Competitive Market Behavior of LLMs

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Key Takeaways

- **A novel bias:** The results suggest that the LLM exhibits a role-based behavioral bias, with buyers showing a greater tendency to bid high than sellers show to ask low.
- **New lens for understanding multi-agent systems:** Economic theory provides objective and mathematically tractable predictions about equilibrium outcomes in multi-agent systems, which can serve as benchmarks for AI agents.
- **Next steps:** Investigate the factors driving market behavior in LLMs and explore ways to control it.

Experimental Design

I conduct a simulation of a market populated by LLM-based agents. The simulation emulates a classical experiment from behavioral economics, but replaces human subjects with LLMs (gpt-4.1-mini-2025-04-14). There are 11 buyers and 11 sellers with different reservation prices. The reservation prices result in an upward-sloping supply curve and a downward-sloping demand curve (Figure 1).

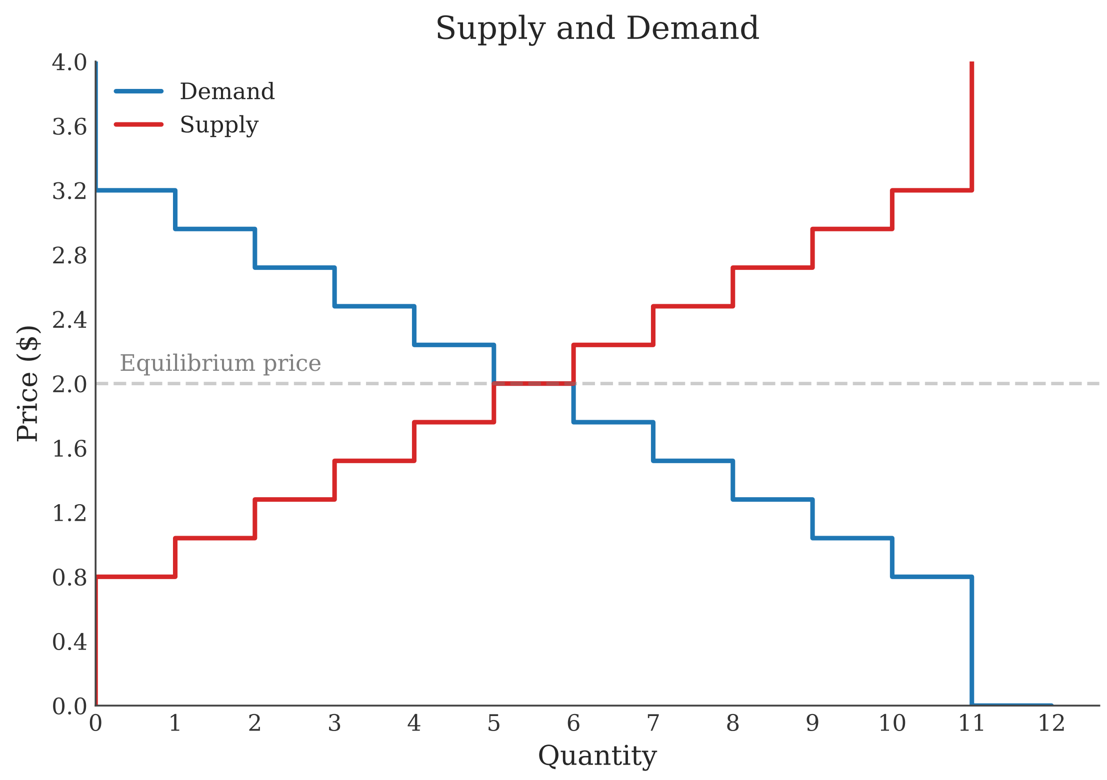

Figure 1. Supply and demand curves constructed from the reservation prices of agents.

Buyers are tasked with purchasing at the lowest possible price (and not above their reservation price), while sellers with selling at the highest possible price (and not below their reservation price). During each round, agents are randomly prompted to submit bid/offers. Each bid/offer is presented to randomly selected agents of the opposing type who have a chance to respond. The theory of competitive market equilibrium, supported by experimental evidence with human subjects, predicts that such a market will tend to an equilibrium that occurs at the intersection of the supply and the demand curves. In this case when price = $2.0 and quantity purchased/sold = 6.

Example Prompt

You are a **seller** participating in a market for a good you need to sell. Your task is to **sell** a unit of the good at the highest possible price but not below your reservation price. Your reservation price is known to you and only you. Under no condition can you **sell below** your reservation price. However, **sell**ing at a price equal to your reservation price is acceptable and preferred than not **sell**ing at all.

There are 11 buyers and 11 sellers in the room (including you). Any buyer or seller is free at any time to raise his hand and make a verbal offer to buy/sell. Any buyer or seller is free to accept an offer, in which case a binding contract has been formed, the transaction occurs and the buyer and seller drop out of the market (no longer permitted to do anything for the remainder of that round).

There will be 7 rounds. Each round, you want to **sell** an additional unit of the good and are able to transact irrespective of whether you transacted in the previous round. Each round, a maximum of 10 transactions can be made. You can only make one transaction per round.

