ADAPTIVE AGENTS IN A PERSISTENT SHOUT DOUBLE AUCTION

C. Preist and M. van Tol. Adaptive agents in a persistent shout double auction. *Proceedings of the First International Conference on Information and Computation Economies,* pp 11-18. ACM Press, 1998.

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CSci 842

CURRENT AGENTS

- Business to Consumer
  - *Jango:* Scans for low prices
  - *Firefly:* Finds similar media choices
  - *PersonaLogic:* Helps select best model of a product
  - *eBay:* bids in auctions

BUSINESS TO BUSINESS AGENT REQUIREMENTS

- Negotiation ability
- Effective representation of goods
- Many negotiations at once
- Effective negotiation strategy
- Understanding of needs of organization

PROBLEMS WITH CURRENT AGENTS

- Difficult to capture trade criteria
- Trust
- Current models of marketplace unrealistic: only one bid at a time (ZIP)

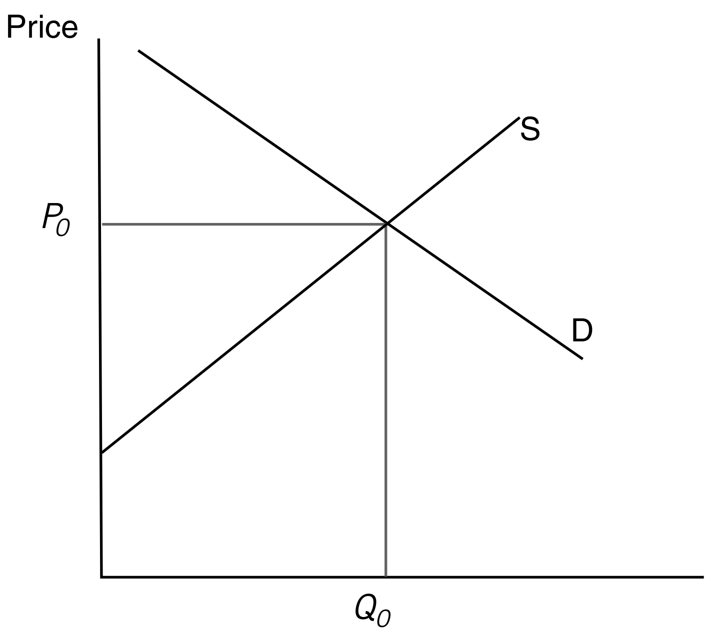
CONTINUOUS DOUBLE SHOUT AUCTION

- Publicly announced bids and offers
- Any buyer can accept offer
- Any seller can accept bid
- Offers and bids persist until altered, accepted or removed
- NYSE

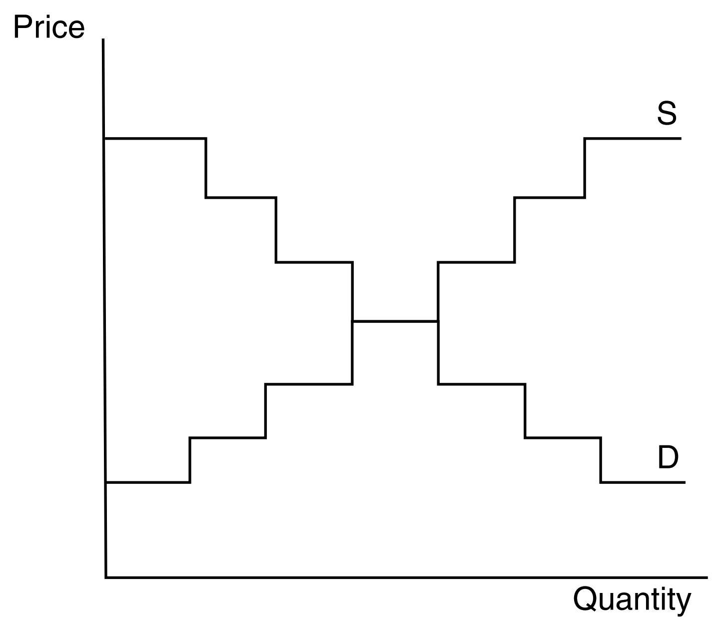
ASSUMPTIONS

- Trading divided into fixed periods
- All participants want to trade one good
- Periods last until all viable trades are made (unbounded trade time)
- Supply and demand are discrete and relatively static

