Bertrand Competition in Oligopsonistic Market Structures

The Case of the Indonesian Rubber Processing Sector

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University of Göttingen

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Outline

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Motivation

- Law of one price (LOP): prices of idential goods differ only by the trade costs between locations
- Empirics: Frequent violations
- One possible explanation – market power
- Research questions
  - Causes of violations of LOP?
  - Role of aggregation over time?
  - Market power: Dynamics between firms?

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  - Theoretical explanations for violations of the LOP?
  - How to generate empirical evidence on that?
  - What are the implications of different levels of temporal aggregation?
  - How to generate insights on the dynamics between firms?
- What we do:
  - Model to explain deviations from LOP
  - Test for violations of LOP by empirical analysis – synchronising and staggering at different time horizons
  - Vector Error Correction Model for analyzing Impulse Response Functions *(not included in presentation)*

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Empirical example

- Rubber value chain in the Jambi Province, Indonesia
- Interface between agricultural supply (rubber farmers and intermediaries) and processing (crumb rubber factories)
- 251 000 rubber farmers, nine processors (five in the capital Jambi City)
- Processors are price takers on international market and set prices on the domestic market
- Price setting by processors on daily basis

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Market power

- Suppliers facing fixed cost for switching buyers (factories)
- Anecdotal 'evidence': stickiness of individual farmers' sales to a specific factory after price changes
- Components of switching costs: economic costs (getting information on the daily prices of all five factories in advance) and unobserved, informal relationships between farmer and factory

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Model

World demand for factory i's output O_D^i:

$$O_D^i = \rho p_O^i \quad (1)$$

p_O is factory i's output price.

Factory i's production function:

$$O_S^i = A^i I_D^i \quad (2)$$

O_S^i: factory i's output supply
A^i: factory i's inverse input requirement (i.e., productivity) in transforming the rubber input I_D^i into crumb rubber

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Model

Aggregate revenue R of all input suppliers (identical raw rubber quantity q) in a switching model:

$$R = r_1 q p^i + r_2 q \bar{p} + r_3 q p^i - \int_0^{r_3 q} \gamma x \, dx + r_4 q \bar{p} - \int_0^{r_4 q} \delta y \, dy \quad (3)$$

p^i: raw rubber price at factory i; $\bar{p}$ average price at other factories

Buyer in previous period	i		not i	
Buyer in current period	i	not i	i	not i
# of farmers	r_1	r_4	r_3	r_2

r_4: farmers incurring switching cost for changing away from i

r_3: farmers incurring switching cost for changing to factory i

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Rewritten in shares

θ^i: share of farmers selling to factory i in previous period
($1 - \theta^i$: farmers selling to other factories in previous period)
ω^i: share of farmers selling to factory i in the current period.

$$R = q(\theta^i \omega^i p^i + (1-\theta^i)(1-\omega^i)\bar{p} + (1-\theta^i)\omega^i p^i + \theta^i(1-\omega^i)\bar{p}) - \int_0^{(1-\theta^i)\omega^i q} \gamma x \, dx - \int_0^{\theta^i(1-\omega^i)q} \delta y \, dy \tag{4}$$

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Behavioural assumptions

Revenue maximisation: $\partial R / \partial \omega^i \stackrel{!}{=} 0$. Solving for ω^i: optimal share ω^i of farmers selling to factory i.

$$\omega^i = \frac{p^i - \bar{p} - \delta}{\delta + \gamma q (1 - \theta^i)^2} \tag{5}$$

Total raw rubber supply for factory i: $I_S^i = \omega^i Q$ with $Q = qF$ (Q: total farm output; F: number of farmers)

Input supply function for factory i in equation 6:

$$I_S^i = \frac{qF(p^i - \bar{p} - \delta)}{\delta + \gamma q (1 - \theta^i)^2} \tag{6}$$

