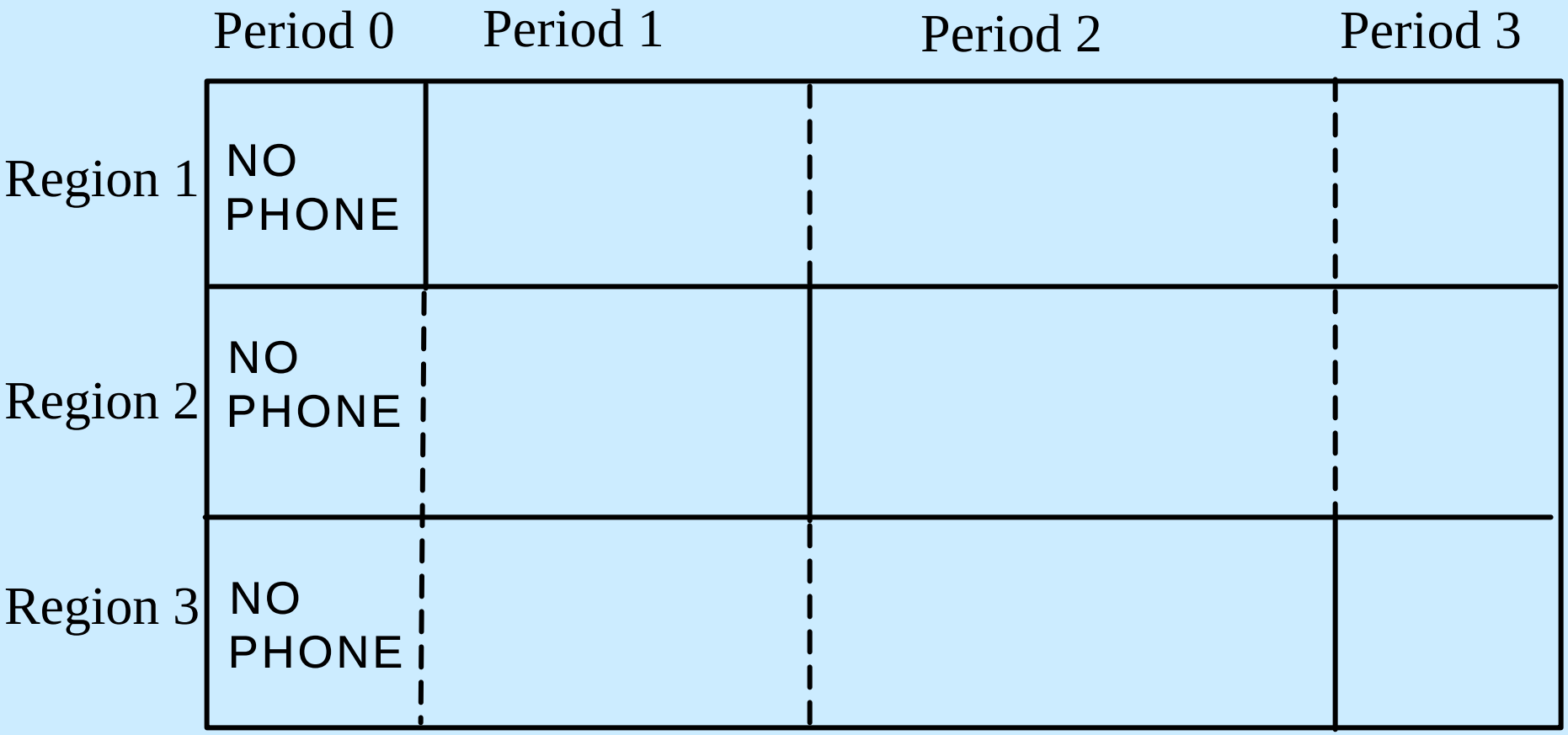

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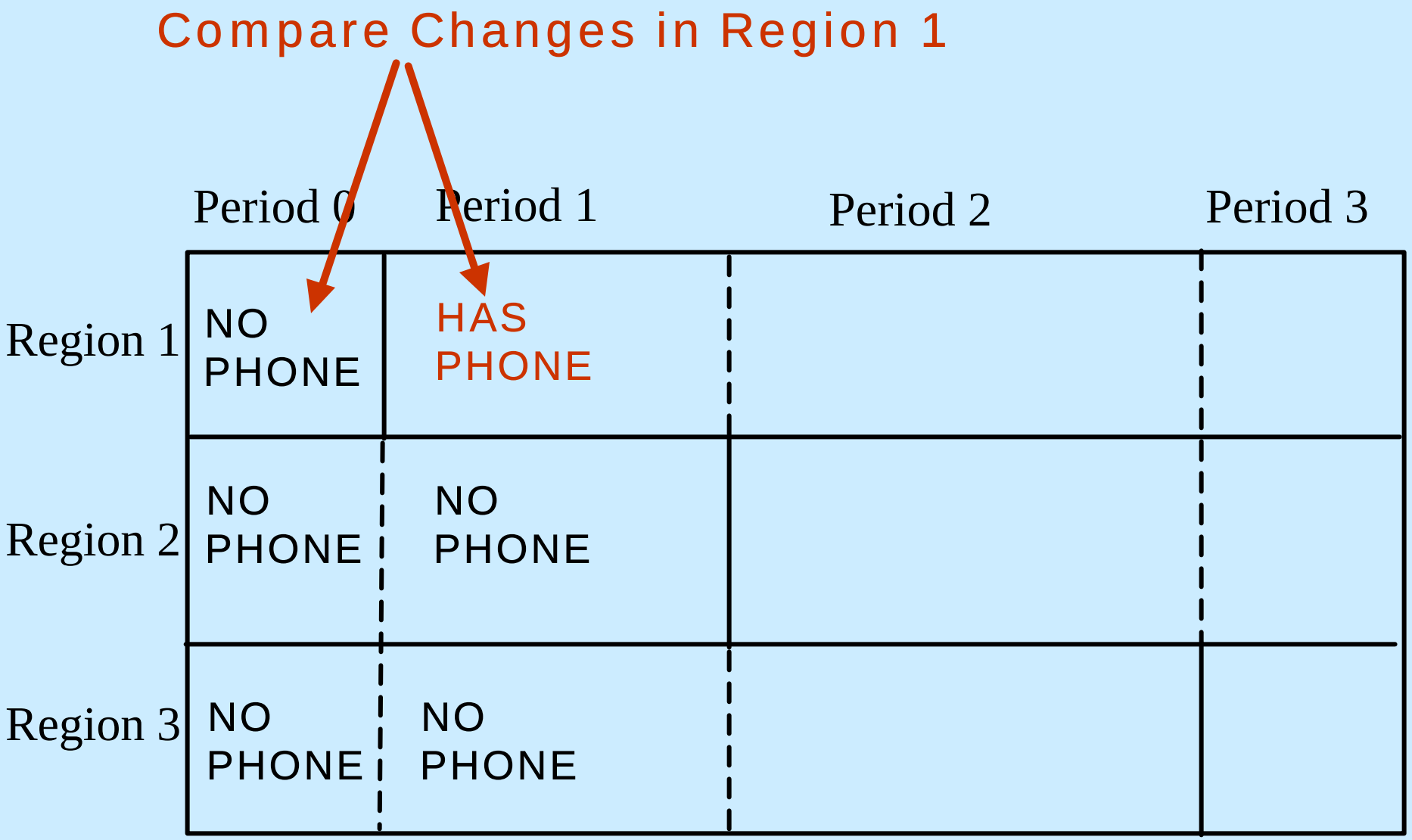