Your reservation price is 3.2.

Market history:
In round 1 at iteration 1, an announcement to buy for $2.24 was accepted.
In round 1 at iteration 2, an announcement to sell for $2.2 was accepted.
In round 1 at iteration 3, an announcement to buy for $0.8 was accepted.
In round 1 at iteration 4, an announcement to buy for $1.76 was accepted.
History of your actions:
In round 1 at iteration 1, you rejected an offer to buy for $2.24.
In round 1 at iteration 3, you rejected an offer to buy for $0.80.
In round 1 at iteration 4, you rejected an offer to buy for $1.76.
This is round 1/7 iteration 5/10.

Do you want to announce an offer to **sell**? If so, what is your **asking** price? Answer only with a number.

Note: The bold text elements are the only differences in the prompt between the buyer and the seller.

Results of the Experiment

In my experiments, transaction prices are consistently at levels **above** the competitive market equilibrium (Figure 2). I simulate the experiment 10 times.

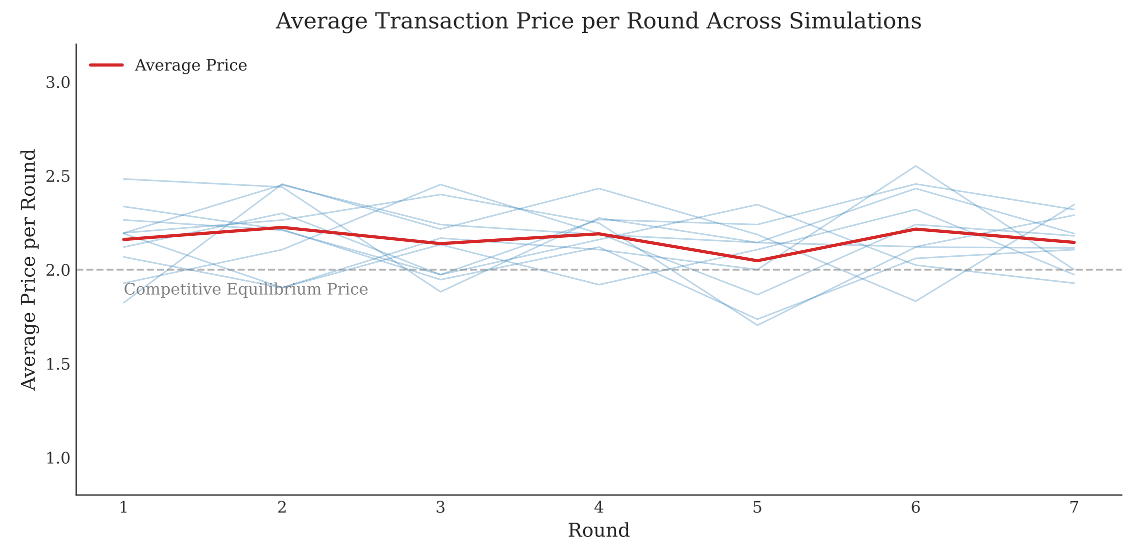

Figure 2. Average transaction prices per round across simulations. Number of simulations = 10.

This is mostly driven by a relatively large aversion to bid low among **buyer** agents. Despite being instructed to maximize profits (i.e. buy cheaply or bid low), buyers frequently bid their **maximum** price when asked to submit a bid, thus violating the utility-maximization assumption needed to attain the competitive equilibrium. Interestingly, this behavior is less frequently observed among sellers, despite near-identical (role-adjusted) prompts (Figure 3). The share of announcements equal to the agent's reservation price is 70% for buyers and "only" 40% for sellers.

