Customer Sharing in Economic Networks with Costs

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Selling a Commodity via Economic Networks with Costs

- **SETTING:** In an economic network, *seller s* has an item for sale. Besides the seller, the economic network includes two categories of agents: *buyers* (customers) who are interested in buying this commodity and *intermediate nodes* who are other sellers or infomediaries.

- **QUESTION:** How to allocate the item globally without observing the economic network in advance?
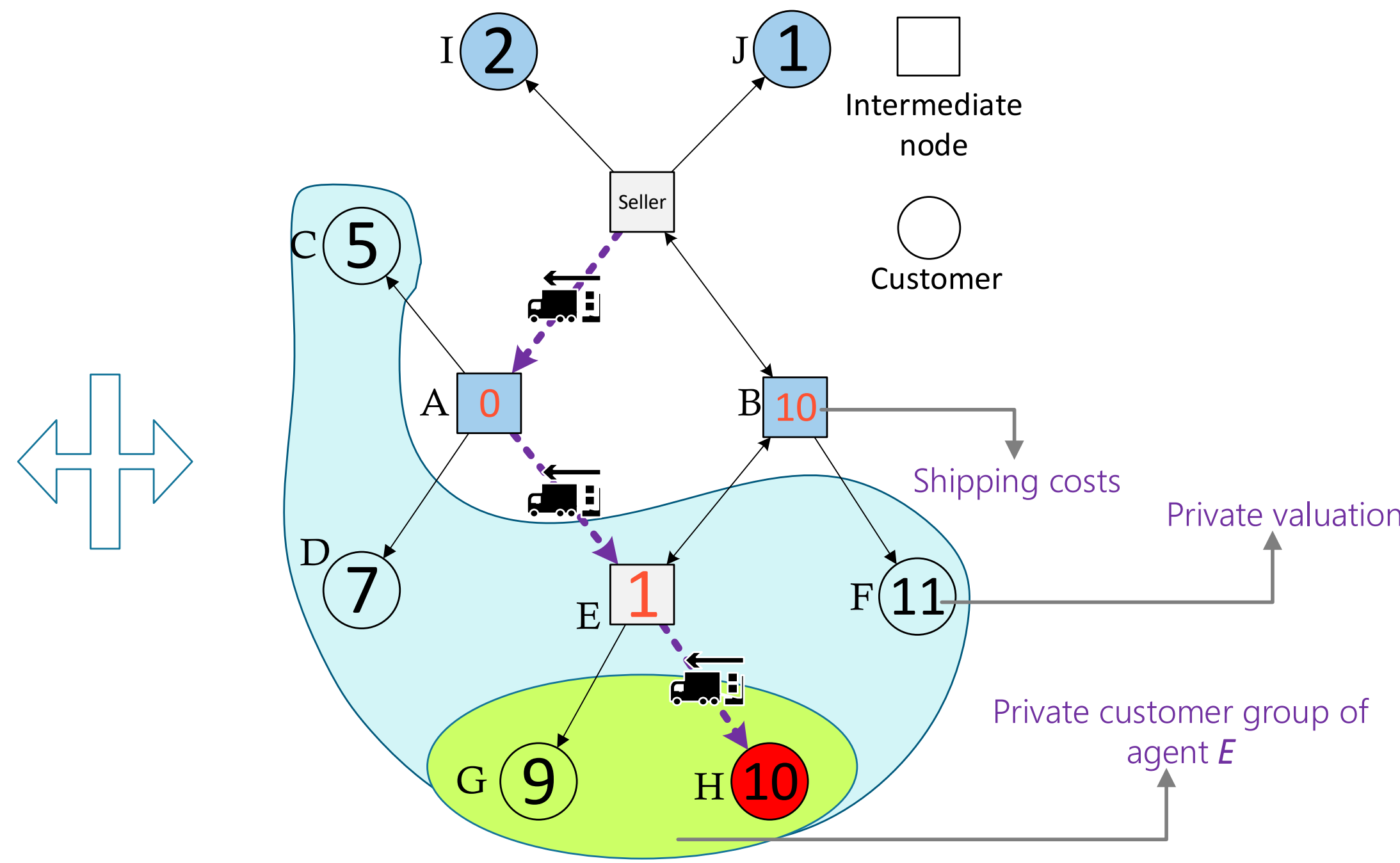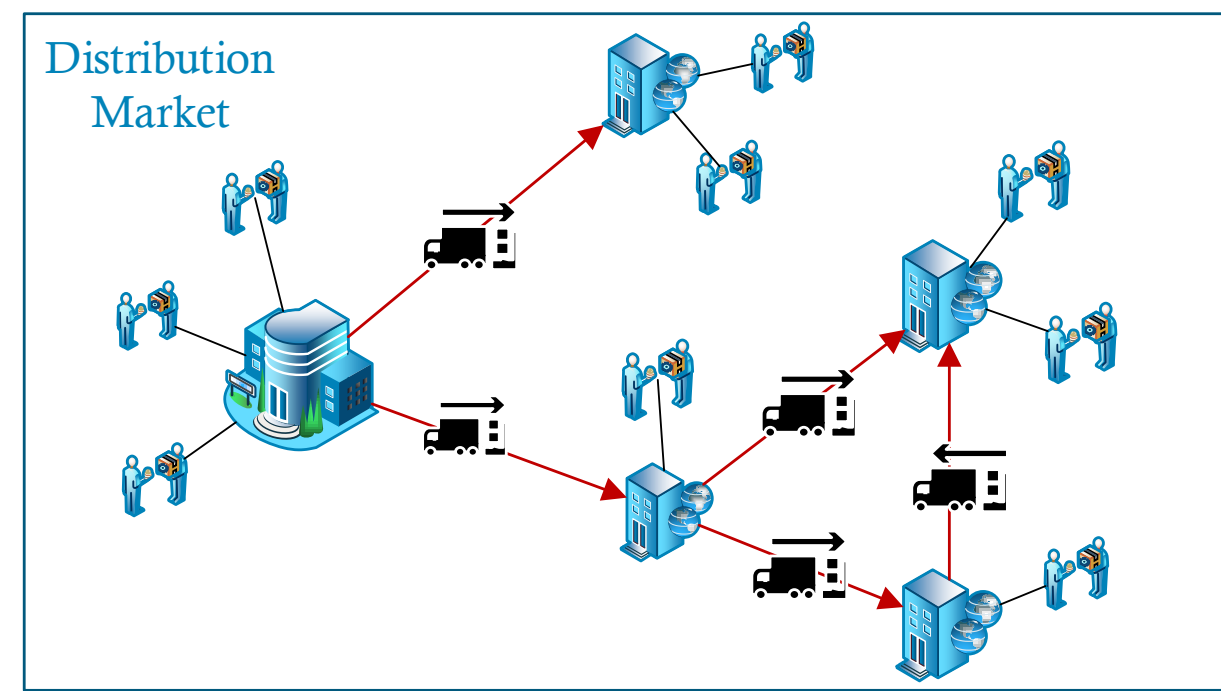
- **Private Customer Group.**
- **Unobservable Network.**
- **Strategic Neighbor-Sharing.**
- **Strategic Bids Report.**
- **Transaction Costs.**
- **Limited Communication.**