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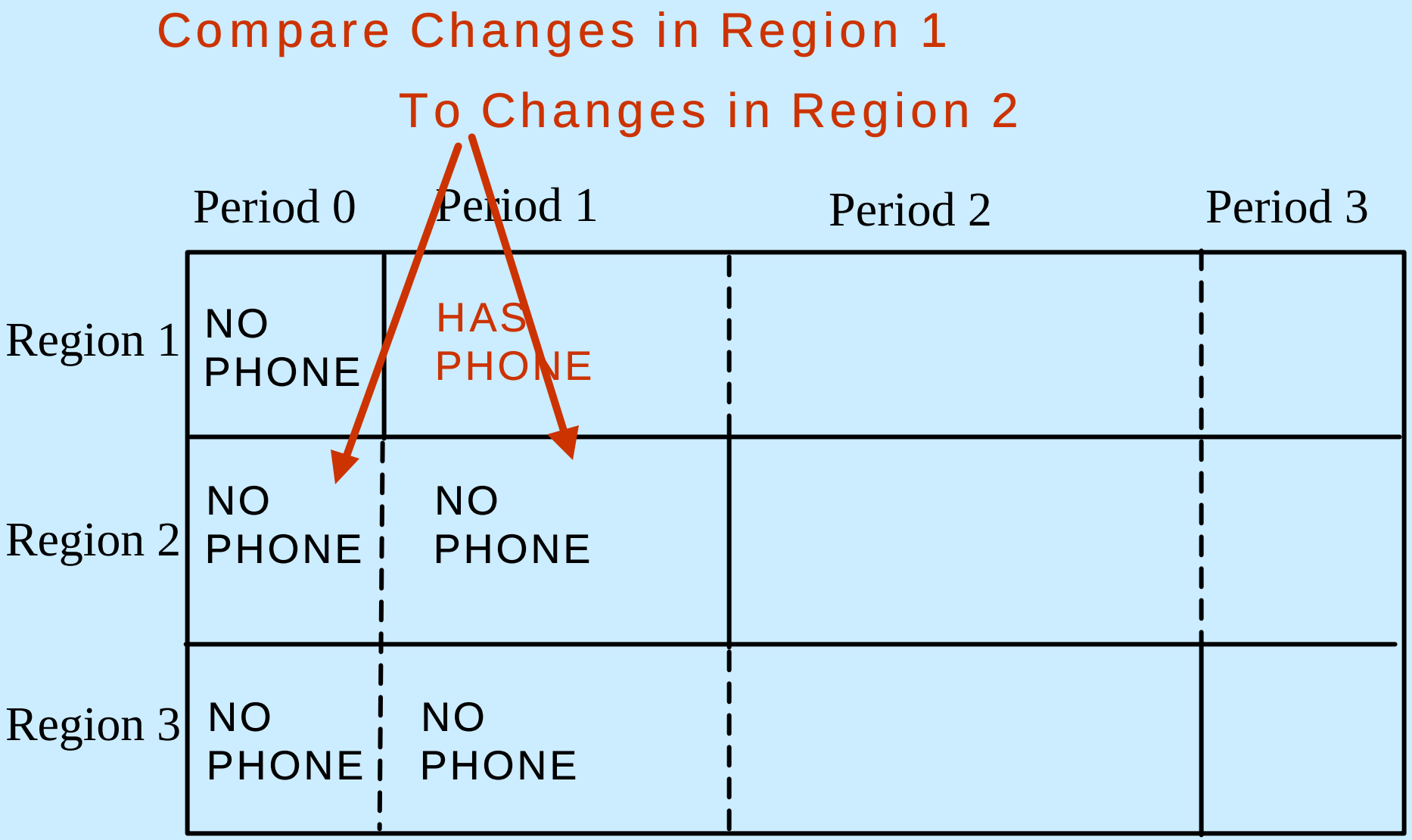

