The Value of Relational Contracting: Evidence from China's Wholesale Vegetable Market

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Roadmap

1. Introduction
2. Background and Data
3. Conceptual Framework
4. Empirical Analysis

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1 Introduction

2 Background and Data

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4 Empirical Analysis

Motivation

- Trading relationships based on informal agreements are pervasive.
- They remain an important but little understood form of vertical coordination in agricultural supply chains, especially in developing countries.

Motivation – What We Have Known

- Informal agreements built-in these relationships are known as Relational Contracts (RC).
  - Originated from Telser 1980, Klein and Leffler 1981
  - MacLeod and Malcomson 1989; Baker et al. 1994, 2002: optimal structure of the informal agreements
  - Levin 2003: enforcement problems and asymmetric information considerations
  - Halac 2012: uncertainty over parties' commitment to the relationship

Core of RC theory

Short-term opportunistic behavior can be disciplined by inter-temporal incentives (expectation of future benefits).

Motivation – Gaps in the Empirical Literature

Challenges

- Relationships are context-specific and hard to measure.
  - Detailed data on relational transactions are not readily available or are hard to access.
- Quantifying inter-temporal incentives is challenging.

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Example

- Macchiavello and Morjaria 2015, AER: delivery of roses by Kenyan exporters is more often guaranteed in longer relationships.
- Antras and Foley 2015, JPE: US poultry processor relaxes financing terms for the foreign buyers with whom they have a long relationship.

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Commonality

- friction to trade
- survey or experimental data
- take the existence of trading relationships as given

This Paper

★ Study informal trading relationships through systematically recorded transactions of a large wholesale vegetable market in China.

Reseach Question

Why are these relationships established? What are the benefits of relational trading to the contractual parties?

This Paper

This study stands out from the existing literature in three ways:

- Relationships under scrutiny emerge inside a well-functioning, almost frictionless spot-market.
- Uses high-frequency observational data.
- Explicitly investigates the value of relational contracting.

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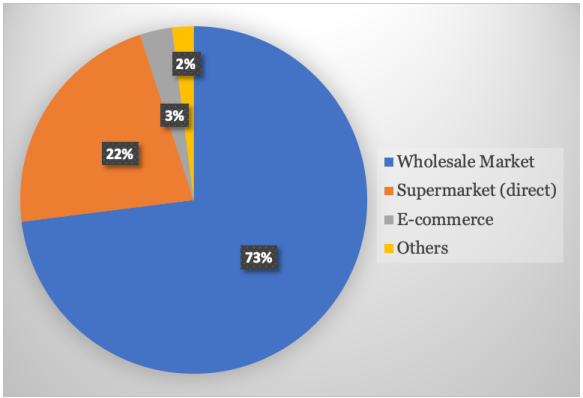
Wholesale Produce Markets in China

- A dominant channel in marketing fresh produce

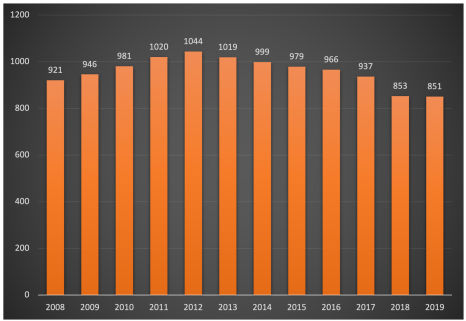


Marketing channel of fresh produce products (vegetable and fruit), 2019

source: China Agriculture Wholesale Market Association

Wholesale Produce Market in China

- 851 wholesale markets with yearly sales volume over 100 million RMB in 2019 (244 specialize in vegetable (28.6%); 134 in seafood (15.7%); 112 in fruit (13.2%))