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Model: Input demand

Market clearance at factory level

$$I_S^i \stackrel{!}{=} I_D^i \tag{7}$$

$$O_S^i \stackrel{!}{=} O_D^i \tag{8}$$

Combined with world demand share (eq. 1) and production function (eq. 2):

$$I_D^i = \frac{\rho p_O^i}{A^i} \tag{9}$$

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Model: Optimal price

Substituting eqs. 9 and 6 into eq.7 and solving for the input price yields optimal sales price of factory i:

$$p_I^i = \rho p_O^i \frac{\delta + \gamma q(1-\theta^i)^2}{A^i q F} + \bar{p} + \delta \tag{10}$$

Price depends

- on its own technology A^i
- …total raw rubber supply – the larger qF, the lower the price
- …market power only if switching costs γ and δ are non-zero

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- Synchronisation vs staggering: evidence for deviations from LOP
- Vector error correction model (VECM) and impulse response functions (IRFs): insights on the dynamics between stakeholders in the market (*not included in presentation*)

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Synchronisation vs staggering

- Synchronisation vs staggering: timing of price changes – whether or not prices change in parallel ('synchronized')
- *Intuition*: compare three sets of time series of prices:
  - Observed series
  - Artificial series with perfect staggering or synchronisation
  - Compare standard deviations of instances of price changes
- *Procedure:* standard deviation of hypothetical scenarios versus SD of the observed data.
  - Five factories: six discrete possibilities for the share of prices changes in any given period (0.0, 0.2, 0.4, 0.6, 0.8, 1.0)
  - Perfect synchronization: Either 0 or 1
  - Perfect staggering: average over the whole observation period.
  - Temporal aggregation: daily – weekly – long-run

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- Buying prices of five crumb rubber factories: *GAPKINDO*
- World prices: *PT. Kharisma* (Jakarta-based marketing company)

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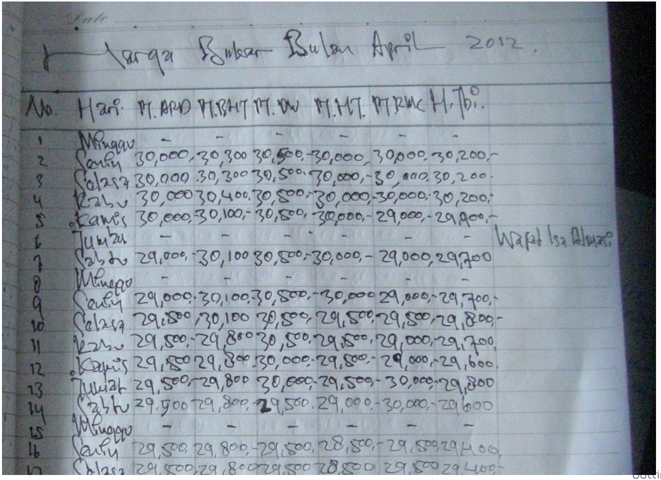

Harga Rubber Bulan April 2012

No.	Hari	M.APD	M.BHT	M.DW	M.MT	M.RMC	H.Tbi.	
1	Minggu	–	–	–	–	–	–	
2	Senin	30,000,-	30,300	30,500,-	30,000,	30,000,	30,200,-	
3	Selasa	30,000	30,300	30,500	30,000,-	30,000	30,200	
4	Rabu	30,000	30,400	30,500,-	30,000,	30,000,	30,200,	
5	Kamis	30,000	30,100,-	30,500	30,000,-	29,000,-	29,900,-	
6	Jumat	–	–	–	–	–	–	Wafat Isa Almasih
7	Sabtu	29,000	30,100	30,500,-	30,000,-	29,000	29,700	
8	Minggu	–	–	–	–	–	–	
9	Senin	29,000	30,100	30,500,-	30,000	29,000,-	29,700,-	
10	Selasa	29,800	30,100	30,500	29,500	29,500	29,800,-	
11	Rabu	29,500,-	29,800	30,500	29,500	29,000	29,700	
12	Kamis	29,500	29,800	30,000	29,500,-	29,000,-	29,600	
13	Jumat	29,500,-	29,800	30,000	29,500	30,000	29,800	
14	Sabtu	29,500	29,800	29,500	29,000,-	30,000,-	29,600	
15	Minggu	–	–	–	–	–	–	
16	Senin	29,500	29,800,-	29,500,	28,500,-	29,500	29,400	
17	Selasa	29,500	29,800	29,500	28,500	29,500	29,400-	