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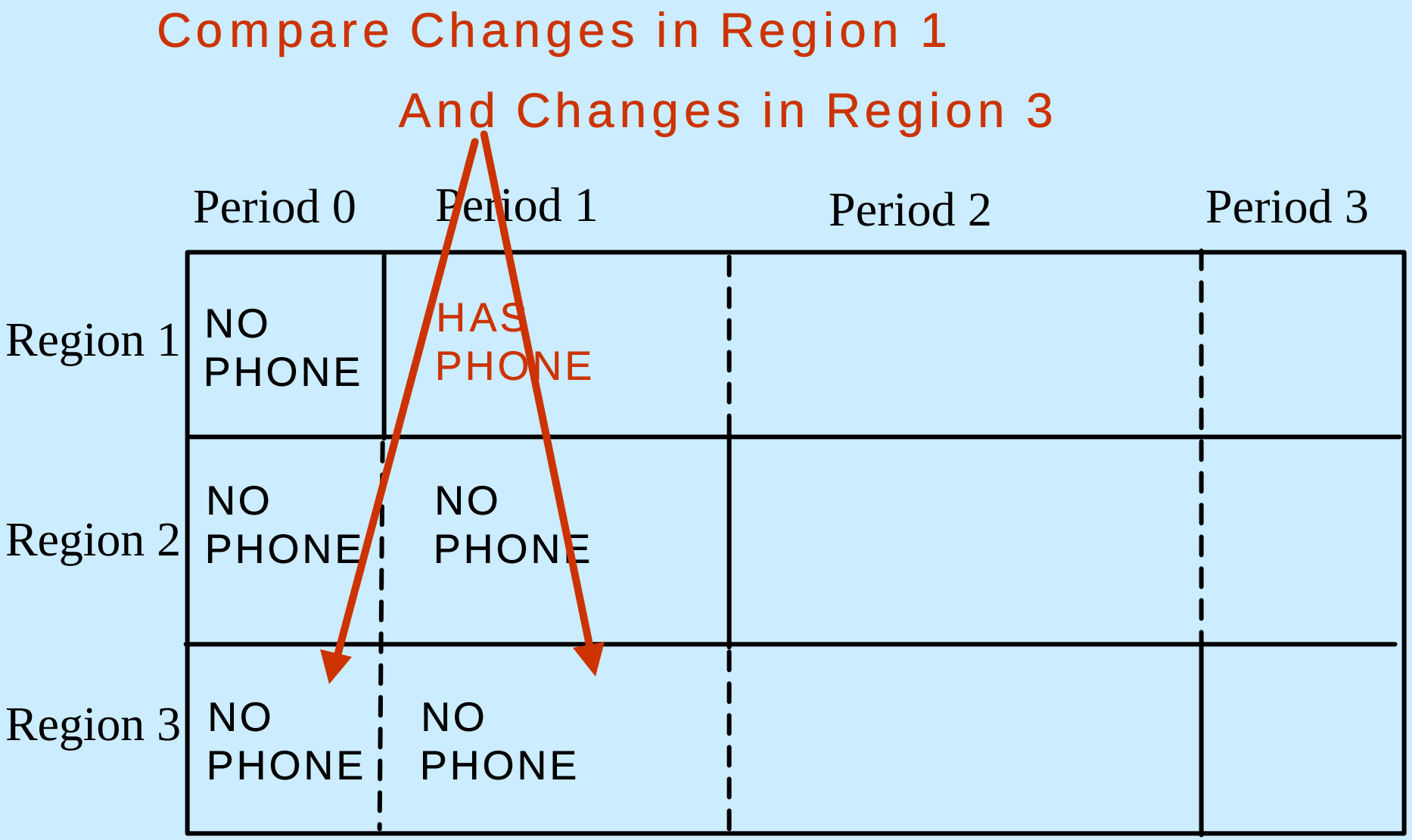
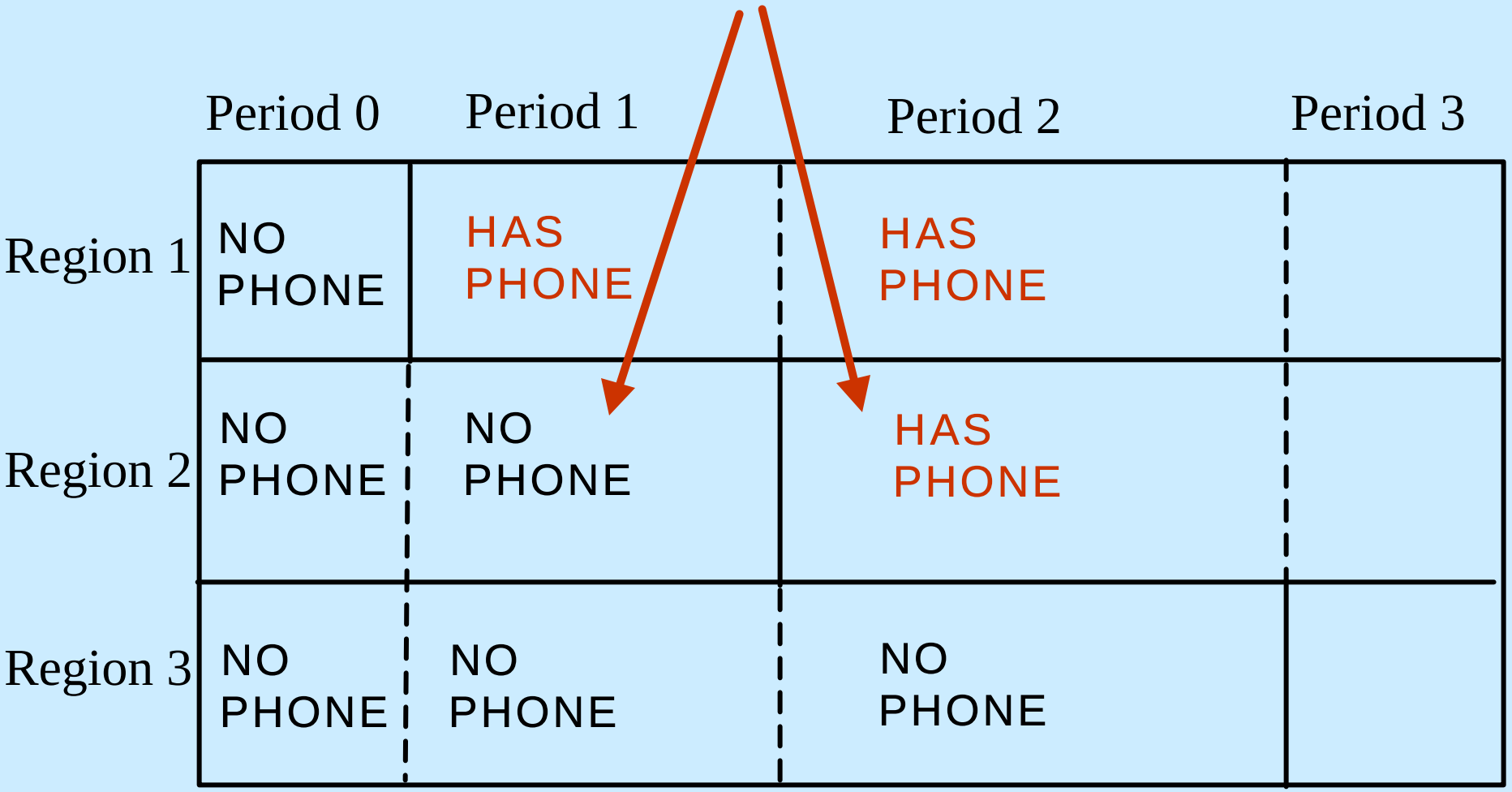