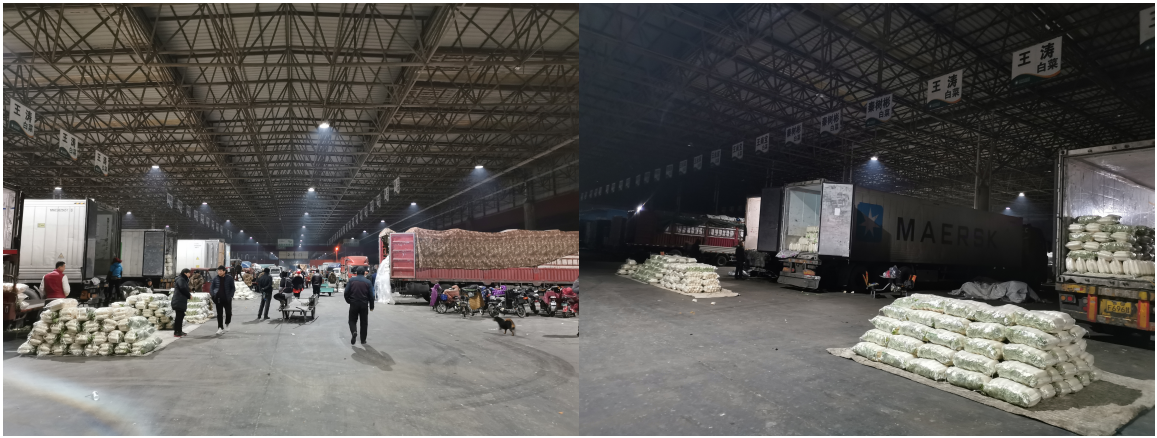


Number of Wholesale Ag Markets over 100 million RMB, 2008-2019

source:National Bureau of Statistics

The Market under Scrutiny

- Opens daily 3:00 am to early afternoon
- products drawn from multiple production regions all over the country

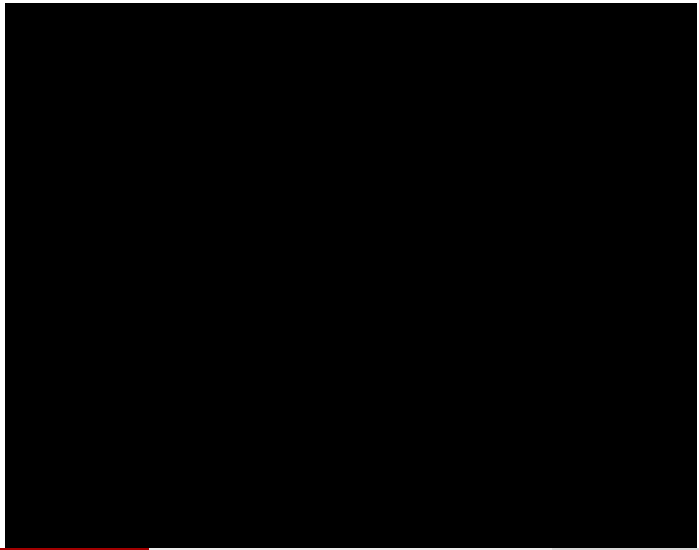


The Market under Scrutiny

- Sellers: wholesale vegetable-merchants. Buyers: secondary wholesalers, retailers, or restaurant, canteen, or supermarket procurers

★ **Prices are transaction-specific**

Video: how transactions are recorded



Data

- Proprietary database
- Date and time, volume, price, **market-specific ID** of the buyer and the seller
- Four years of daily transactions: 2016 – 2019
- Two major commodities:
  - **Cauliflower** (253,022 transactions)
  - Chinese cabbage (186,294 transactions)

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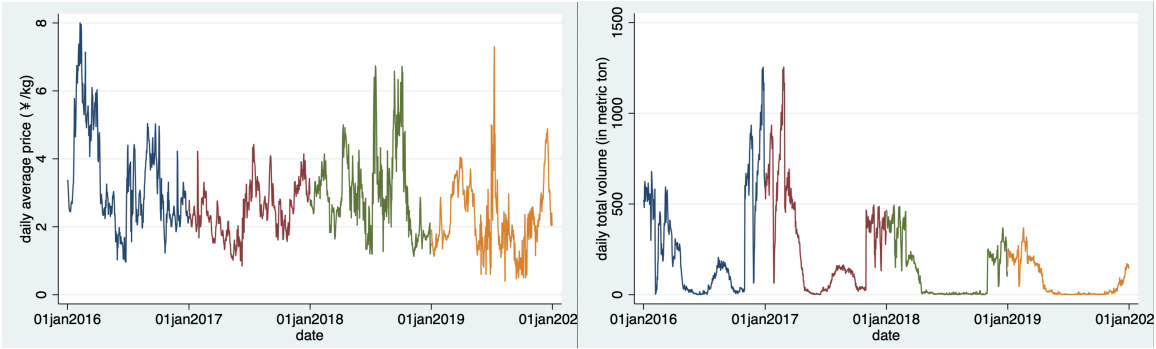
  - **Cauliflower** (253,022 transactions) $\Leftarrow$ focus of this study
  - Chinese cabbage (186,294 transactions)

