

Strategic Delay in Dynamic Nonlinear Pricing

Perishable Flowers with Deadline

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January 29, 2020

- Dynamic pricing is widespread
- Sellers hold sales promotions for:
 - Cost reasons: product close to **expiring**
 - Strategic reasons: **sorting buyers** based on their product valuations and patience
- Dynamic pricing → possibility for strategic delay by buyers
- Existence of dynamic pricing → failure of Coase conjecture
 - In reality, a seller does not compete hard with future self for various reasons

- **Event tickets**
 - Tickets worthless after event
 - Prices decrease over time leading up to event
- **Clothing**
 - Retailers purchase winter coats in fall, go on sale in January
 - Winter coat less valuable after winter is over
- **Food**
 - Food goes on sale as expiry date approaches
 - Food lower quality (less fresh)
- **Our setting: largest wholesale flower market in Tokyo**
 - Flower prices decrease over time
 - Flower quality decreases over time

Motivation 1: Welfare effects of delay

- Strategic delay has ambiguous welfare effects
- **Waiting is costly**
 - Inefficient waiting by patient buyers
 - Lost gains from trade between sellers and patient buyers
- **Waiting may reduce information asymmetry**
 - Patient (impatient) buyers may have low (high) valuations
 - Timing of sales may help reveal buyers' valuations
- Are buyers **forward-looking or myopic**?

Motivation 2: Incentive to delay purchase

The existing literature says:

- strategic buyer delay is **NOT** a great deal (Sweeting, 2012)
- buyers' incentive to delay likely depends on **the size of purchase and repeated interactions**
- there is a surge in B2B transactions with evolution of e-commerce and supply chains

Our data allow us to examine how buyer heterogeneity in size is related to incentive to delay purchase, i.e., get discount

Motivation 3: Dynamic pricing and Quantity discount

The existing literature looks at either dynamic pricing or quantity discount separately

- Sellers choose not only the timing of sales but also **how**
- Quantity discount is an additional strategic instrument
- Missing either time or quantity data will average out the extent of discrimination arising from the missing source

There is virtually **no previous work** that looks at the interplay of inter-temporal and second degree price discrimination

Motivation 4: Deadline effect

- Most of the previous work on inter-temporal price discrimination looks at airline tickets
 - prices generally **increase** toward the date of departure
- In many other cases, observe **decreasing** price trend
 - event tickets, food, clothing, flowers, etc
- Buyers have an incentive to delay purchase if get discount from doing so
- The unique institutional setting here allows us to examine buyers' forward-looking behavior closely

Advantages of our empirical setting

- 1 Repeated interactions between buyers/sellers
- 2 Relevant time cycle is 1-2 days
 - with lifetime of flowers 1-2 weeks
- 3 A large amount of money at stake
 - Average monthly expenditure: \$5K
 - 90th percentile monthly expenditure: \$60K
 - Average buyer in top 10% spends \$1.5M annually
- 4 Multi-unit purchases
 - Second degree price discrimination in play
- 5 Intersection of dynamic and second degree price discrimination

- Are sellers and buyers strategic in a market with repeated interactions and a lot of money at stake?
- Are buyers forward-looking?
 - A: **yes and the extent differ across buyer size.**
- Is equilibrium pricing consistent with existing theories?
 - A: **remarkably so.**
- Can we say anything about welfare?