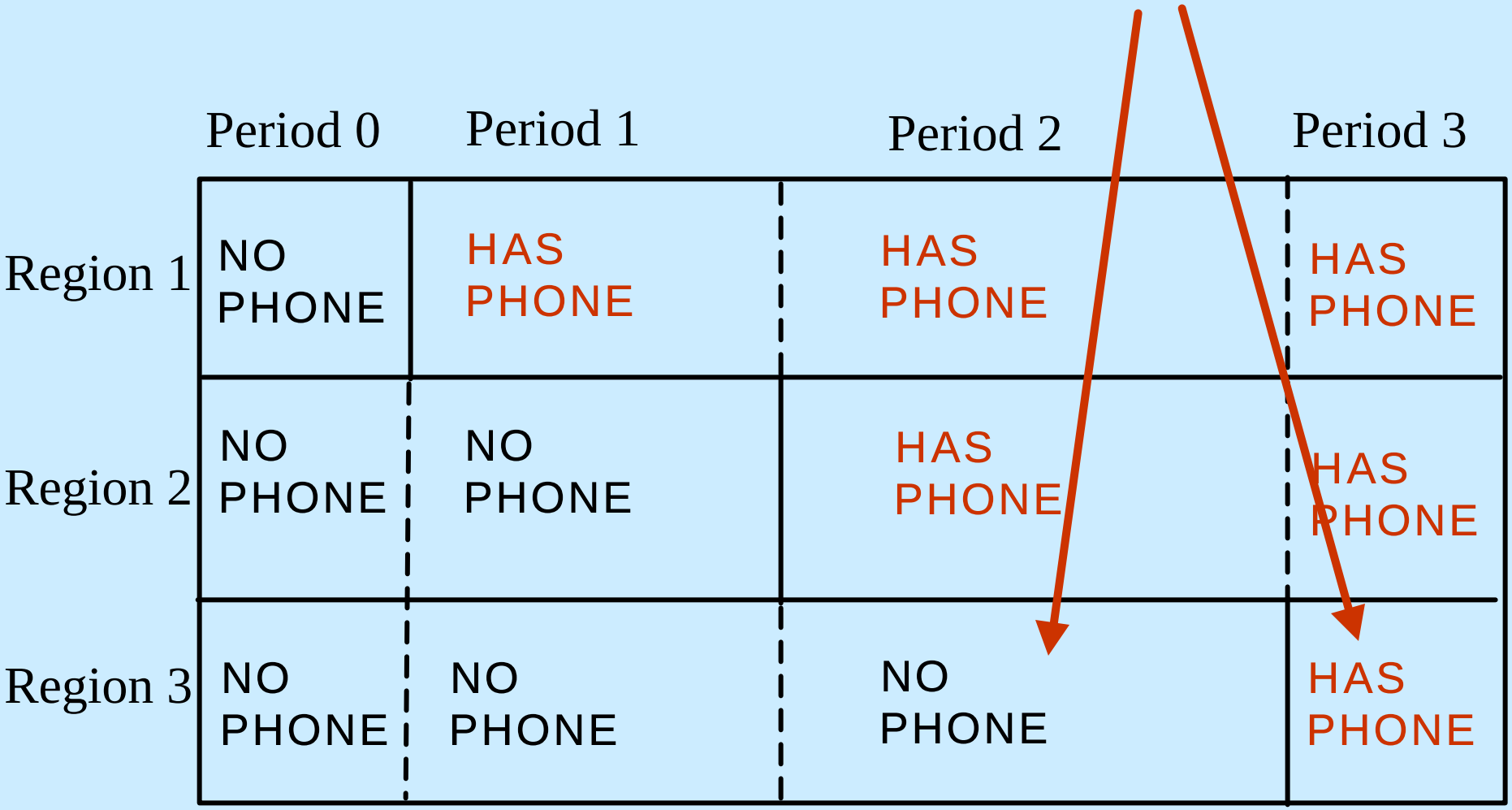
Empirical Strategy

The do the same when region 2 adds the phone



Empirical Strategy

And when region 3 adds the phone



Empirical Strategy

In order to quantify the effects and control for other factors that may affect arbitrage, we estimate

$$Y_{r,t} = a + \sum_{r=1}^{2} \sum_{p=0}^{3} b_{Rr\_Pp} Region_r Period_p + g Z_{r,t} + e_{m,t}$$

Y: max-min spread, coefficient of variation, waste, LOP (more later), profits, consumer prices, consumer welfare.

Controls for fixed-differences across regions, time effects common to all regions, differential trends or changes common to all regions.

Identifying Assumption

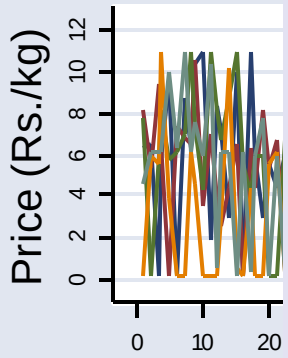
In the absence of mobile phones, there would have been no differential change across the regions.

Placement definitely non-random. Based on population density.

1. No pre-existing differential trends across regions.
2. No other factors changed differentially that could also have influenced market outcomes.
3. Migration, entry/exit, did phones change anything else (wealth)? Other changes (collusion)

Empirical Strategy

	Period 0 (Pre-phone)	Period 1 (Region I has phones)	Period 2 (Region II has phones)	Period 3 (Region III has phones)
(Max-Min) (Rs.)				
Region I	7.71 (.48)	1.77 (.17)	1.38 (.06)	1.39 (.08)
Region II	7.25 (.56)	7.38 (.29)	1.63 (.11)	1.41 (.08)
Region III	7.67 (.41)	7.06 (.23)	7.70 (.22)	2.13 (.21)
Coefficient of Variation (%)				
Region I	.66 (.05)	.14 (.02)	.09 (.004)	.09 (.005)
Region II	.62 (.07)	.65 (.04)	.11 (.01)	.09 (.005)
Region III	.66 (.04)	.64 (.04)	.73 (.04)	.17 (.02)
Waste (%)				
Region I	.068 (.012)	0.0 (.00)	0.0 (.00)	0.0 (.00)
Region II	.054 (.010)	.049 (.006)	0.0 (.00)	0.0 (.00)
Region III	.063 (.009)	.059 (.006)	.057 (.006)	0.0 (.00)


Price (Rs./kg)
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4
6
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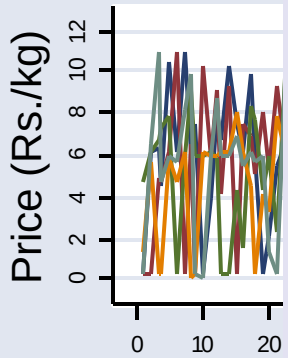
12
0
10
20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12
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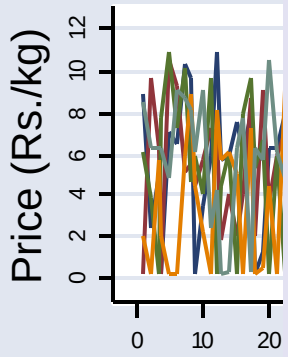
20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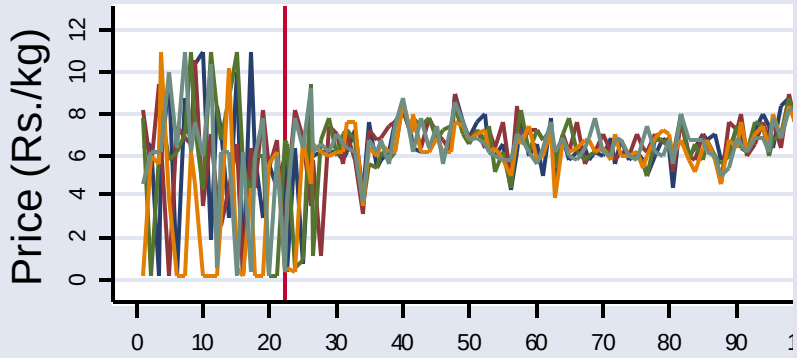
Price (Rs./kg)
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30
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50
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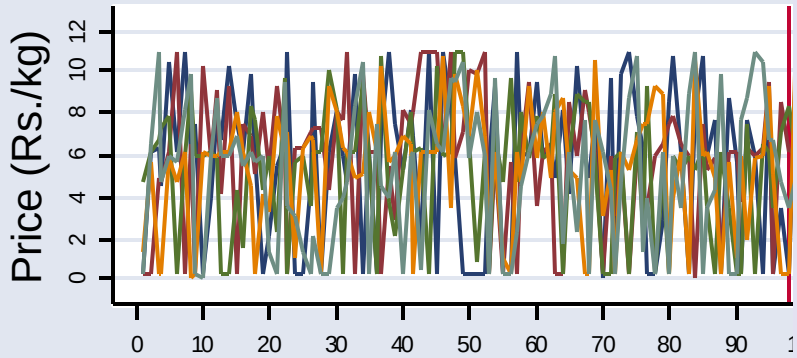
80
90