SUPPLY AND DEMAND



Traditional



Agents:
Time in discreet rounds

ROUNDS

- First round: all agents bid/offer
- Subsequent rounds: each can update bid/offer if it chooses
- Trades when bids and offers meet
- Trade is made at average if highest bid is lower than lowest offer

AGENT ALGORITHM SELLER

- Profit margin, $\mu = [0,\infty)$
- Limit price, L
- Minimum price, $p = L(1 + \mu)$
- Offers at price p, accepts bids $\geq p$

AGENT ALGORITHM BUYER

- Profit margin, $\mu = [-1,0]$
- Limit price, L
- Minimum price, $p = L(1 + \mu)$
- Bids at price p, accepts offers $\leq p$

AGENT ALGORITHM

- Initially assigned a random profit margin
- Each agent monitors marketplace, using algorithm to modify μ to maximize profit
- Each round is two phases

ROUND PHASE ONE: TARGET PROFIT MARGIN

- B_{max} is highest bid in round
- S_{min} is lowest offer
- δ is random value, $\ll B_{max}$ and S_{min}
- τ is target value for agents to adjust toward
- Those with no goods to sell continue to monitor, not reducing μ

ROUND PHASE ONE: TARGET PROFIT MARGIN

Buyers:

If $S_{min} > B_{max}$ then
$\tau = B_{max} + \delta$

If $S_{min} \leq B_{max}$ then
$\tau = S_{min} - \delta$

ROUND PHASE ONE: TARGET PROFIT MARGIN

Sellers:

If $S_{min} > B_{max}$ then
$\tau = S_{min} - \delta$

If $S_{min} \leq B_{max}$ then
$\tau = B_{max} + \delta$

DETERMINATION OF δ

If $\tau = B_{max} + \delta$

then $\delta = r_1 B_{max} + r_2$

If $\tau = S_{min} - \delta$

then $\delta = r_1 S_{min} + r_2$

– Where r_1 and r_2 are independent, random, identically distributed in [0,0.2]

ROUND PHASE TWO: USE RULE ON PROFIT MARGIN

- *Widrow-Hoff with momentum* (also used for back propogation in neural networks)
- $p(t+1) = \gamma p(t) + (1-\gamma)\beta(\tau(t) - p(t))$
- β is learning rate
- γ is momentum (damps oscillation)

INTUITION BEHIND HEURISTICS

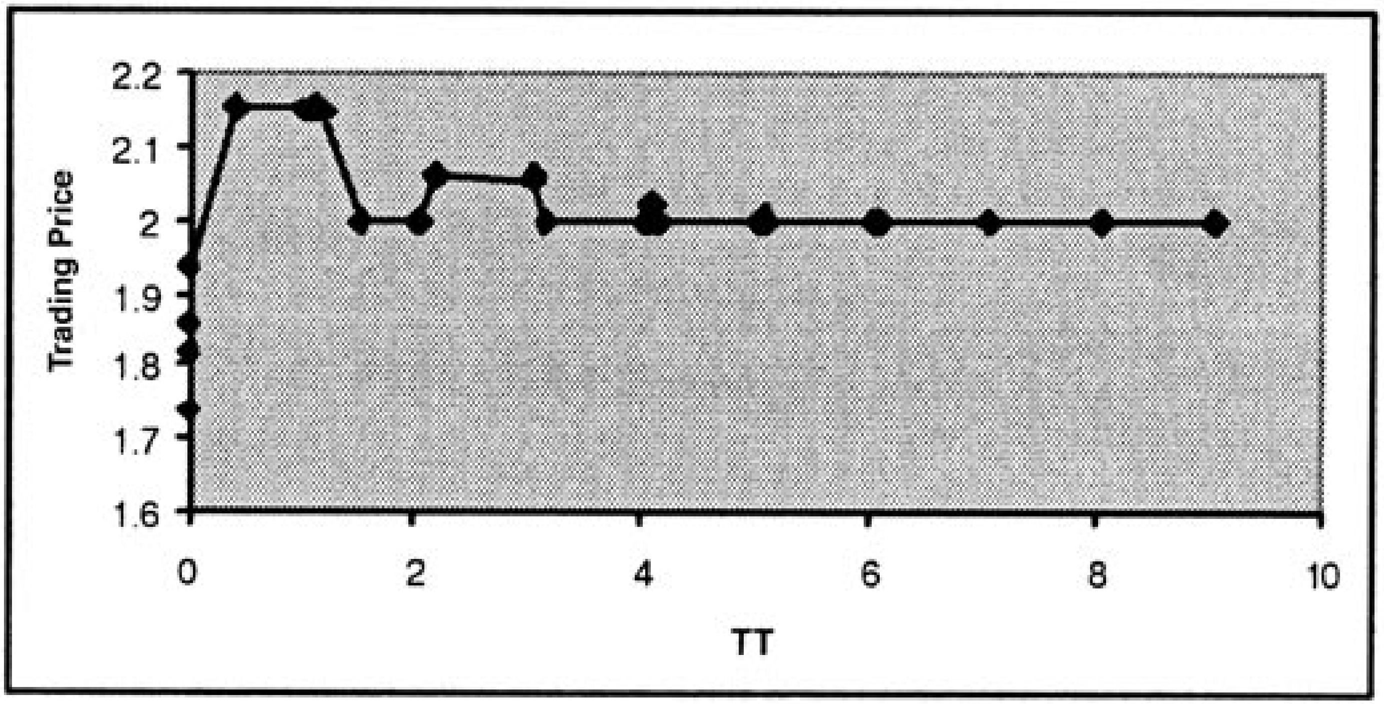
- If no trading, attempt to be most competitive: target better than competition
- If trading, test market: target slightly better than current best price
- Don’t jump straight to target value