Data - Daily Fluctuation in Price and Volume



left - Volume weighted price; right - Volume

Data - Trading Day Summary Statistics

	Cauliflower (Obs: 1339 days)			
Variable	Mean	Standard Dev.	Min.	Max.
Avg. price (¥/kg)	2.92	1.35	0.80	8.82
Number of transactions	149	150	1	635
Total trading volume (kg)	155,025	208,877	64	1,254,370
Avg. transaction size (kg)	557	213	64	4,077
Number of buyer	135	134	1	621
Number of sellers	18	15	1	87
Seller HHI	0.23	0.23	0.02	1
Buyer-Seller ratio	6.49	4.05	0.40	22.00

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Conceptual Framework - Theory Foundation

- Relational Contracts are: (*Baker et al., QJE, 2002*)
  - informal/ implicit agreements built in long-term relationships
  - regulate obligations and performance
  - not third-party enforceable
  - sustained via repeated interactions

Conceptual Framework - Setup

- Incentive Compatibility (IC) constraints:
  Buyer (she):

$$\frac{\delta}{1-\delta}(U_t - U_t^0) \geq \pi_t^B((p_t - \underline{p}_t) * q_t | c_B) \tag{1}$$

  Seller (he):

$$\frac{\delta}{1-\delta}(V_t - V_t^0) \geq \pi_t^S((\overline{p}_t - p_t) * q_t) \tag{2}$$

- U_t, V_t: net present value of future payoffs
- δ: discount factor

Conceptual Framework - Breaking down IC Constraints

- Outside option:
  - U_t^0: become a nomad buyer, or to search for an alternative partner
  - V_t^0: sell via sporadic orders, or to commit to a new buyer

- One-time gain from deviation:
  - $\pi_t^B((p_t - \underline{p}_t) * q_t | c_B)$
    - c_B: cost of search. $\underline{p}_t$: lowest price offer the buyer could possibly find
  - $\pi_t^S((\overline{p}_t - p_t) * q_t)$
    - $\overline{p}_t$: highest price the seller could possibly sell at

Focus: U_t and V_t

Continuation value of the relationship to the buyer/seller.

Hypotheses on U and V

Hypothesis I

Sellers give their relational buyers a price discount.

- Buyers who have a relational seller obtain systematically lower prices in the Ancona wholesale fish market. (Gallegati et al. 2011)
- Bilateral inter-dealer relations lower markups significantly in the OTC corporate bond market. (Hendershott et al. 2020)

Hypotheses on U and V

Hypothesis II

Relational contractual parties share inter-temporal price risk with each other.

- Dealers in financial markets exploit the benefit of trading relation to trade at better terms in times of market turmoil. (Di Maggio et al. 2017)
- Field interview: a buyer claims to be able to negotiate a smaller price increase when market supply drops unexpectedly, and is willing to compensate the seller when price drops substantially.

Hypotheses on U and V

Hypothesis III

Buyers/Sellers obtain higher assuredness in supply/demand via trading with stable partners.

- Buyers constantly face the risk of not being served or being rationed in market for perishable products. (*Weisbuch, Kirman, and Herreiner, 2000*)
- By forming a long-term relationship with a landlord, potential borrowers ensure future access to credit in a rationed world. (*Fafchamps, 2010*)
- Field interview: sellers satisfy the need of relational customers first.

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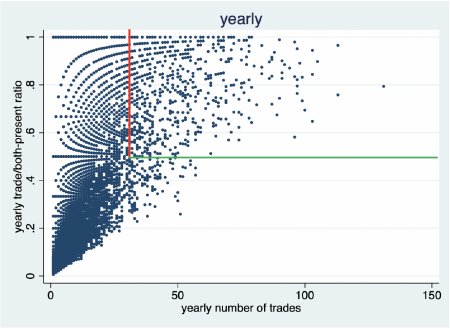
Defining Relationship - Baseline Dummy

A relationship exists if the buyer i and the seller j:
(i) trade more than 30 times in a year (peak season)
(ii) has a "trade/both-present" ratio (*tp* ratio) ≥ 0.5 in that year



tp ratio:
"**number of days the buyer and the seller trade**" divided by "**number of days the buyer and the seller are both present**"