Price (Rs./kg)
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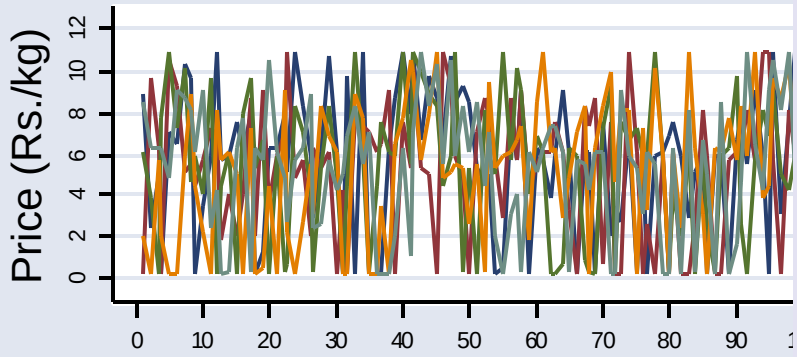
Price (Rs./kg)
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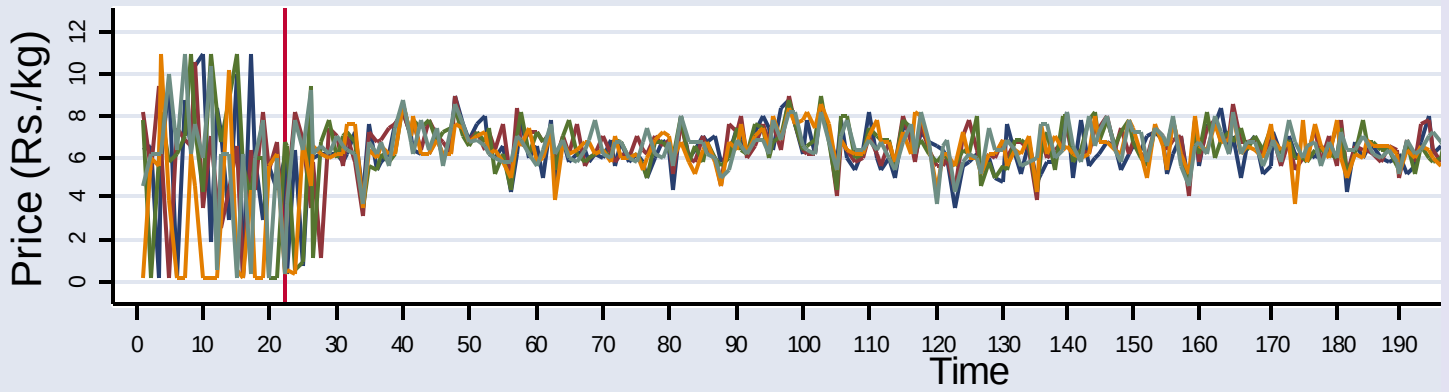
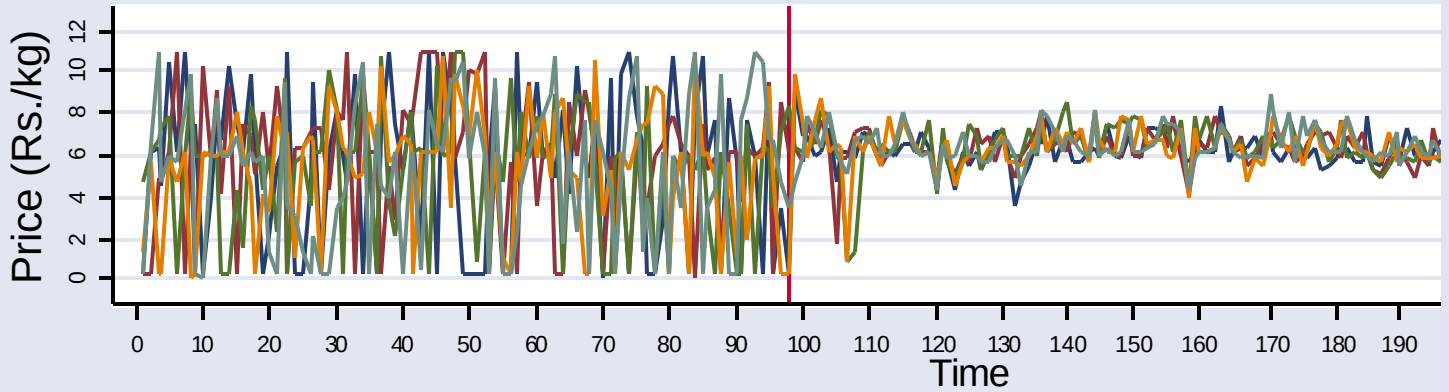
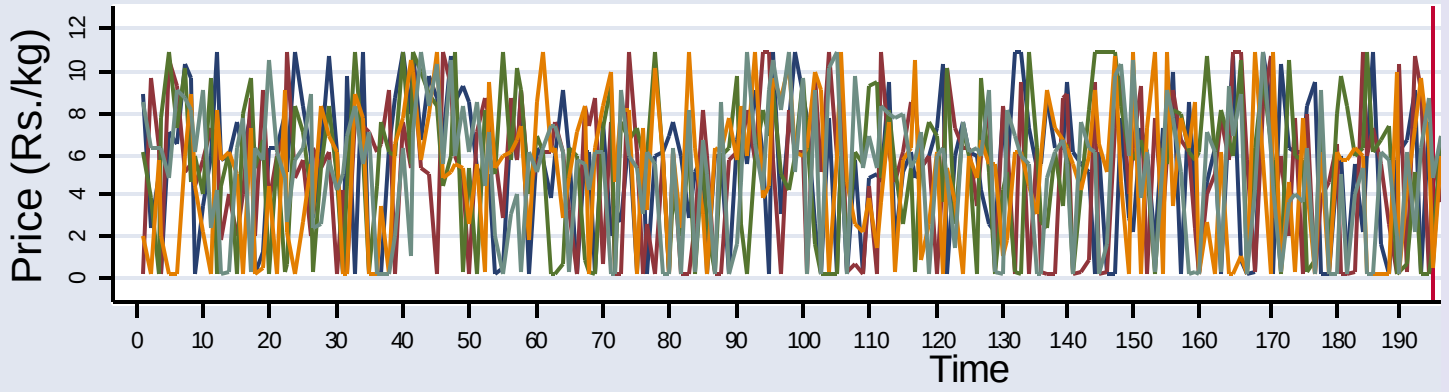

Price (Rs./kg)
0 2 4 6 8 10 12
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190
Time


Price (Rs./kg)
0 2 4 6 8 10 12
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190
Time