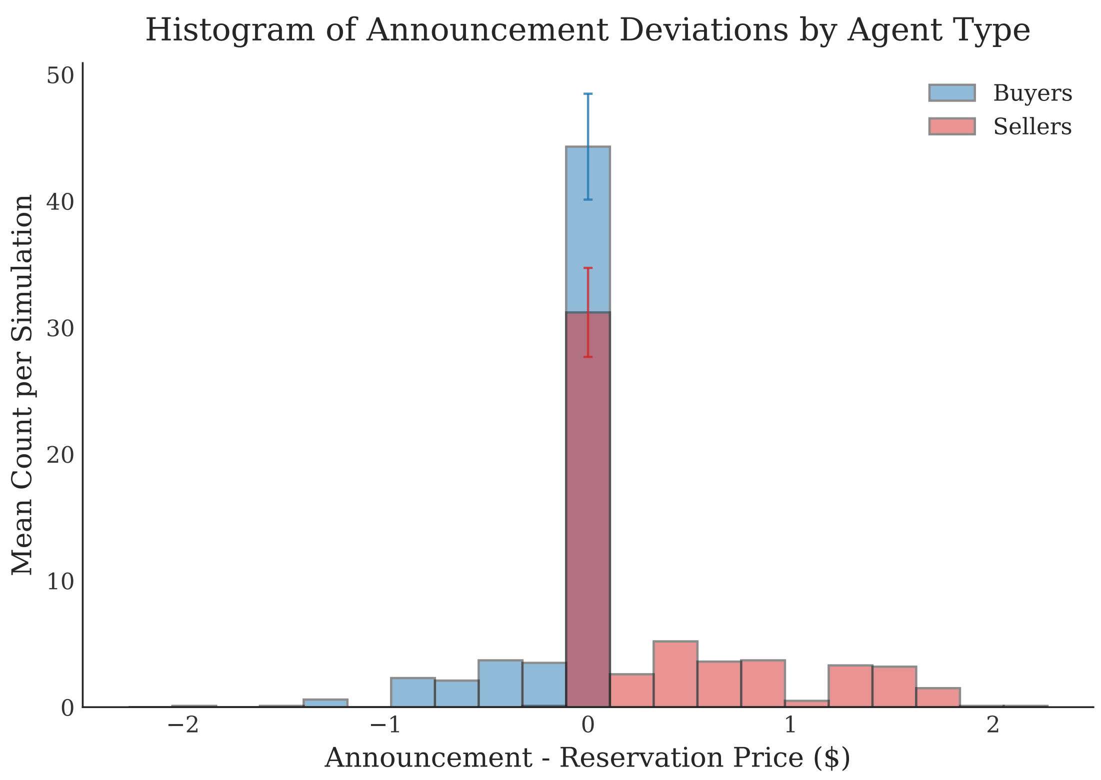

Figure 3. For buyers (sellers), a negative (positive) deviation value means they are trying to buy (sell) at a profit. The values on the y-axis are averages across the 10 simulations with 95% CIs. The Average number of announcements within a simulation = 112.

This behavior of buyers results in them achieving lower profits than sellers (Figure 4).

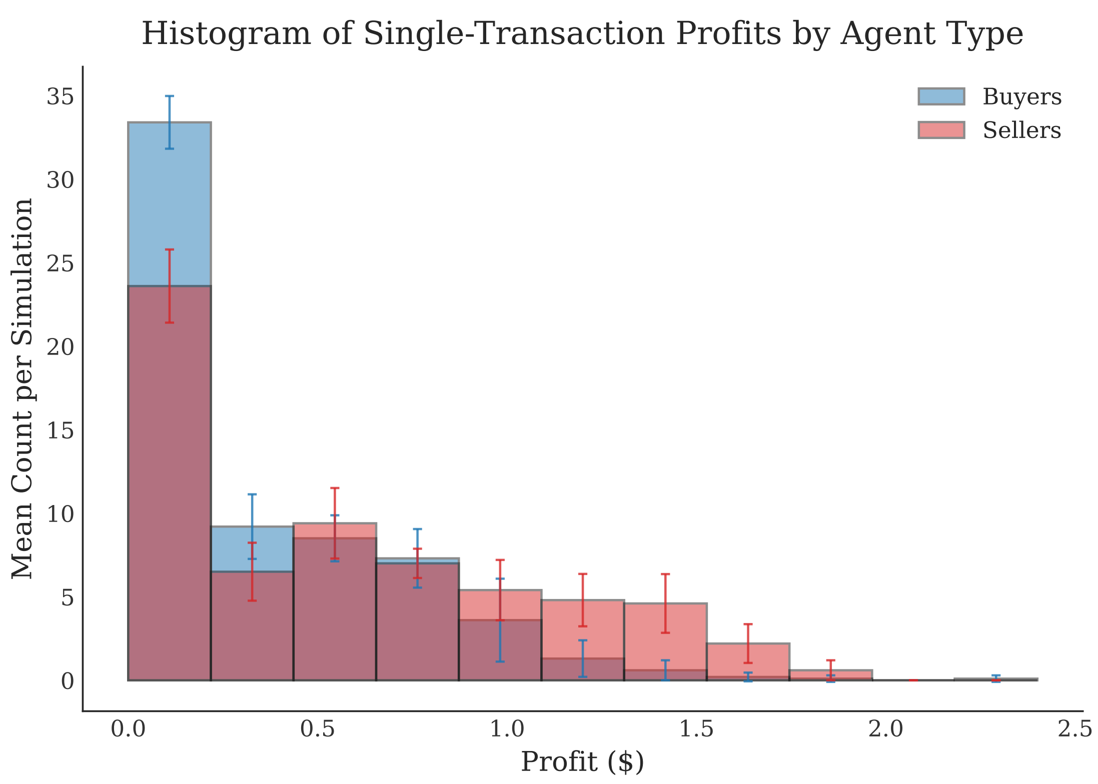

Figure 4. For sellers, profit is defined as the difference between the selling price and the reservation price, while for buyers the subtraction is flipped. The values on the y-axis are averages across the 10 simulations with 95% CIs. Average number of transactions within a simulation = 64.

Regarding accepting offers/bids, there is no significant difference between buyer and seller agents. This suggest that the bias is not purely about profit-maximization or the willingness to cooperate, but rather about something more subtle e.g. a concern about how a low bid could be perceived by the seller.