Summary Statistics - Relationship

Variable	Obs.	Mean	Standard Dev.	Min.	Max
Panel A: Relationship characteristics					
Avg. number of trades per year	557	48	16	30	131
Avg. trading Volume per year (kg)	557	52,848	38,092	7,582	254,052
Avg. number of days both are present per year	557	63	22	31	165
Avg. yearly tp-ratio	557	0.77	0.14	0.51	1
Avg. number of trades per month	557	12	4	5	27
Length (in days)	557	228	209	33	1199
Frequency (avg. time-gap between two subsequent transactions)	557	4	3	1	14
Panel B: Number of relationships per buyer and seller					
Number of relationships per buyer	362	1.54	0.89	1	5
Number of relationships per seller	63	8.84	8.06	1	35

Testing Hypothesis I – price discount

$$\begin{aligned}\mathbf{P}_{i,j,t} = \alpha &+ \beta \mathbf{R}_{i,j,t} + \mathbf{Z}_{i,j,t}\omega + \mathbf{X}_t\gamma \\ &+ \sum \mu_h M_h + \sum \tau_l Y_l + \theta_i + \epsilon_{i,j,t}\end{aligned} \tag{3}$$

- $\mathbf{P}$ = transaction price; $\mathbf{R}$ = relationship dummy; $\mathbf{Z}$ = transaction specifics; $\mathbf{X}$ = market condition on day t
- M_h, Y_l, θ_i = month, year, seller fixed effects

Result

$\beta = \mathbf{0.17}$, corresponding to a 4-8% price premium.

▸ Sensitivity Checks

Testing Hypothesis II - risk-sharing

★ Is price response to supply shock different in relational transactions?

$$\begin{aligned}\mathbf{P}_{i,j,t} = \alpha_1 \mathbf{R}_{i,j,t} + \alpha_2 \mathbf{R}_{i,j,t} \times \textbf{positive supply shock}_t \\ + \alpha_3 \mathbf{R}_{i,j,t} \times \textbf{negative supply shock}_t + \mathbf{Z}_{i,j,t}\omega + \mathbf{X}_t\gamma \\ + \sum \mu_h M_h + \sum \tau_l Y_l + \theta_i + \epsilon_{i,j,t}\end{aligned} \tag{4}$$

⇒ **supply shock**: positive/negative if daily trading volume is one s.d. above/below a two-week rolling average

▸ IC Constraints

Testing Hypothesis II - Regression Results

	(1) Price	(2) Price
Relationship	0.174***	0.173***
	(0.021)	(0.023)
Positive supply shock	−0.113***	−0.125***
	(0.029)	(0.031)
Negative supply shock	0.100**	0.113***
	(0.020)	(0.043)
Relationship × Positive shock		0.079***
		(0.021)
Relationship × Negative shock		−0.071**
		(0.043)
Seller fixed effect	Y	Y
R^2	0.572	0.573

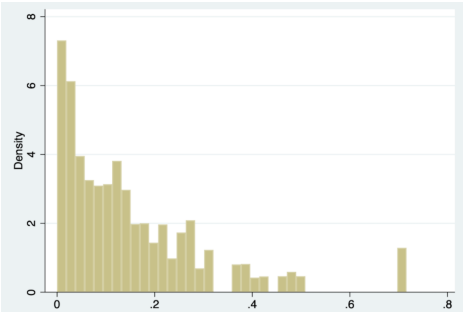
Robust standard errors clustered at the seller level. Significance levels: *** = 1%, ** = 5%, * = 10%.
Number of observations = 218,249.

Intensity Index

- A continuous measure of relationship:

$$R_{i,j,Y} = \lambda_{i,j,Y} \times tp_{i,j,Y}$$

  - $\lambda_{i,j,Y}$: normalized number of trades between i and j in year Y.
- Captures relatively how intense the interaction is between buyer i and seller j.



Distribution of the index

Testing Hypothesis II – Results

	(1) p	(2) p
R Index	0.105*	0.115**
	(0.066)	(0.057)
Positive Shock	−0.085***	−0.091***
	(0.019)	(0.017)
Negative Shock	0.062***	0.066***
	(0.021)	(0.024)
R Index × Positive Shock		0.103**
		(0.049)
R Index × Negative Shock		−0.186***
		(0.049)
R^2	0.722	0.731
Seller FE	Y	Y

Robust standard errors clustered at the seller level. Significance levels: *** = 1%, ** = 5%, * = 10%.
Number of observations = 111,535.