RESULTS

- Compared against ZIP
- Used $\beta = 0.3$, $\gamma = 0.05$
- 11 buyers and 11 sellers
- Priced to generate symmetric curves intersecting at $2.00

RESULTS

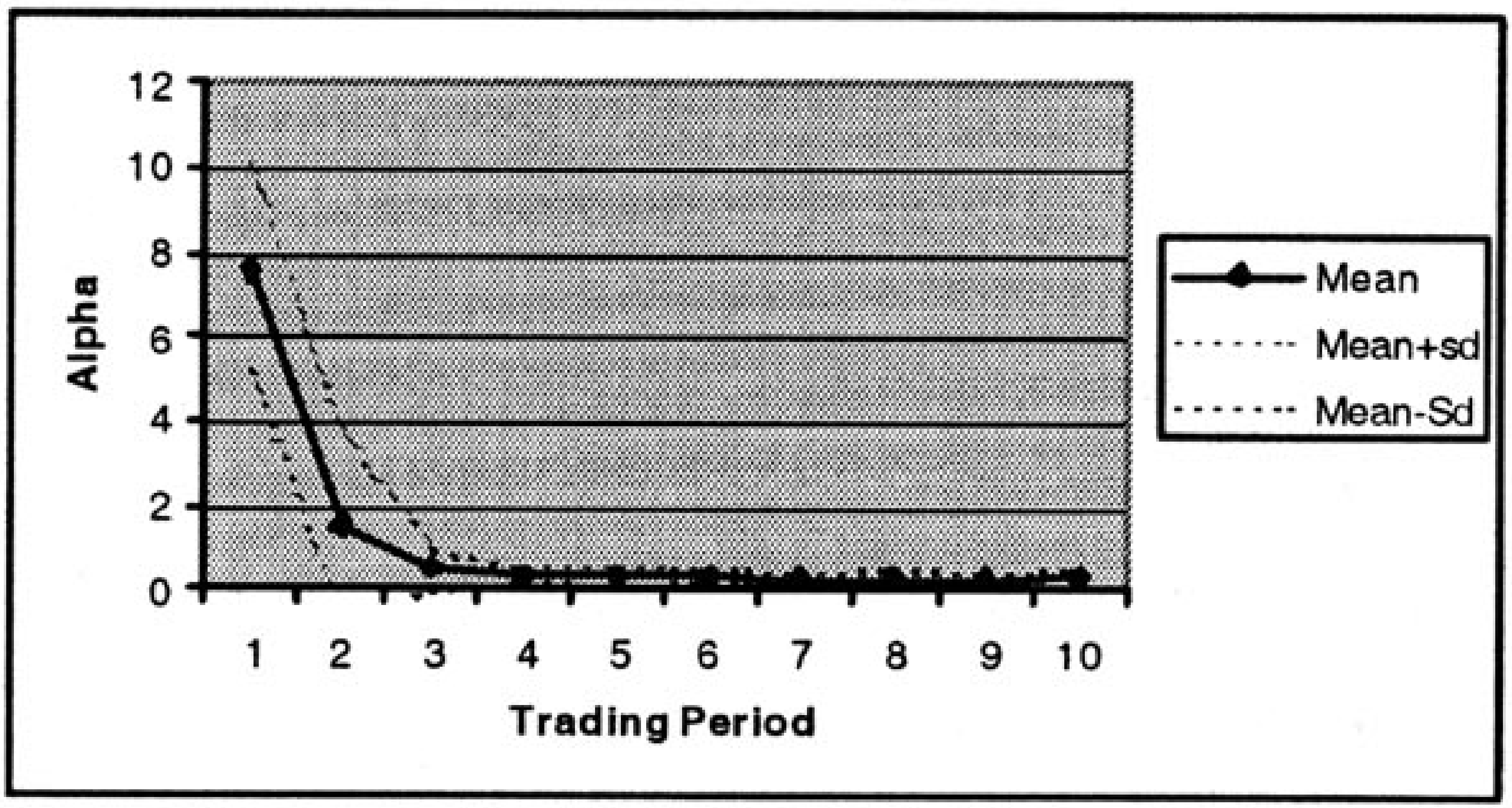
Time series of trading prices



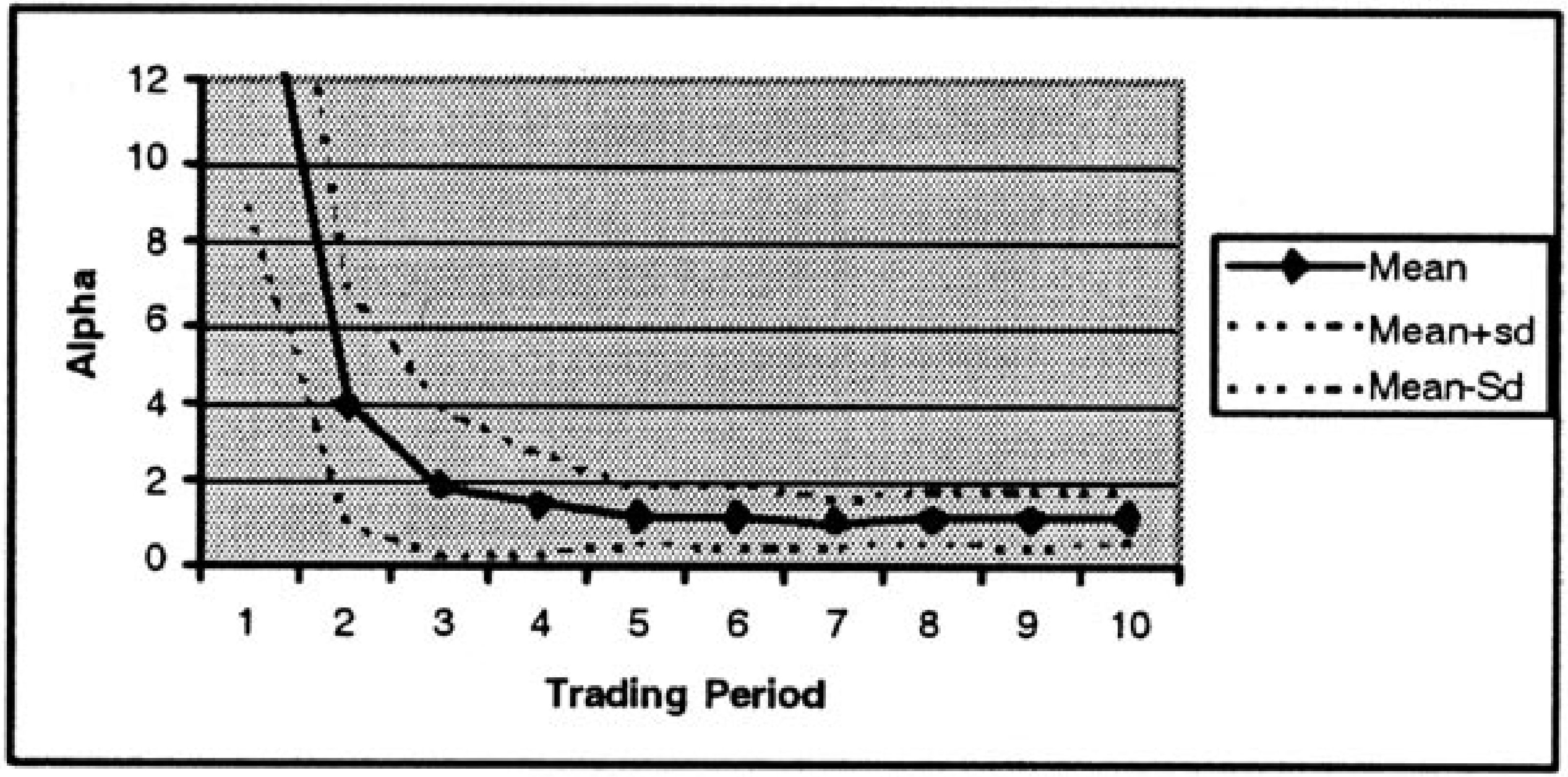
SMITH'S ALPHA (1962)

