

DYNAMIC PRICING IN BILATERAL RELATIONSHIPS: EXPERIMENTAL EVIDENCE

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Point of departure

- The **prices** of many goods and services **vary over time**.
- Sellers are increasingly **tracking individual consumers**.
- **Scant empirical evidence** due to a lack of clean field data.

Why do prices vary over time?

1. The economic **environment changes** (e.g., demand, cost).
2. Agents **update their beliefs** about a fixed economic environment.

What we do

Study a **fixed environment in the lab** where the **seller updates her belief** about the buyer's willingness to pay.

Received wisdom: The Coase (1972) conjecture and its failures

- Without commitment, a durable good monopolist is **gradually lowering prices** (Stokey 1981; Bulow 1982; Fudenberg et al. 1985, Gul et al. 1986).
- **But: “Coasian dynamics”** do not always emerge (Hart & Tirole 1988; Board & Pycia 2014; Tirole 2016, Nava & Schiraldi 2019).

“Simplest” setting: Finite bilateral relationship (Hart & Tirole 1988)

- **Finite:** $T < \infty$ periods.
- **Bilateral:** 1 seller/1 buyer
- **Asymmetric information:** buyer has private valuation.
- **Mode of trade:** sale/rental and non-/commitment

Research question

How well does dynamic monopoly pricing theory work in the lab?

Coasian dynamics (selection)

Coase (1972), Stokey (1981), Gul et al. (1986), Hart & Tirole (1988), Board & Pycia (2014), Tirole (2016), Nava & Schiraldi (2019).

Experimental evidence on the Coase conjecture

Reynolds (2000), Cason & Sharma (2001), Fanning (2022), Fanning & Kloostermann (2022).

Ultimatum games

Camerer & Thaler (1995), Fehr & Schmidt (1999), Camerer (2003), Oosterbeek et al. (2004)

Our contribution

Go beyond the Coase conjecture and study **Sale vs. Rent** and **Non-Commitment vs. Commitment** (2x2 treatments).

Main takeaway

Theory does a good job at predicting **mean prices** but cannot capture the **widely different individual price paths**.

Three new insights

1. **Role of commitment**

Commitment has **less bite** than theory predicts.

2. **Selling vs. renting**

Theory **works better** for renting than for selling.

3. **Strategic behavior**

Under **selling**, the majority of sellers and high-value buyers is strategic. Under **renting**, ratcheting is key, whereas strategic delay is less important.

THEORY



Assumptions (Hart & Tirole 1988)

- Finite-horizon durable-good setting, with zero production cost and unit demand in every period $t = 1, \dots, T < \infty$.
- The buyer and seller are risk-neutral and have the same discount factor $\delta \in (0, 1)$.
- The **buyer** has private per-period valuation $b \in \{\underline{b}, \bar{b}\}$, with $\bar{b} > \underline{b} > 0$.
- The **seller's** prior belief that the valuation is high is μ_1 , with $\mu_1 > \underline{b}/\bar{b} \equiv \bar{\mu}$.

Mode of trade: sale vs. rental

- Let $x_t(b) \in \{0, 1\}$ denote the consumption choice of a type- b buyer in period t .
- **Sale:** The good is **sold** once and for all future periods (i.e., if $x_t = 1$, then $x_{t+1} = 1, \dots, x_T = 1$).
- **Rental:** The good can be **rented** in every period separately.

EXPECTED UTILITY AT $t = 1$

Buyer

$$U(b) = \mathbb{E} \left[\sum_{t=1}^T \delta^{t-1} x_t(b) (b - p_t) \right], \quad b \in \{\underline{b}, \bar{b}\}, \quad (1)$$

Seller

$$\pi = \mathbb{E} \left[\sum_{t=1}^T \delta^{t-1} x_t(b) p_t \right]. \quad (2)$$

Notation

Let $\Delta_t \equiv \sum_{\tau=t}^T \delta^{\tau-t}$ denote the (present discounted) number of periods from t onward.

EXPERIMENT



- Programmed in oTree, conducted in the Behavioral Lab at University of St. Gallen, Switzerland.
- 1,410 bilateral relationships in 18 sessions (< 2h per session).
- Show-up fee of CHF 20; assigned as anonymous buyers or sellers to a single session that implemented the sale or rental model.
- Random matching for relationships of ten periods ($T = 10$).
- **Treatments**
 1. Sale with commitment [SC].
 2. Sale without commitment [SNC].
 3. Rental with commitment [RC].
 4. Rental with commitment [RNC].
- Average earnings in the sale and rental model were CHF 24 and CHF 32, respectively.