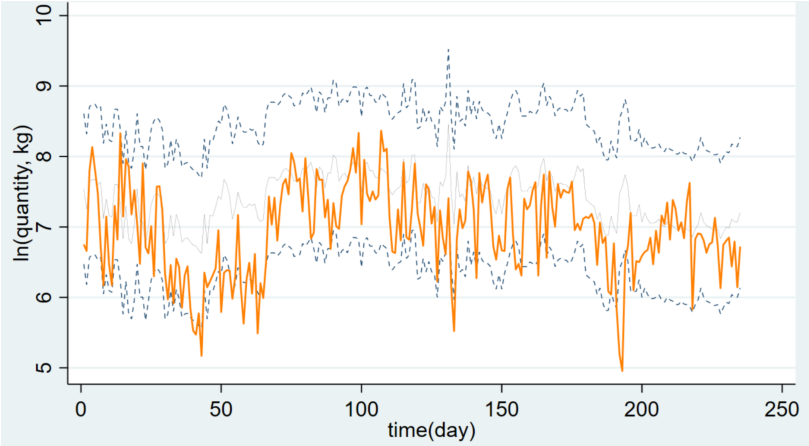
Testing Hypothesis III - supply assuredness

- Step I: use a Zero Inefficiency Stochastic Frontier (ZISF) model to estimate how frequently and how severely each individual buyer is rationed.
- Step II: link the likelihood and magnitude of rationing to the relational practice of each individual buyer.

Zero Inefficiency Stochastic Frontier (ZISF) model

- Stochastic Frontier Model (SFM) (Aigner et al. 1977): estimate production function assuming each firm potentially produces less than it might due to a degree of inefficiency.
- **Zero Inefficiency Stochastic Frontier (ZISF)** model (Kumbhakar et al. 2013) allows both fully efficient and inefficient observations. Inefficiency term $u_i = 0$ for some firm i and $u_i > 0$ for others. The probability of being fully efficient is p.

Visualizing Rationing - Single Buyer Example



Testing Hypothesis III – ZISF Estimation

- Buyer i's purchase function is

$$Q_t^i = \theta_t^i p_t^{i\gamma} exp(\alpha^i + z^i\beta + \upsilon_t^i) \tag{5}$$

  - P_t^i: (avg.) price buyer i faces on day t
  - $\upsilon^i \sim N(0, \sigma^2_{\upsilon^i})$
  - $\theta_t^i = 1$ if buyer i gets what she desires on day t, $\theta_t^i < 1$ if she is rationed.
- Logarithmic transformation:

$$\ln Q_t^i = \alpha^i + \gamma P_t^i + z^i\beta^i + \upsilon_t^i - u_t^i \tag{6}$$

  - $u_t^i = -\ln(\theta_t^i)$. $u_t^i \sim N^+(0, \sigma^2_{u^i})$
- $1\{u_t^i = 0\} = p^i$.

Testing Hypothesis III – ZISF estimation

- Sub-sample: buyers who have a sufficient number of purchases (cutoff: $t \geq 200$ days)
- Estimation performed for each individual buyer's time series of purchase [1]
- Controls: time, day-of-week, month, and year fixed effects
- Parameters of interest:
  - **overall likelihood of rationing**: $1 - \hat{p}^i$
  - **mean of observation-specific probability of rationing**, $1 - \check{p}^i_t$
  - **magnitude of rationing**
  - Alternatively, a censored approach

[1] not treated as time series as every purchase is independent; discontinuous as buyers do not come everyday

Testing Hypothesis III – Link rationing to R (full sample)

- Define $RB^i = 1$ if buyer i has at least one relationship. $RB^i = 0$ if buyer i is a nomad buyer.
- Comparing means of the two groups:
  - **Ration**^{i} is one of the measurements of rationing

$$\textbf{Ration}^i = \alpha + \beta RB^i + \epsilon^i \tag{7}$$

Testing Hypothesis III – Link rationing to R (subsample RB)

- Characterizing relational activity of buyer i:
  - fraction of relational purchase, f_R^i
  - number of relationships, N^i

$$\textbf{Ration}^i = \alpha + \beta f_R^i + \xi N^i + \epsilon^i \tag{8}$$

Testing Hypothesis III – Primary Results

	overall likelihood of rationing		average prob. of rationing	
	(1)	(2)	(1)	(2)
Panel A. All buyers				
Buyer having at least one R	-.181***		-.157***	
	(.037)		(.034)	
Panel B. RB				
Fraction of relational purchase		-.058***		-.060***
		(.021)		(.020)
Number of R		.033***		.031***
		(.009)		(.008)
Observations	363	125	363	125

Significance levels: *** = 1%, ** = 5%, * = 10%.