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Synchronisation vs. staggering

- *Short run (daily):*
  - Average price changes: 31 % (221 over 705 days)
  - Hypothetical standard deviation (SD): *0.464* for the case of perfect synchronization
  - Observed SD of share of price changes per period *0.30*
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  - Prices are not synchronised on a daily basis.
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- *Medium run (weekly averages):*
  - Variable subject to investigation: number of processors changing the price during one week at least once
  - Observed data: mean = 0.9 and SD = *0.18*
  - Indicates nearly perfect synchronisation on a weekly basis
  - (On a monthly basis, the synchronisation is perfect)
  - Note that this approach only captures whether a price has changed or not and does not suggest the magnitude.
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Outline

Summary

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Thank you very much for your attention!

Questions, comments, suggestions are welcome!

Contact: bbruemm@gwdg.de

VECM results

VARIABLES	(1) D_ln_pBuy1	(2) D_ln_pBuy2	(3) D_ln_pBuy3	(4) D_ln_pBuy4	(5) D_ln_pBuy5	(6) D_ln_pWorld
L._ce1	-0.196***	-0.0880***	-0.127***	-0.161***	0.0265	-0.0591
	(0.0329)	(0.0276)	(0.0267)	(0.0247)	(0.0248)	(0.0389)
LD.ln_pBuy1	-0.0728	0.0878**	0.0384	0.0280	-0.00213	-0.00498
	(0.0491)	(0.0413)	(0.0399)	(0.0369)	(0.0370)	(0.0581)
L2D.ln_pBuy1	-0.0660	0.122***	0.126***	0.0933***	0.0269	0.00302
	(0.0466)	(0.0392)	(0.0379)	(0.0350)	(0.0351)	(0.0552)
L3D.ln_pBuy1	-0.0283	0.0677*	0.0824**	0.108***	0.0724**	-0.0456
	(0.0448)	(0.0377)	(0.0365)	(0.0337)	(0.0338)	(0.0530)
LD.ln_pBuy2	0.150***	-0.162***	0.151***	0.0925**	0.0985**	0.0155
	(0.0531)	(0.0447)	(0.0432)	(0.0399)	(0.0400)	(0.0628)
L2D.ln_pBuy2	0.122**	-0.237***	0.0245	-0.0197	-0.00473	0.0920
	(0.0530)	(0.0446)	(0.0432)	(0.0399)	(0.0400)	(0.0628)
L3D.ln_pBuy2	-0.0243	-0.114**	0.0351	0.0251	0.0382	0.178***
	(0.0530)	(0.0446)	(0.0431)	(0.0398)	(0.0399)	(0.0627)
LD.ln_pBuy3	0.193***	0.175***	-0.140***	0.205***	0.158***	-0.128*
	(0.0652)	(0.0548)	(0.0530)	(0.0490)	(0.0491)	(0.0771)
L2D.ln_pBuy3	0.0734	0.0930	-0.0770	0.175***	0.162***	-0.107
	(0.0674)	(0.0567)	(0.0549)	(0.0507)	(0.0508)	(0.0798)
L3D.ln_pBuy3	0.195***	0.108*	-0.00220	0.0837*	0.130***	-0.0955
	(0.0653)	(0.0550)	(0.0532)	(0.0491)	(0.0492)	(0.0773)
LD.ln_pBuy4	0.153**	0.0828	0.189***	-0.0825*	-0.0485	0.0990
	(0.0612)	(0.0515)	(0.0498)	(0.0460)	(0.0461)	(0.0724)
L2D.ln_pBuy4	0.116*	0.0935*	0.101**	-0.0412	-0.0496	-0.0182
	(0.0612)	(0.0515)	(0.0498)	(0.0460)	(0.0461)	(0.0724)
L3D.ln_pBuy4	0.0739	0.0795	0.0206	-0.0853*	-0.0557	-0.176**
	(0.0581)	(0.0489)	(0.0473)	(0.0437)	(0.0438)	(0.0688)

Impulse response functions

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