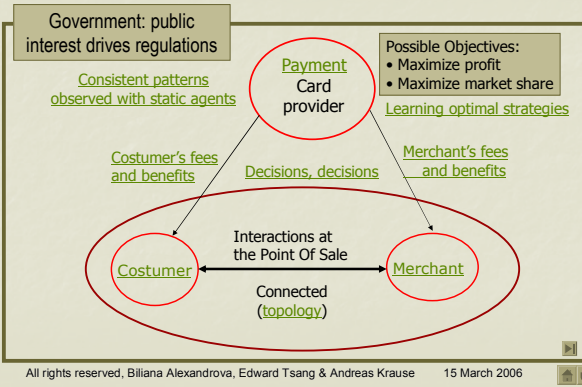


Artificial Payment Card Market A Multi-Agent Approach

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Agent-based Payment Card Market Model



Payment Methods

- Set of payment methods \mathcal{E}
- *Cash* is the benchmark payment method
- All other payment methods are called *Card Payments*
- For each *Card Payment* consumers and merchants face different benefits and costs

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The Merchants

- Set of merchants \mathcal{S}
- Each merchant has a fixed location
- Each merchant offers the same good
- The price of the good is $p = 1$
- Fixed marginal cost $c < p$

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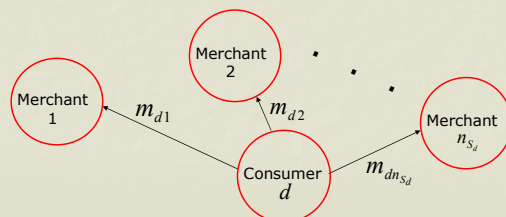
The Consumers

- Set of consumers \mathcal{D}
- Each consumer has a fixed position
- Each consumer has a fixed income I_d
- The common utility is $\pi \geq p$
- Consumer's preferences $r'_{d,s} = \frac{1}{m}$

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Network structure Consumer-Merchant

- Each Consumer $d \in \mathcal{D}$ has access to $S_d \subseteq \mathcal{S}$ where $|S_d| = n_{s_d}$ and could be Small World or local connections



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Card Payments benefits and costs

- Benefits
 - The consumer for each unit of good obtains a benefit of $b_{i,e} \in [b; \bar{b}]$
 - The merchant for each unit of good sold obtains a benefit $\beta_{i,e} \in [\beta, \bar{\beta}]$
- Costs
 - The issuer charges the consumer for each unit of good a common fee of $f_e \geq 0$ and for every period a membership fee of $F_e \geq 0$
 - The acquirer charges the merchant for each unit of good sold a common fee $\gamma_e \geq 0$ and for every period a membership fee of $I_e \geq 0$

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Decisions Modelled

- Consumers
 - Which merchant to chose?
 - Which card to use?
 - Which card to hold?
- Merchants
 - Which card to hold?
- Card Payment Provider
 - Consumers' benefits and costs
 - Merchants' benefits and cost
 - Publicity cost

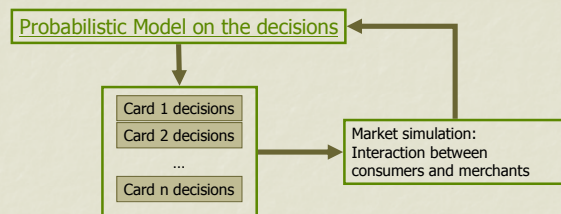
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Consistent Observations: Static Agents

- Runs converged after 1,000 iterations
- Case 1: customers only record all cards accepted
 - Only two cards survived, one dominating
- Case 2: customers take note of common cards with each merchant visited
 - More cards survived
- Case 3: customers know cards accepted by merchants and merchants know cards owned by visiting customers
 - All cards survived
- Indifferent whether cards have varying benefit

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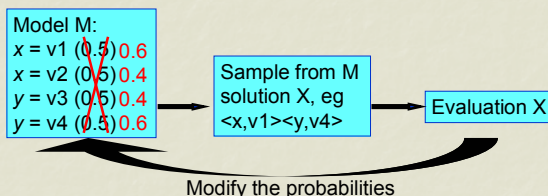
Learning optimal strategies



- Each card makes the following decisions:
 - Publicity cost, fixed/variable fees to consumers/merchants
- **PBIL** used to evolve strategies
 - Converged after 3,000 runs; observations being analysed

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Population-based Incremental Learning (PBIL)



- Statistical approach
- Related to ant-colonies, GA

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Conclusion, Credit Card Payment Analysis

- Observation on market with *static agents*:
 - Information about the market is crucial
 - More information → less dominance
- Observation on market with *evolving agents*:
 - On-going research
 - Convergence of strategies observed
 - How sensitive are those observations to parameters?

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