Table 1: Parameter Values

Parameter	Label	Value
Horizon	T	10
Low valuation	\underline{b}	50
High valuation	\bar{b}	100
Relative valuation	$\underline{b}/\bar{b} \equiv \bar{\mu}$	0.5
Prior belief (high valuation)	μ_1	0.6
Discount factor	δ	0.6

SCREENSHOT: PRICING WITH COMMITMENT ($t = 1$)

Your decision

Price in Round 1

 points

Price in Round 2

 points

Price in Round 3

 points

Price in Round 4

 points

Price in Round 5

 points

Price in Round 6

 points

Price in Round 7

 points

Price in Round 8

 points

Price in Round 9

 points

Price in Round 10

 points

Next

SCREENSHOT: PRICING WITHOUT COMMITMENT ($t = 1$)

Your decision in round 1

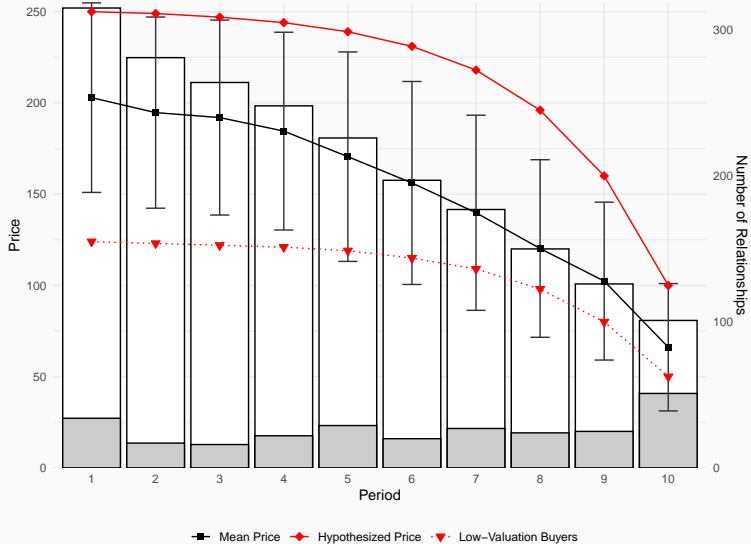
What price between 0 points and 275 points do you want to set?

points

Next

RESULTS 1: SALE

SALE WITH COMMITMENT [SC]



SALE WITH COMMITMENT [SC]: ANALYSIS

Hypothesis 1 (Sale with Commitment)

Sellers commit to a declining path of prices p_1, p_2, \dots, p_{10} that fully extract the surplus of high-value buyers, and only high-value buyers purchase.

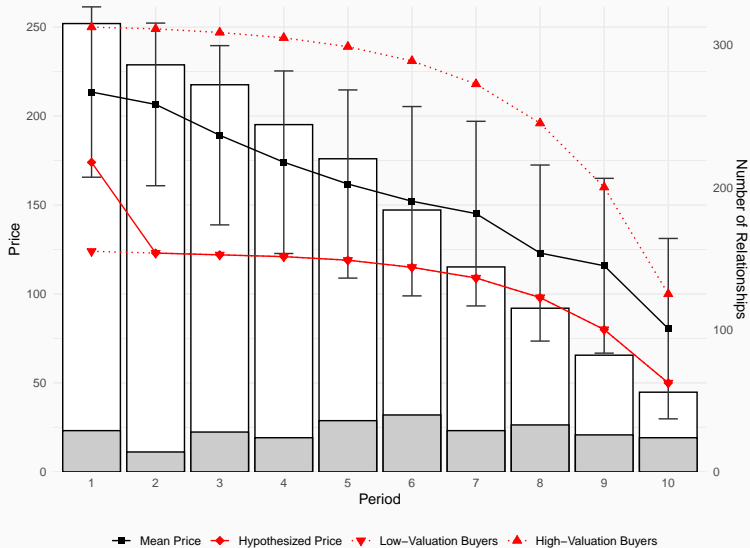
Observations

1. **Declining mean prices:** sellers understand that the value diminishes.
2. **Sellers leave substantial rent to buyers:** $\sim 30\%$ of the surplus.
3. **“Too much trade (too late)”:** trade happens in all 10 periods (not just the first), and the good is sold in 265 of 315 relationships ($> 60\%$).
4. **“Average Efficiency”:** 30% of the expected surplus is realized.

Comparison to Ultimatum game

- Rent distribution is similar (Osterbeek et al. 2004), but two key differences: surplus is (i) **uncertain** and (ii) **changes** over time.
- **Explanations:** social preferences, risk aversion, non-exp. discounting.

SALE WITHOUT COMMITMENT [SNC]



Hypothesis 2 (Sale without Commitment)