Price (Rs./kg)
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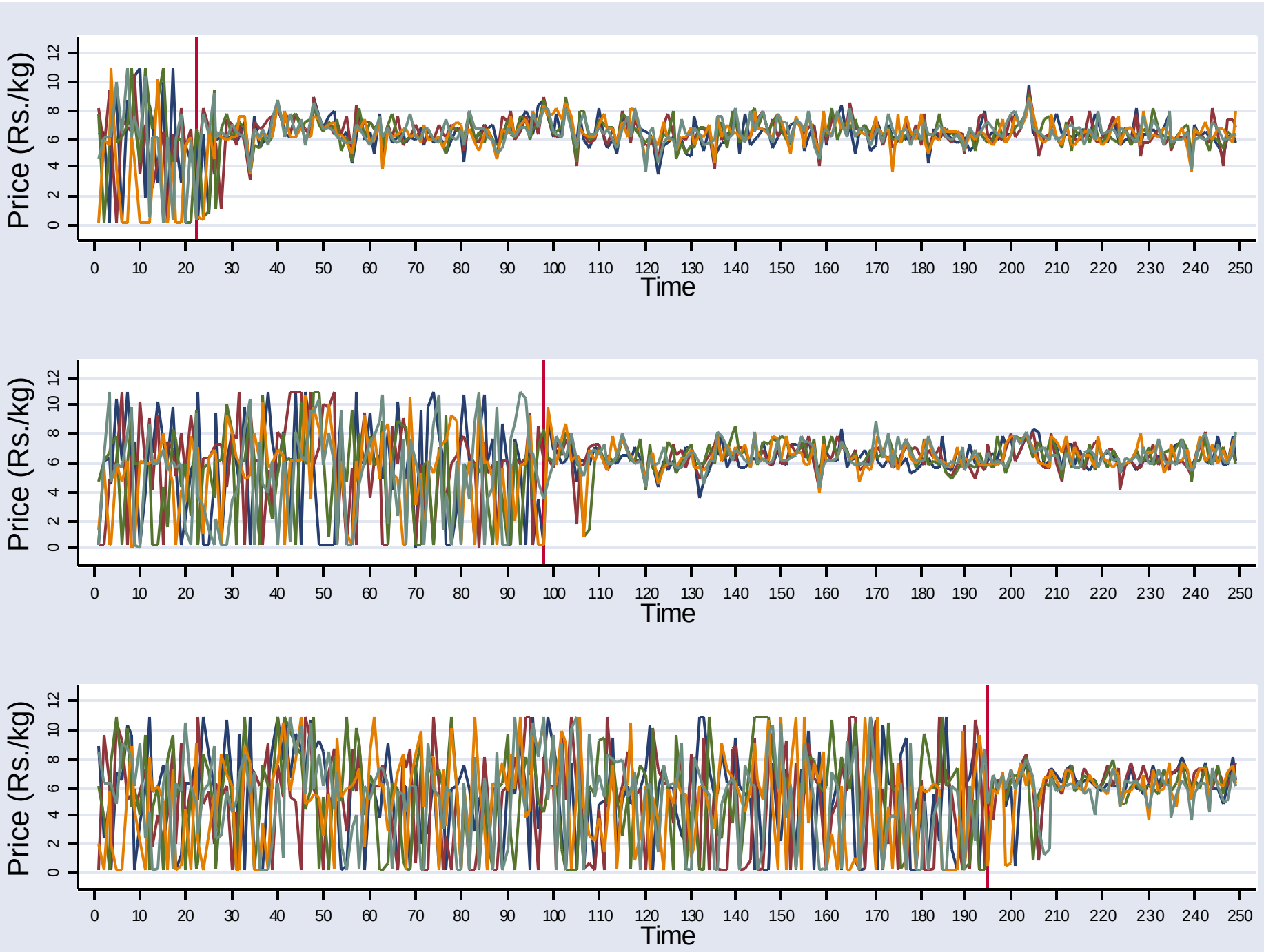
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190
Time


Price (Rs./kg)
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Time
Price (Rs./kg)
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0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250
Time
Price (Rs./kg)
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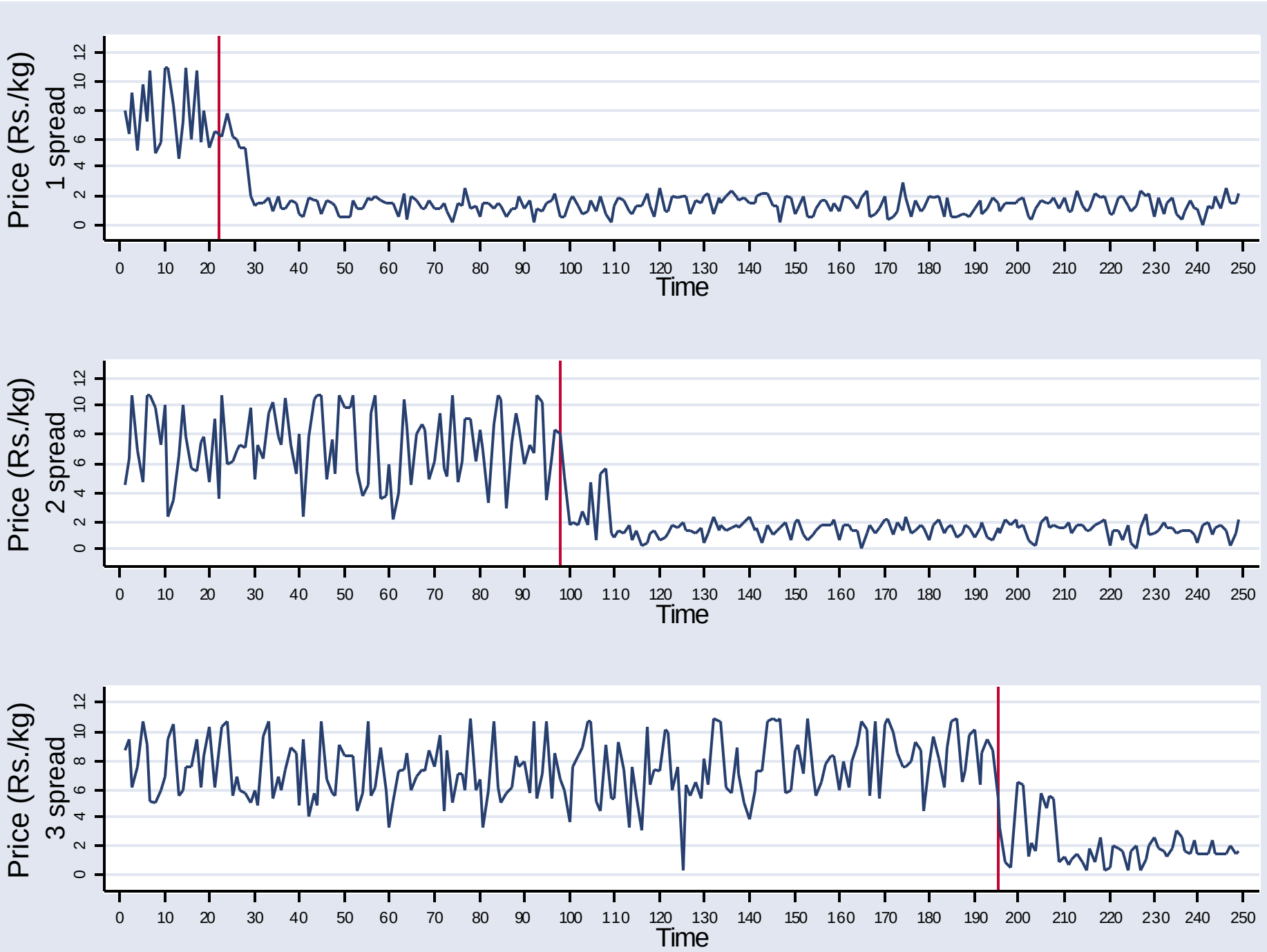
12
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250
Time


Price (Rs./kg)
1 spread
0 2 4 6 8 10 12
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250
Time
Price (Rs./kg)
2 spread
0 2 4 6 8 10 12
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250
Time
Price (Rs./kg)
3 spread
0 2 4 6 8 10 12
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250
Time


% fishermen with waste
1 pct_has_waste
0
.05
.1
.15
.2
.25
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250
Time
% fishermen with waste
2 pct_has_waste
0
.05
.1
.15
.2
.25
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250
Time
% fishermen with waste
3 pct_has_waste
0
.05
.1
.15
.2
.25
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250
Time

Identifying Assumption

1. Pre-existing differential trends across regions.
2. Other factors that could have influenced markets.

The changes around the three discrete points are sudden and sharp. It's unlikely something else just happened to change at these three same exact moments (and in the same direction).