- **ASSUMPTIONS:**
  - Costs are public knowledge, e.g. costs for shipping the item.
  - Intermediates nodes have no valuations on the commodity.
  - Initially, the seller is only aware of her neighbors.

- **CHALLENGE:** Incentivize intermediate nodes to **share their customer groups to the seller** and **increase the seller's revenue** compared with holding an auction in her neighbors only.

- **The VCG mechanism is not applicable:**
  - In the following line network, each intermediary pays -1 and the winner pays 0. Eventually, the seller's revenue is $-(N-1)$.
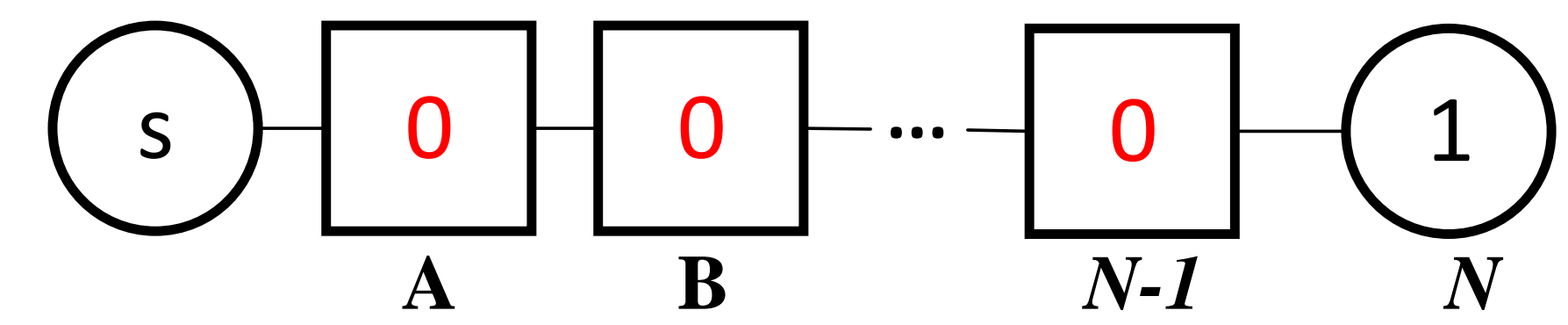
Customer Sharing Mechanism

- **Threshold Neighborhood:** Given the agents' type report profile t', for each intermediate node $i \in N$, define