Hypotheses Testing Results

Hypothesis I

Sellers ~~give~~ charge relational buyers a price ~~discount~~ **premium**.

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Hypothesis III

Buyers obtain higher assuredness in supply. ✓
Sellers obtain higher assuredness in demand. **?**

Concluding Remarks

Relational Contracting

- enables sellers to charge a price premium.
- enables the sharing of inter-temporal risk: price response is smaller in relational transactions when supply makes large swings.
- provides buyers with greater stability in supply.

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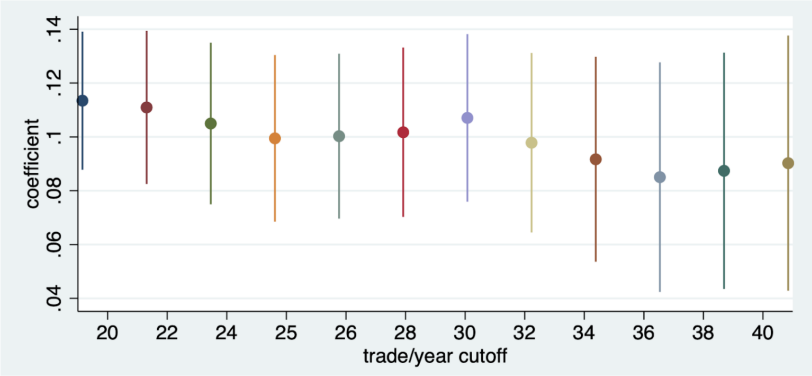
Testing Hypothesis I – Sensitivity Check



Notes: Each point estimate is the coefficient of the "relationship" dummy. The tp ratio cutoff is fixed at 0.4*. All coefficients are significant at 1%.

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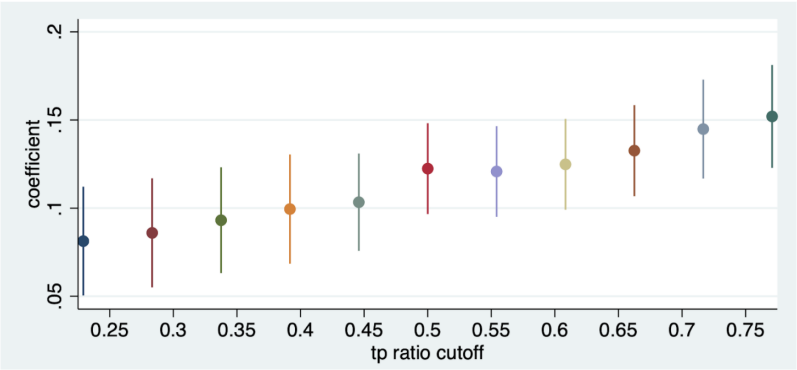
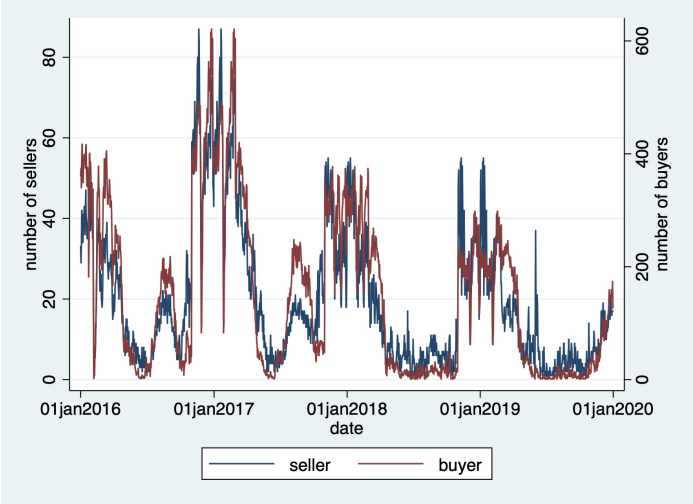
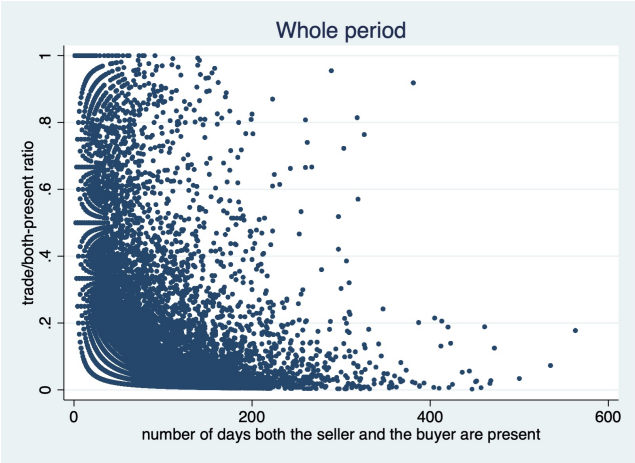