Further, no other big changes seen, so they would have changed only at these times.

3. Maybe phones changed something other than arbitrage.
   - Wealth: Ambiguous effect.
     - No evidence showing that it affects dispersion (not quality)
     - We don't see the effects for other prices

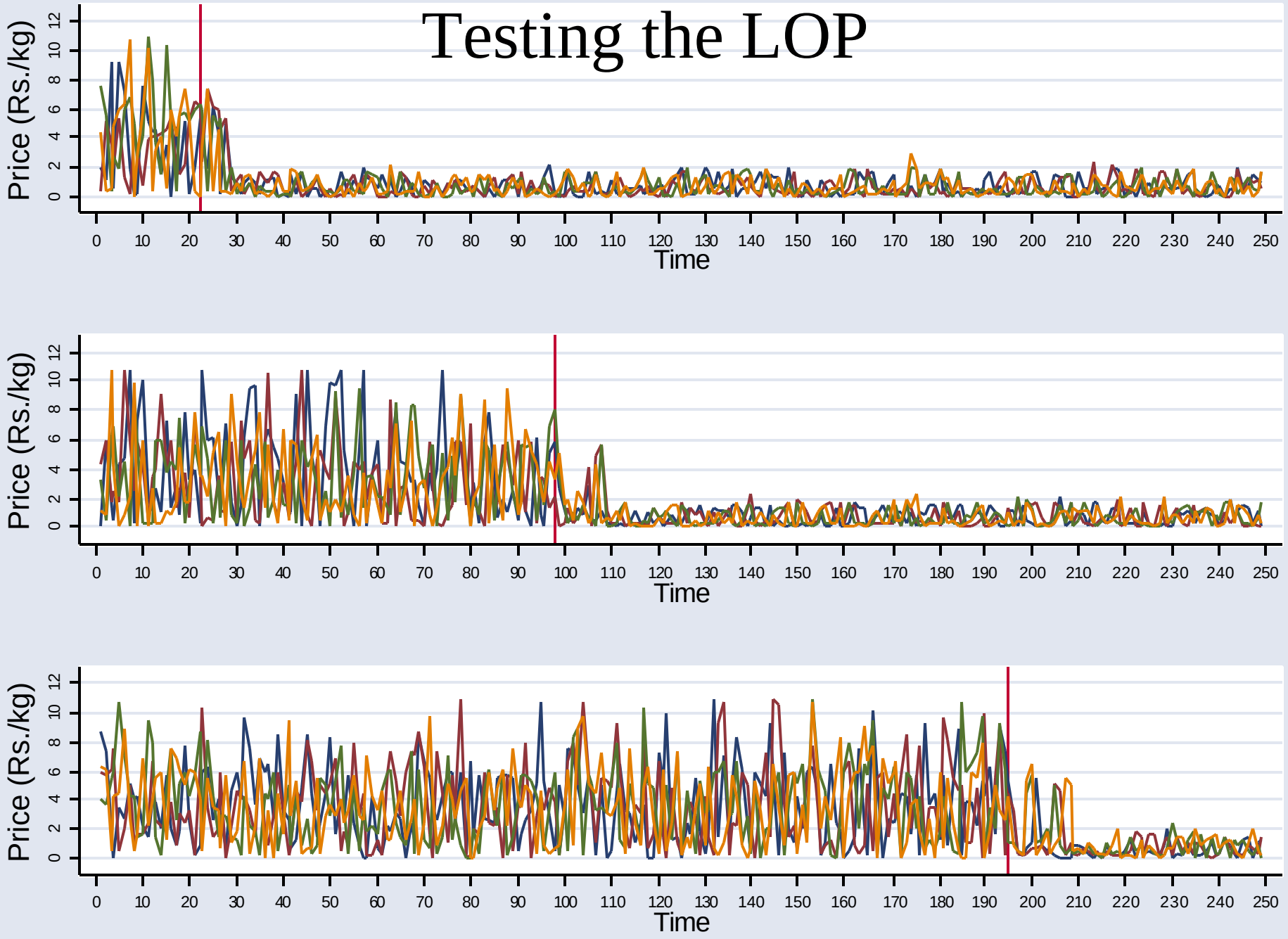
Identifying Assumption

3. Migration of fishermen. Some predictions counter, depends on selection effect and shape of demand curve. Makes region II poor control for region I, and means we're getting combined effect.
4. For (c), (e), (f), assuming all effects felt in that period.
   - Graphs suggest if there was an effect, likely small.
   - Test whether region I and III changed differentially one period later (though possible offsetting effects).
5. Effects of entry/exit.
   - High costs and learning, caste. Data shows little change, though later, new boats bigger.

	Max-Min Spread	Coefficient of Variation	% Have Waste
Region I	.03 (.51)	-.004 (.07)	.01 (.01)
Region II	-.42 (.51)	-.03 (.07)	-.002 (.01)
Period 1	-.59 (.41)	-.024 (.057)	-.004 (.009)
Period 2	.025 (.40)	.066 (.056)	.01 (.008)
Period 3	-5.5 (.43)	-.49 (.060)	-.045 (.009)
RegionI_Period1	-5.3 (.58)	-.49 (.08)	-.060 (.012)
RegionI_Period2	-6.3 (.57)	-.63 (.08)	-.068 (.012)
RegionI_Period3	-.08 (.60)	-.074 (.09)	-.010 (.012)
RegionII_Period1	.71 (.58)	.045 (.08)	-.001 (.012)
RegionII_Period2	-5.6 (.57)	-.58 (.08)	-.055 (.012)
RegionII_Period3	-.30 (.60)	-.04 (.08)	.002 (.013)
Fuel Cost	.008 (.02)	.003 (.003)	.0005 (.0004)
Wind	.13 (.17)	.037 (.024)	-.003 (.004)
Weather	.24 (.14)	.007 (.02)	.0007 (.003)
Sea	.08 (.26)	.049 (.037)	.0045 (.0055)
F-test (wind, weather, sea) [Prob>F]	2.04 [ ]	.95 [ ]	.25 [ ]
Number of Observations	747	747	747

	Max-Min Spread	Coefficient of Variation (%)	Waste (%)
ADDING PHONE TO REGION I			
(a) $(Y_{I,1} - Y_{I,0}) - (Y_{II,1} - Y_{II,0})$	-6.1	.53	-.059
$= b_{RI\_P1} - b_{RII\_P1}$	(.58)	(.08)	(.012)
(b) $(Y_{I,1} - Y_{I,0}) - (Y_{III,1} - Y_{III,0})$	-5.3	-.49	-.060
$= b_{RI\_P1}$	(.58)	(.08)	(.012)
ADDING PHONE TO REGION II			
(c) $(Y_{II,2} - Y_{I,1}) - (Y_{I,2} - Y_{I,1})$	-6.4	-.62	-.055
$= b_{RII\_P2} - b_{RII\_P1}$	(.36)	(.05)	(.008)
(d) $(Y_{II,2} - Y_{II,1}) - (Y_{III,2} - Y_{III,1})$	-5.4	-.48	-.047
$= b_{RII\_P2} - b_{RII\_P1} - b_{RI\_P2} + b_{RI\_P1}$	(.36)	(.05)	(.007)
ADDING PHONE TO REGION III			
(e) $(Y_{III,3} - Y_{III,2}) - (Y_{I,3} - Y_{I,2})$	-5.5	-.56	-.057
$= b_{RI\_P2} - b_{RI\_P3}$	(.40)	(.06)	(.008)
(f) $(Y_{III,3} - Y_{III,2}) - (Y_{II,3} - Y_{II,2})$	-5.3	-.54	-.058
$= b_{RII\_P2} - b_{RII\_P3}$	(.40)	(.06)	(.008)

Testing the LOP



Testing the LOP

For each date, estimate cost of traveling between all pairs of markets, using that day's fuel prices, and the weather, wind, and sea conditions for each catchment zone for a hypothetical boat carrying average catch on that date.