- Measure of convergence on equilibrium
- Standard deviation of actual trade prices from equilibrium, expressed as percentage of equilibrium
- $\alpha = \dfrac{\sqrt{(\sum_{i=1}^{n}(p_i - P_0)^2)/n}}{P_0}$
- Can be used as measure of efficiency

MEAN ALPHA OF PS AGENTS



MEAN ALPHAS OF ZIP AGENTS



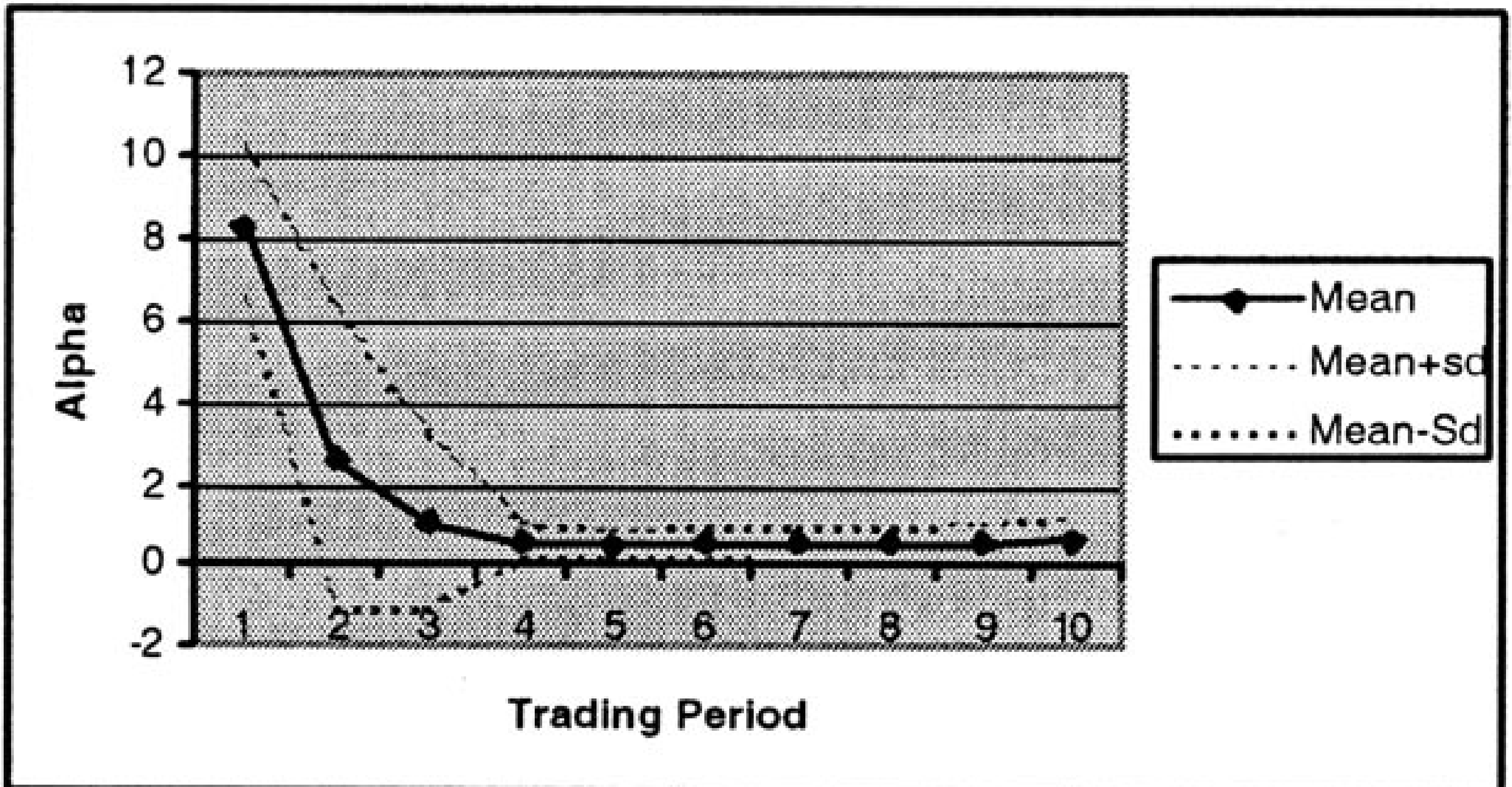
RESULTS DISCUSSION

- PS stabilize more quickly than ZIP