i's *threshold neighbourhood* $r_i^{*\prime}$ as the minimum subset of r_i' that **makes the winner under efficient allocation changed if i does not share the sale information to $r_i^{*\prime}$**, i.e., $r_i^{*\prime} = \arg\min_{r_i'' \subseteq r_i'}\{|r_i''|\}$ where $\pi_{m'}(r_i' \backslash r_i'', t''_{-i}) = 1 \wedge \pi_m(r_i', t'_{-i}) = 1 \wedge m' \neq m$ and π is an efficient allocation. In the following example, i's threshold neighborhood is $\{A, B\}$.
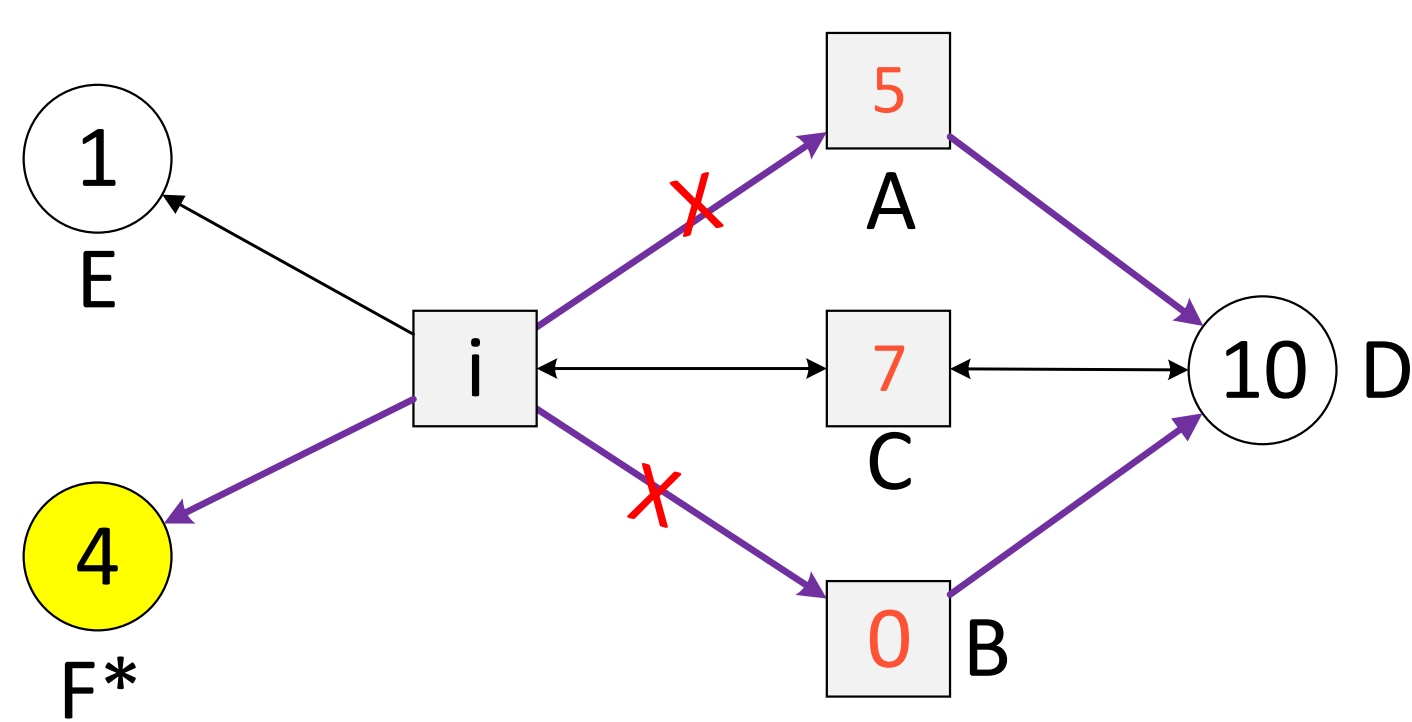
- **Allocation policy:** Given a feasible type profile t', allocate the commodity to buyer $m = \arg\max_{j \in N} SW_j$ (i.e., efficient allocation) and trade the commodity along LCC_m which is the trading chain with least costs from s to m.