Ex, boat with 400kg of sardines, an additional 30km of calm seas with no wind and clear weather consumes an additional 29.6liters of fuel. With choppy seas adds 4.3 liters.

→when kerosene is 15Rs/liter, fuel cost is 444Rs, so 2 markets 30km away shouldn't differ by more than 1.1Rs/kg.

Add time and depreciation

	Period 0 (Pre-phone)	Period 1 (Zone 1 Adoption)	Period 2 (Zone 2 Adoption)	Period 3 (Zone 3 Adoption)
erall				
Region 1	.67	.03	.04	.03
Region 2	.69	.68	.06	.05
Region 3	.73	.71	.71	.08
th Time + Depreciation				
Region 1	.61	.01	.02	.02
Region 2	.63	.62	.03	.03
Region 3	.68	.63	.64	.04
n-Monsoon (w/o time+dep)				
Region 1	.67	.01	.01	.00
Region 2	.69	.65	.00	.01
Region 3	.73	.68	.67	.01

If demand curves do their job, the allocation can be said to be efficient.

Welfare Effects

TABLE VIII
EFFECTS OF MOBILE PHONES ON PRODUCERS AND CONSUMERS: POOLED TREATMENTS

	(1) Quantity Sold	(2) Price	(3) Revenue	(4) Costs	(5) Profits	(6) Adj. Profits	(7) Users Ad. Profit	(8) Non-User Ad. Profit	(9) Consumer Price
Treatment	18	.12	114	45	67	60	85	40	-.41
	(3.0)	(.04)	(38)	(19)	(31)	(31)	(35)	(24)	(.22)
Region I	-8.0	-.003	-28	-18	12	14	16	14	.51
	(2.9)	(.03)	(13)	(29)	(13)	(14)	(15)	(15)	(30)
Region II	-4.4	-.06	-36	-3.1	-40	-36	-31	-38	.38
	(2.3)	(.02)	(10)	(23)	(15)	(18)	(19)	(19)	(.27)
Period 1	-19.6	.30	-24	5.1	-19.8	-15	-15	-15	.22
	(3.2)	(.03)	(14)	(2.3)	(4.2)	(4.3)	(4.4)	(4.3)	(.05)
Period 2	-71	.79	-120	7.9	-112	-110	-103	-119	.65
	(3.6)	(.04)	(.16)	(3.5)	(34)	(35)	(36)	(39)	(.27)
Period 3	-110	1.0	-200	15.8	-184	-189	-191	-185	.81
	(4.3)	(.05)	(14)	(7.6)	(15)	(23)	(43)	(44)	(.35)
Obs.	74,700	74,700	74,700	74,700	74,700	74,700	33,615	41,805	747

Data from the Kerala Fisherman Survey conducted by the author. Standard errors in parentheses. All prices in 2001 Rs.

Table 7. Estimated Effects of Mobile Phones on Producers and Consumers

	Fishermen				Consumer
	Costs	Revenue	Profits	Adj. Profits	Price
ADDING PHONE TO REGION I					
(a) $(Y_{I,1} - Y_{I,0}) - (Y_{II,1} - Y_{II,0})$	48	115	67	58	-.43
$= \beta_{RI\_P1} - \beta_{RII\_P1}$	(17)	(39)	(21)	(21)	(.21)
(b) $(Y_{I,1} - Y_{I,0}) - (Y_{III,1} - Y_{III,0})$	44	112	68	62	-.41
$= \beta_{RI\_P1}$	(15)	(31)	(23)	(23)	(.22)
ADDING PHONE TO REGION II					
(c) $(Y_{II,2} - Y_{I,1}) - (Y_{I,2} - Y_{I,1})$	51	123	71	62	-.39
$= \beta_{RII\_P2} - \beta_{RII\_P1}$	(22)	(41)	(28)	(28)	(.22)
(d) $(Y_{II,2} - Y_{II,1}) - (Y_{III,2} - Y_{III,1})$	49	128	79	71	-.38
$= \beta_{RII\_P2} - \beta_{RII\_P1} - \beta_{RI\_P2} + \beta_{RI\_P1}$	(18)	(48)	(28)	(29)	(.22)
ADDING PHONE TO REGION III					
(e) $(Y_{III,3} - Y_{III,2}) - (Y_{I,3} - Y_{I,2})$	45	108	62	56	-.38
$= \beta_{RI\_P2} - \beta_{RI\_P3}$	(24)	(52)	(26)	(26)	(.21)
(f) $(Y_{III,3} - Y_{III,2}) - (Y_{II,3} - Y_{II,2})$	43	99	55	50	-.38
$= \beta_{RII\_P2} - \beta_{RII\_P3}$	(20)	(48)	(24)	(23)	(.20)

Notes: Standard errors in parentheses. All prices in 2001 Rs.

Consumer Welfare

- Estimate demand curves, before and after phones
- Estimate CS, integrate under demand curve, over price line, for empirical distributions of price.
  - Problems…constant MU income. But, small effects, and Willig, and Wright/Williams.
  - Misses benefits more predictable prices.
- Captures Δ welfare from intertemporal substitution.
- Estimate CS increased by ~20Rs/month/person.
- Positive…but relative to MPCE, very small (2.5%).

Education and Health

- Barriers such as access, cost and demand. But, income itself may play a role.

- Using same identification strategy as above, increasing income leads to:
  - Small increase in Prob(enrolled)) among 14+ (6%)
  - Small increase in Prob(use health care if sick) (5%)
  - Small dec. in Prob(sick)…but not statistically significant.

Conclusions

- Poor information limits market functioning.
  - Are other limitations (mrkt power, interlinked trans.)
- Info. makes markets work & markets help the poor.

  It's the I, not the T!
- Persistent—markets are the gift that keep on giving!
- Private sector, not development project. Sustainable.

Is there a role for IT in development?

- Kerala a special case?
  - Education doesn't matter
  - Limited storage, perishable (fish, milk, fruits+veg, eggs…labor?)
  - See it lots of places.
    - But, anecdotes vs. evidence. Ex. Grameen lady.
    - Other places observed in India, incl online commodity price web sites…
- No substitute for some other key investments.
- Digital Provide: Invisible Hand of Market=Helping Hand to the Poor
  - Information makes markets work & markets help the poor.
  - Best way to end deprivation (and improve health and education) is increase earnings capacity.
- It's not middlemen. Too many?…no, too few!

Is there a role for IT in development?

Should govt. give out phones or build kiosks?

--Maybe…but not based on what I've shown. People pretty good at figuring things out themselves…

--But maybe a strategy of enabling markets,

- Removing barriers...Roads, telecoms regulation, land reform