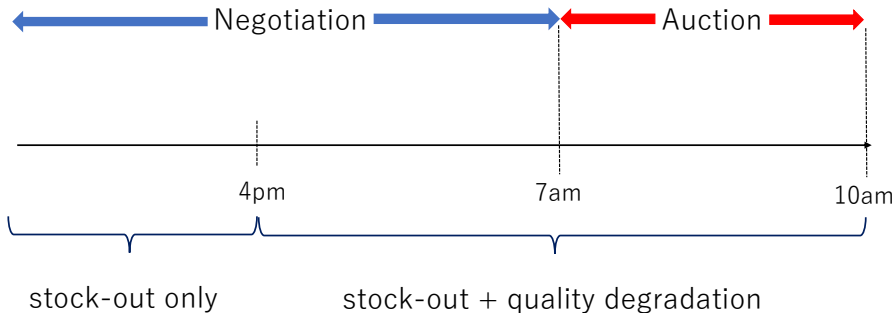
- Sweeting (JPE, 2012) find consumers myopic when purchasing baseball tickets
- Knittel et. al (AER, 2013) find consumers forward-looking (gas prices) when buying vehicle

- Platform: Ota Kaki
 - Largest flower market in Tokyo with market share of 40%
 - Charges 8% of sale to sellers while charges 0% to buyers
- All transactions over the period of FY 2017-2018
 - transaction price and quantity
 - exact date and within-day timing of transaction
 - transaction type (i.e., negotiation or auction)
 - buyer and seller IDs

Timeline of events

- 1 Booking transaction starts
 - buyers tell the platform how many of which variety they want
- 2 Sellers inform the platform about what they want to sell
 - price, flower type, stock, etc
- 3 The platform collects those wanted flowers, and get back to the buyer with total price
- 4 Product information is listed on the platform website
- 5 Buyers call the platform to negotiate the price of flowers
- 6 Flowers arrive at the platform (4pm ~)
 - 1 Purchased flowers re-shipped
 - 2 Leftover flowers go to auction
- 7 Descending price auctions for leftover flowers start at 7am in the following day

Negotiation and Auction



Negotiation and Auction



Negotiation

Auction



Summary Statistics

Fiscal Year	2017	2018
Value (JPY)	25B	24B
Quantity	387M	382M
Transactions	4.6M	4.6M

Fiscal Year	Buyer		Seller	
2018	Mean	SD	Mean	SD
Value (JPY)	28M	90M	6.1M	33M
Quantity	445K	1.47M	96K	0.66M
Transactions	5.4K	15K	1.1K	6.2K
N	860		3994	

- Less buyers than sellers
- Large heterogeneity in both buyer and seller size

Most Frequently Traded Flowers



Rose



Crysanthemum

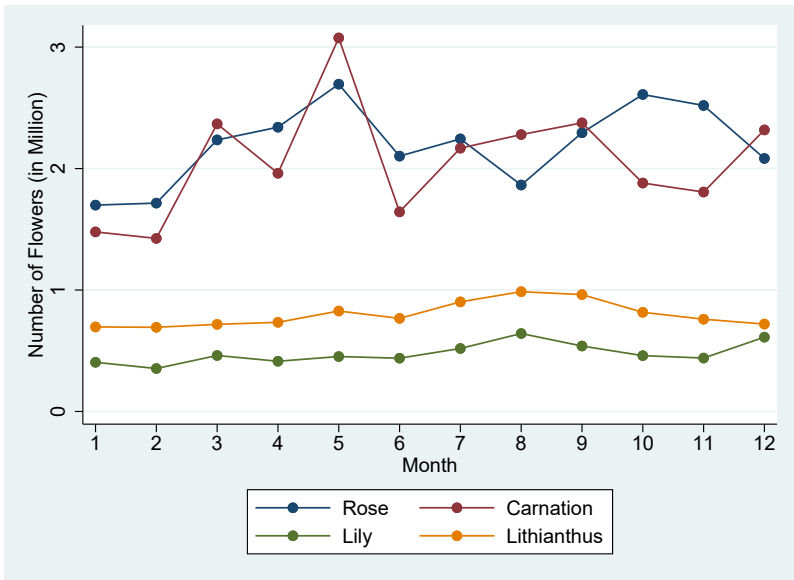


Carnation



Lily

Seasonality in Consumption



Buyer Heterogeneity

FY = 2018	Mean	SD	Min	Max	N
# of flower types purchased / day	7.77	6.24	1	41	860
# of varieties purchased / day	18.0	29.6	1	299	860
# of transactions / day	21.7	45.0	1	644	860
# of flowers purchased / day	1762	4638	10	75K	860
Total spending / day	120K	300K	1058	3.5M	860