- Remain more stable.
- Zip reach mean α of just over 1%
- PS agents reach $\alpha = 0.4\%$
- Also more stable in earlier trading periods

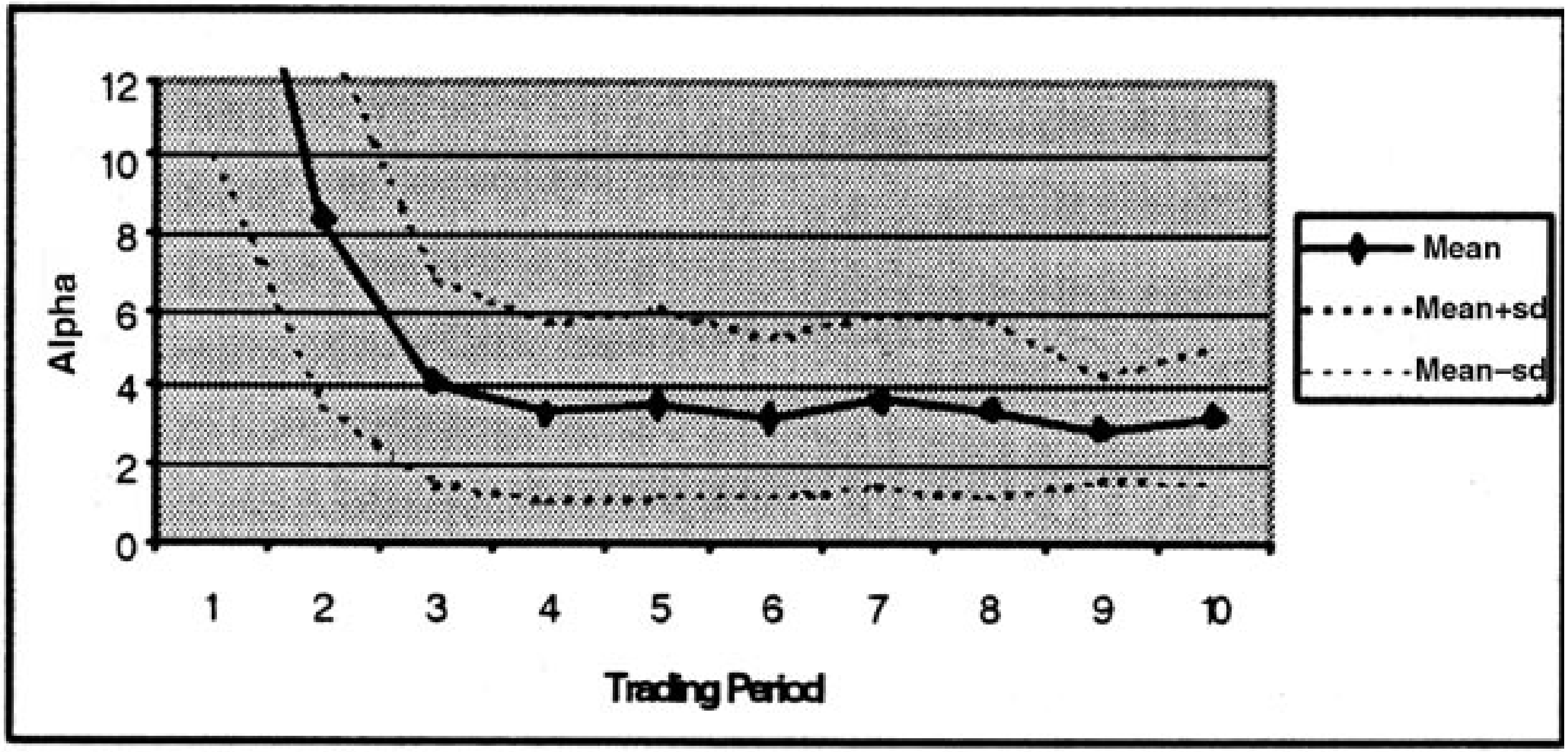
RESULTS DISCUSSION

- Relatively more stable given length of trade period
- 48 vs. 1570 rounds to reach $\alpha < 1\%$
- More robust to changes in learning rate (see following figures)
- At any given time, have more complete information