Notes: Each point estimate is the coefficient of the "relationship" dummy. The trade/year cutoff is fixed at 25. All coefficients are significant at 1%.

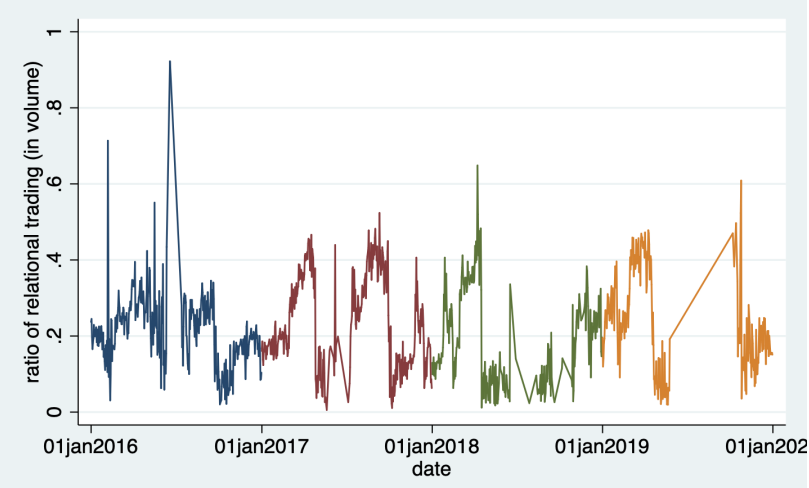
Daily Number of Buyers and Sellers



TP-ratio versus Number of Days Both are Present - Whole Period (cauliflower)



Daily Fraction of Relational Trading



Summary Statistics - Trading Activity

Table 2: Summary statistics: trading activity (cauliflower)

Type	Variable	Mean	Standard Dev.	Min.	Max.
Panel A: Buyers					
All buyers (N=4611)	Number of days present per year	16	27	1	201
	Total purchase per year (metric ton)	136	196	2	2,287
	Avg. daily purchase (kg)	1,333	1,000	14	16,810
	Number of sellers traded with per year	23	15	1	78
	Avg. number of sellers per day	1.6	0.5	1.0	4.2
Regular buyers(N=456)	Number of days present per year	93	30	60	201
	Total purchase per year (metric ton)	288	261	4	2,287
	Avg. daily purchase (kg)	1,670	959	56	7,512
	Number of sellers traded with per year	37	16	2	78
	Avg. number of sellers per day	2.0	0.5	1.2	4.2
Panel B: Sellers					
All sellers (N=1604)	Number of days present per year	21	31	1	205
	Total sales per year (metric ton)	20,781	23,475	10	114,905
	Avg. daily sales	12,373	6,250	62	31,047
	Number of buyers traded with per year	258	158	3	687
	Avg. number of buyers per day	15.1	6.0	1.0	36.3
Regular sellers (N=65)	Number of days present per year	96	33	56	205
	Total sales per year (metric ton)	35,792	25,009	1,379	114,906
	Avg daily sales	18,747	9,366	658	112,365
	Number of buyers traded with per year	379	111	113	687
	Avg. number of buyers per day	20.9	6.2	4.8	36.8