- **Payment policy:** The payment policy is defined for each category of agents as follows.

  - for customer $i \in N$, her payment is defined as:

 $$W_{-i}^* - W^*(t') + v_i(t_i', \pi^{csm}).$$

  - for an intermediate node i, her payment is:

  $$W_{-d_i}^* - W_{-r_i^{*\prime}}^* + v_i(t_i', \pi^{csm}),$$

  where $W_{-r_i^{*\prime}}^*$ denotes the maximum social welfare under feasible type profile $(r_i' \backslash r_i^{*\prime}, t''_{-i})$ and $v_i(t_i', \pi^{csm})$ is i's valuation function.

Main Result

- **Theorem:** Customer Sharing Mechanism is **efficient, individually rational, incentive compatible and budget balanced**. The seller's revenue is no less than $W_{-d_{1^*}}^*$ where 1^* is the first agent in LCC_m with $r_{1^*}^{*\prime} \neq r_{1^*}$. That is, all intermediate nodes will share their neighbors to the seller, all buyers will bid truthfully and at the same time, the seller achieves a revenue that is no less than that given in the Vickrey auction since $r_s \subseteq -d_{1^*} \cup \{1^*\}$.
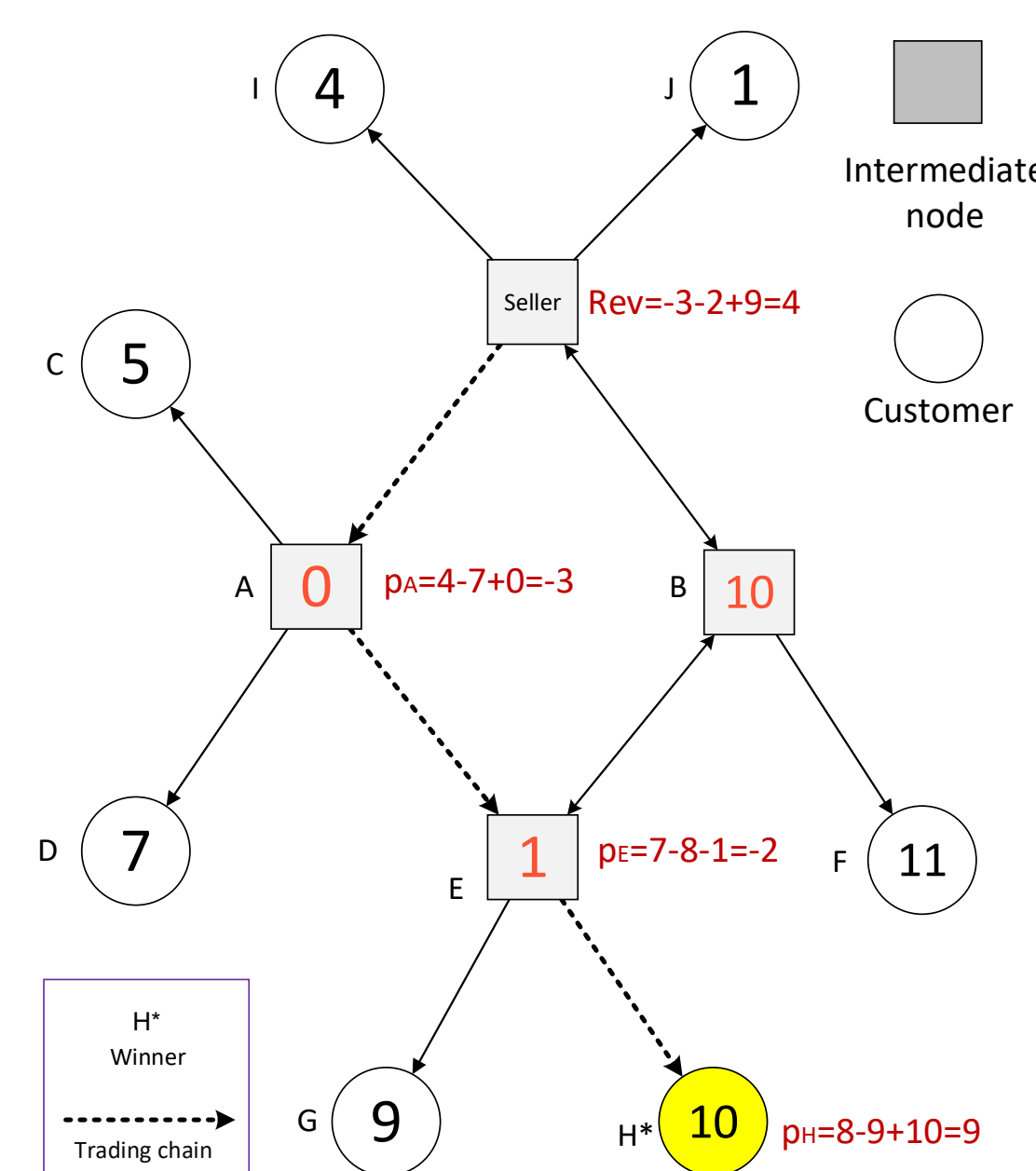
- The winner is H* and the trading chain is Seller-A-E-H.
- A's threshold neighborhood is {E} and her payment is -3.
- E's threshold neighborhood is {H*} and her payment is -2.
- Winner H*'s payment is 9.
- Other agents pay 0 according to the payment policy.
- The seller's revenue is 4.

The Key Literature

References

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[3] Bin Li, Dong Hao, Dengji Zhao, Tao Zhou. Customer Sharing in Economic Networks with Costs. IJCAI-ECAI 2018.

[4] Galen Pickard, Wei Pan, Iyad Rahwan, Manuel Cebrian, Riley Crane, Anmol Madan, and Alex Pentland. Time-critical social mobilization. Science, 334(6055):509-512, 2011.