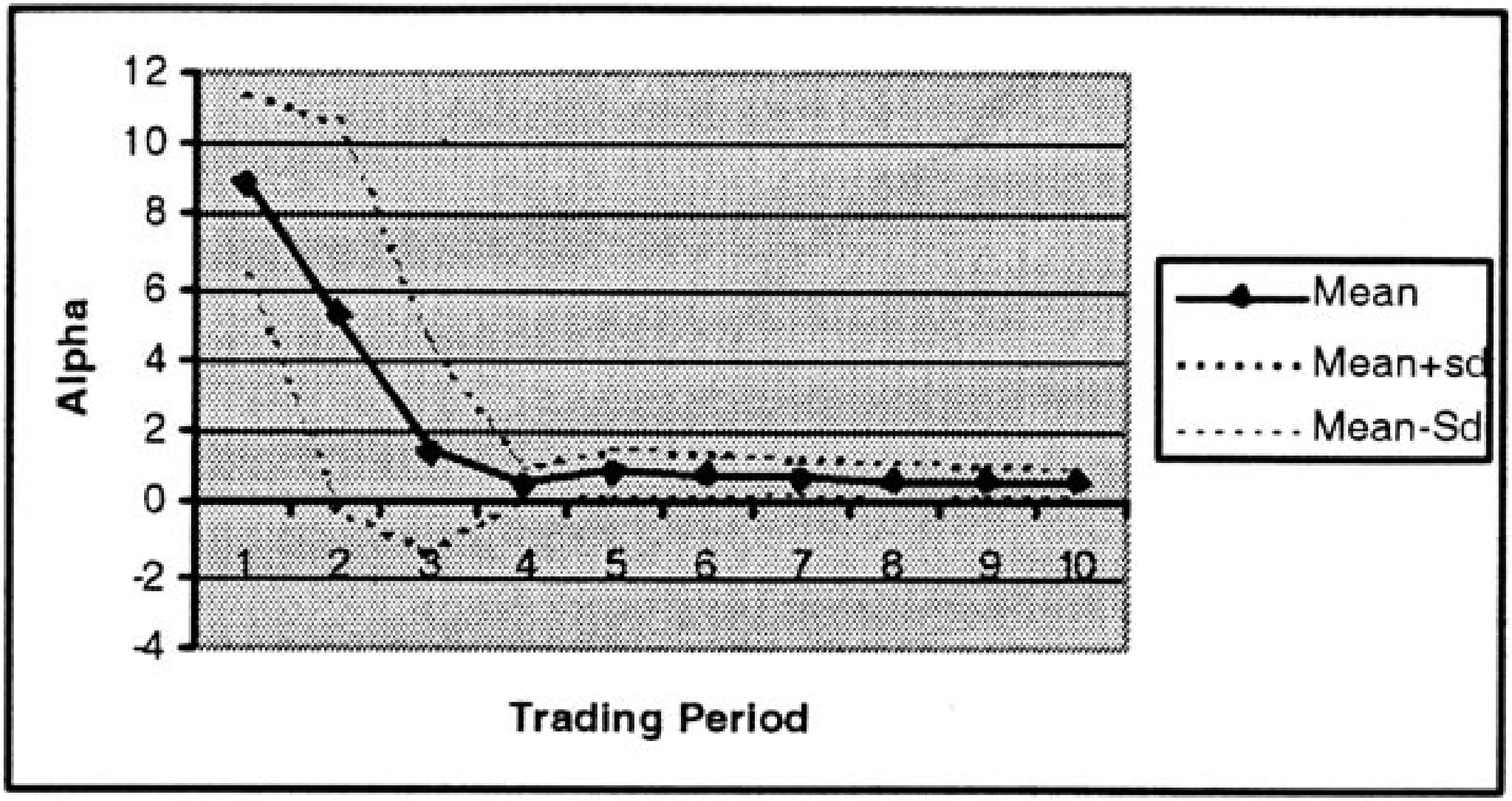
ALPHA OF PS AGENTS WITH γ=0.7



ALPHA OF ZIP AGENTS WITH γ=0.7



ALPHA OF ZIP AGENTS WITH γ=0 (HEURISTICS ONLY)