Variance decomposition: Negotiated transactions

FY = 2018	σ_{bd}	σ_{bdv}	σ_{bdvs}	σ_{bdvr}
$\log(\text{price})$.392	.731	.244	.259
$\log(\text{quantity})$.385	.538	.443	.456

b : buyer, d : date, v : variety, s : seller, r : rest

Timing of purchase: Negotiation

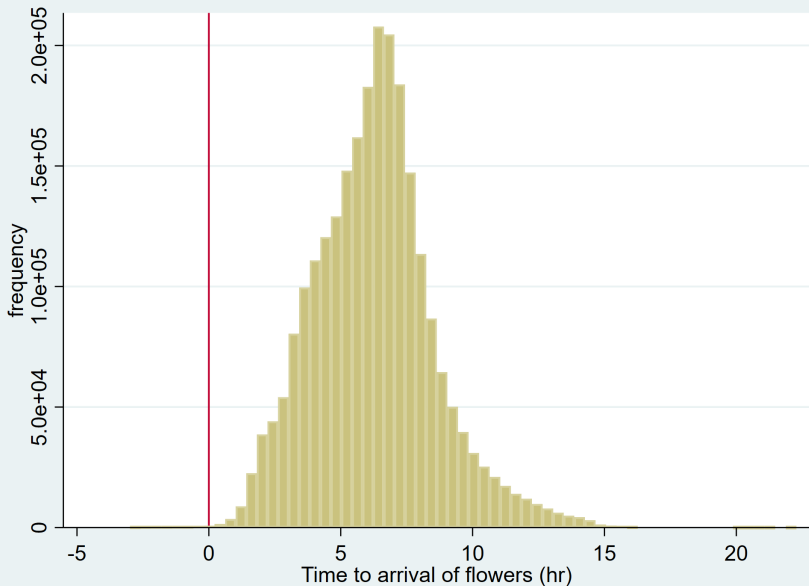
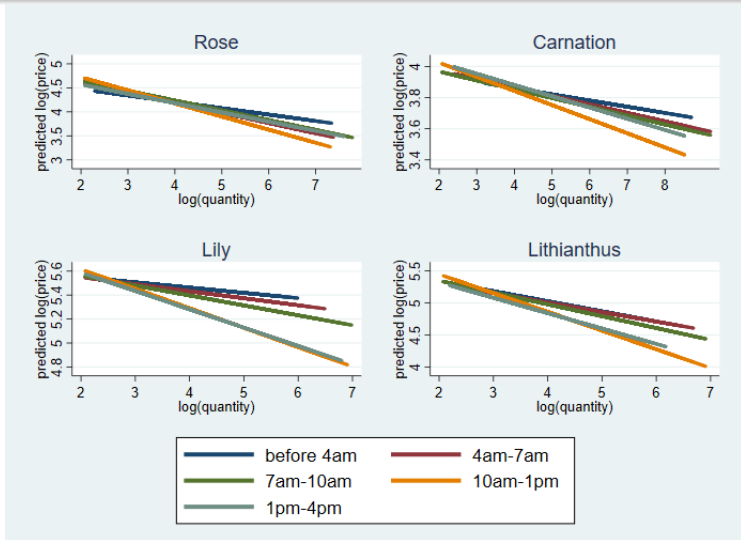