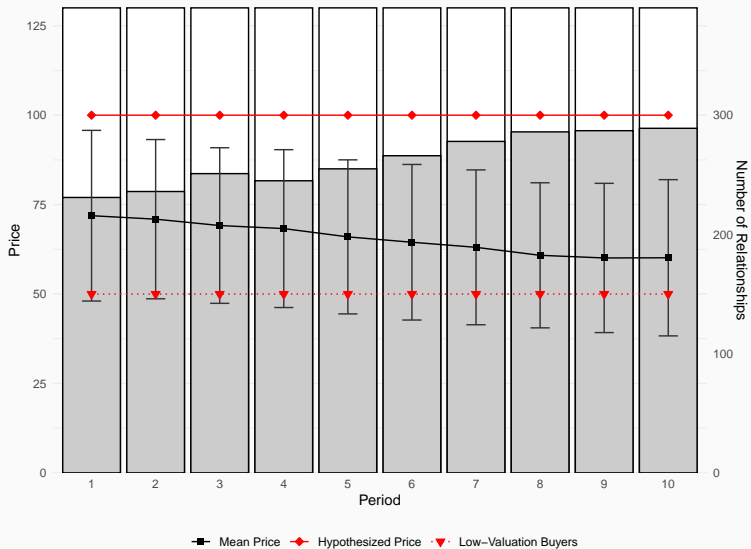
The seller sets the price $p_1 = 174$ in the first period, and, if rejected, lowers the price to $p_2 = 123$ in the second period. Given this pricing strategy, a high-valuation buyer is indifferent between purchasing in the first or second period, while a low-valuation buyer purchases in the second period.

Observations

1. **Declining mean prices**, which is consistent with Coasian dynamics.
2. **Higher-than-predicted mean prices**, first price even higher than in the SC treatment (213.51 vs. 202.89, $p < 0.01$ Wilcox).
3. **“Too little trade (too late)”**: trade happens in all 10 periods (not just the first two), but only in 283 of 315 relations ($< 100\%$).
4. **“Average Efficiency”**: 25% of the expected surplus is realized.

RESULTS 2: RENTAL

RENTAL WITH COMMITMENT [RC]



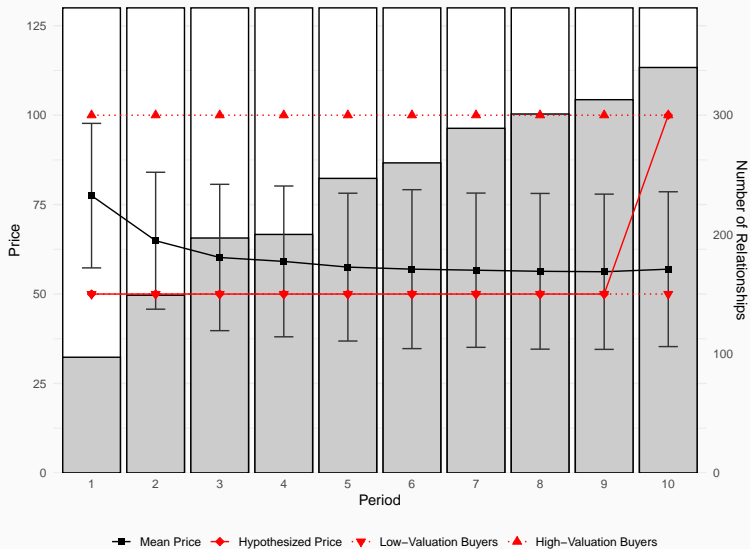
Hypothesis 3 (Rental with commitment)

Sellers commit to constant prices $p_t = 100$, $t = 1, \dots, 10$, that fully extract the surplus of high-valuation buyers, and only high-valuation buyers rent the good in each period.

Observations

1. **Mean prices are almost constant**, if anything slightly declining.
2. **Mean prices are lower than predicted**, sellers leave ca. 35% of the surplus.
3. **"Too much trade"**: trade happens in all 10 periods, and the good is rented in 290 of 390 relations ($> 60\%$).
4. **"Average Efficiency"**: 99% of the expected surplus is realized, but consumers earn higher-than-predicted share.

RENTAL WITHOUT COMMITMENT [RNC]



Hypothesis 4 (Rental without commitment)

Sellers set constant rental prices $p_t^{RNC} = 50$ for $t = 1, \dots, 9$, so that high- and low-valuation buyers rent the good each period. In period 10, the price is $p_{10}^{RNC} = 100$ and fully extracts the surplus of high-valuation buyers.

Observations

1. **Mean prices are gradually declining at the beginning, then roughly constant** (“hockey stick”).
2. **Mean prices are higher than predicted**, but significantly lower than with commitment (60.25 vs. 65.49, $p < 0.01$, Wilcox).
3. **“Too much trade”**: trade happens in all 10 periods, and the good is rented most often in the last period (in 340 of 390 relationships).
4. **“Average Efficiency”**: 66% of the expected surplus is realized, which is less than with commitment.

DISCUSSION

Role of commitment

Why do sellers commit to prices that leave rents to buyers?

- Commitment is **not salient** in the experiment.
- **Inverse endowment effect** (Kahnemann et al. 1990) because the good becomes obsolete when the relationship ends.

Selling vs. renting

Why does theory work better for renting?

- The dynamics of **renting** are **easier** to understand.
- Yet, even under renting, we observe **complex** price paths.

Strategic behavior

Who behaves strategically?

- Under **selling**, the majority of sellers and buyers behaves strategically.
- Under **renting**, **ratcheting** is predominant.

CONCLUSION

Main takeaway

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Three new insights

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