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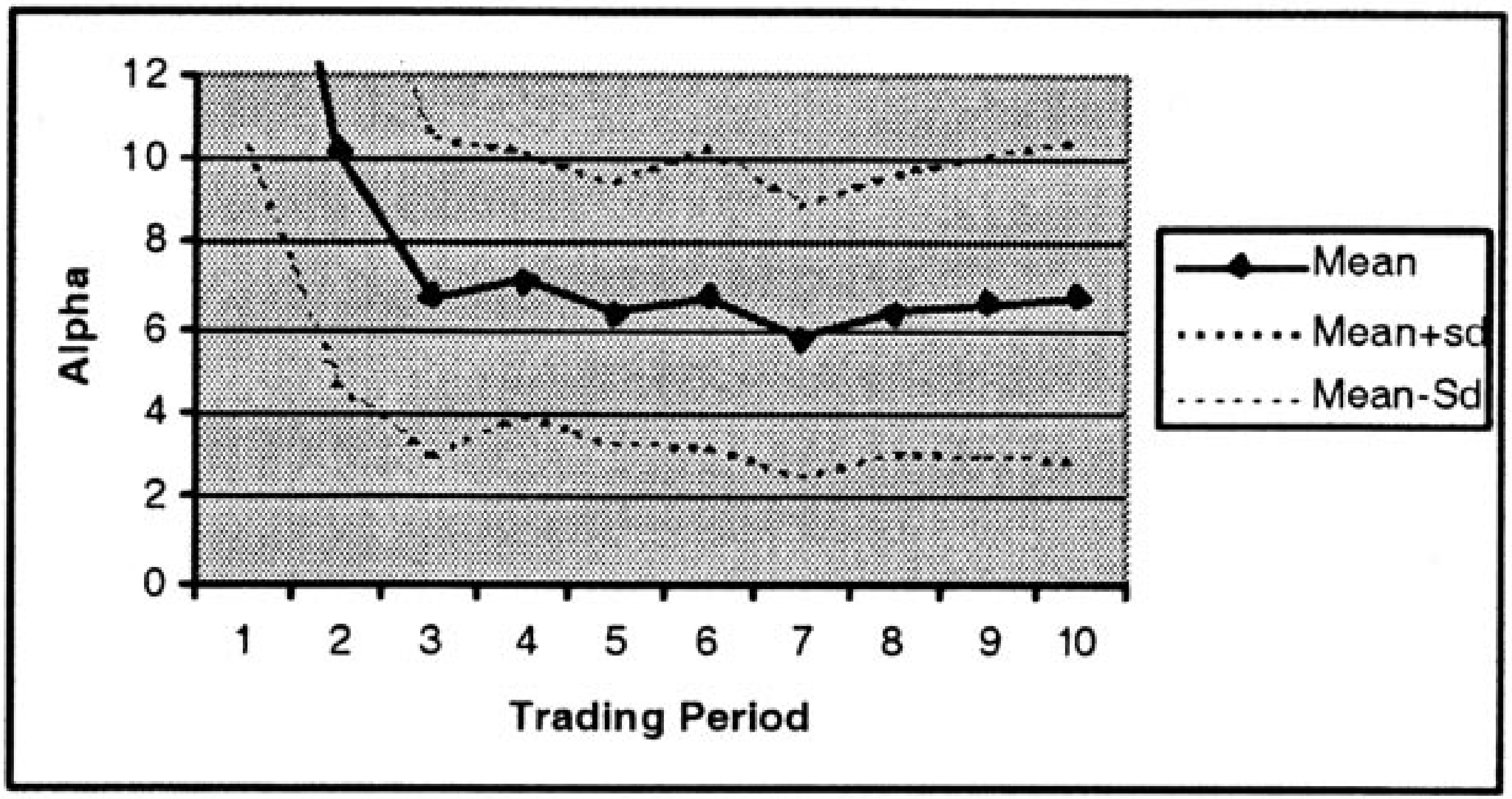

FURTHER WORK: REMOVE ASSUMPTIONS

- Continuous trading
- Bounded trade time
- Continuous supply and demand curves, which vary more frequently