Table: Dynamic Nonlinear Pricing Schedule

Dependent variable	$\log(\text{price}/\text{flower})$	
1 {10am – 1pm}	-.0854 (.010)	.00402 (.027)
1 {1pm – 4pm}	-.135 (.0040)	.153 (.012)
1 {after 4pm}	-.040 (.0036)	-.0316 (.010)
$\log(\text{quantity})$		-.178 (.0025)
1 {10am – 1pm} $\times \log(\text{quantity})$		-.0332 (.0070)
1 {1pm – 4pm} $\times \log(\text{quantity})$		-.0795 (.0029)
1 {after 4pm} $\times \log(\text{quantity})$		-.00863 (.0024)
seller-variety-date FE	yes	yes
R-sq	0.939	0.947
N	2.5M	2.5M

Dynamic Nonlinear Pricing Schedule



- Net of seller-variety specific date fixed effects
- Pronounced quantity discount right before the arrival of flowers

Strategic delay by buyers

- The above reduced-form results indicate that a buyer can attain quantity-discount by delaying its purchase
- The incentive to delay purchase may depend on “buyer size”
 - The larger the quantity demanded, the larger the amount of money at stake
- If there is a fixed cost in delaying, those larger buyers have larger incentive to wait
- We empirically examine this hypothesis via **a test of forward-looking behavior**

Test of forward-looking buyers

- Is the demand for flowers affected by expected availability of flowers in the future
- More specifically, we examine if buyers' demand is decreasing in the expected auction quantity
 - If flowers available at auction at a lower price, then buyers are induced to delay purchase
- If buyers' current demand depends on future availability, then evidence of forward-looking buyers
 - If correlation is due seller's expected availability, then would observe a positive correlation
 - This suggests that we obtain a lower bound if we find a negative correlation

Test of forward-looking buyers

- If larger buyers have larger incentive to delay, then the effect of future price will also be larger
- We conduct the above test in a reduced-form (do not attempt to estimate demand elasticity)

- **Reduced-form quantity**

$$q = X^S \beta^S + X^B \beta^B + \alpha eq + \varepsilon$$

where:

- 1 q : the current number of transacted flowers
- 2 $\{X^S, X^B\}$: current seller and buyer characteristics
- 3 eq : **expected number of flowers in auctions**
 - $H_0 : \alpha = 0$ (myopic buyers)
 - $H_A : \alpha < 0$ (forward-looking buyers)
 - The more flowers available in the future, the more likely a buyer can flowers at a lower price
 - If eq reflects sellers' expectation, then $\alpha > 0$

- **Construction of expected quantity in auction**

- ① For a given variety of flowers in a given month and day of the week, calculate mean auction price and mean total quantity of flowers.
- ② Regress actual quantity of flowers available in auctions on the above price and quantity together with covariates.
- ③ Obtain predicted quantity, which we use as eq

- **Heterogeneity in response**

- ① The incentive to delay varies across **buyer size**
- ② The incentive to delay varies across **time of the day**

Test results

Dependent variable	$\log(q)$				
	before 4am	4am-7am	7am-10am	10am-1pm	1pm-4pm
<i>eq</i>	.0392 (.029)	.0143 (.015)	-.0239 (.00384)	-.0156 (.0044)	-.00255 (.0128)
$\mathbf{1}\{large\ buyer\} \times eq$	-.0335 (.021)	-.0573 (.0094)	.0106 (.0027)	.0135 (.0032)	-.0295 (.010)
<i>initial stock</i>	.115 (.022)	.101 (.011)	.0768 (.0029)	.0305 (.0036)	.0203 (.229)
<i>current stock</i>	.330 (.010)	.305 (.0052)	.210 (.0014)	.201 (.0020)	.229 (.0067)
seller-variety-month FE	y	y	y	y	y
buyer-variety-month FE	y	y	y	y	y
N	16548	63220	560809	437143	70708

Robustness

- The results are robust to inclusion of flower type-date FE

Interpretation

- Both small and large buyers demand less when a lot of flowers are expected in auctions
- As the deadline approaches, large buyers (that ships flowers somewhere) buy a lot before deadline for shipping today
- After the deadline, there is not much to gain from buying via negotiation and so wait