

The Ninth Crime Mapping Conference

Dynamic Spatial Models of Fraudulent Behavior: Combining GIS and ABM

March 30, 2007

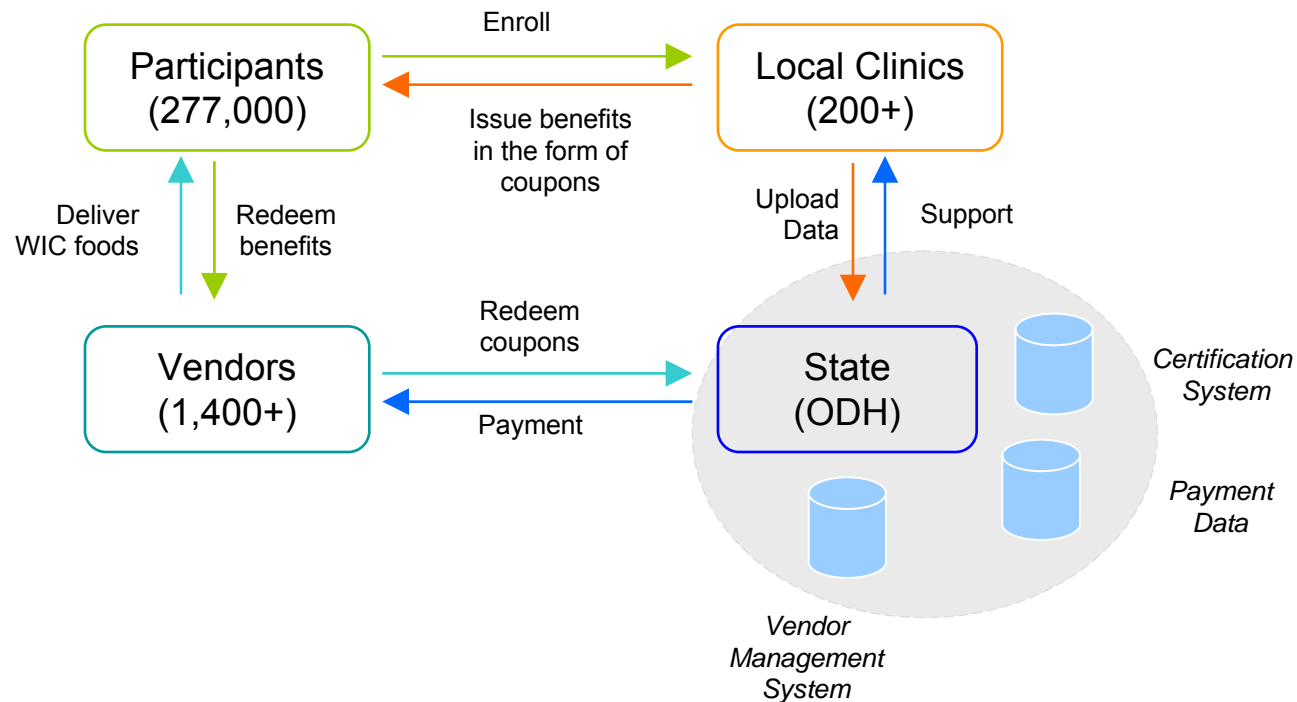
Yushim Kim
John Glenn School of Public Affairs
The Ohio State University

Research Question

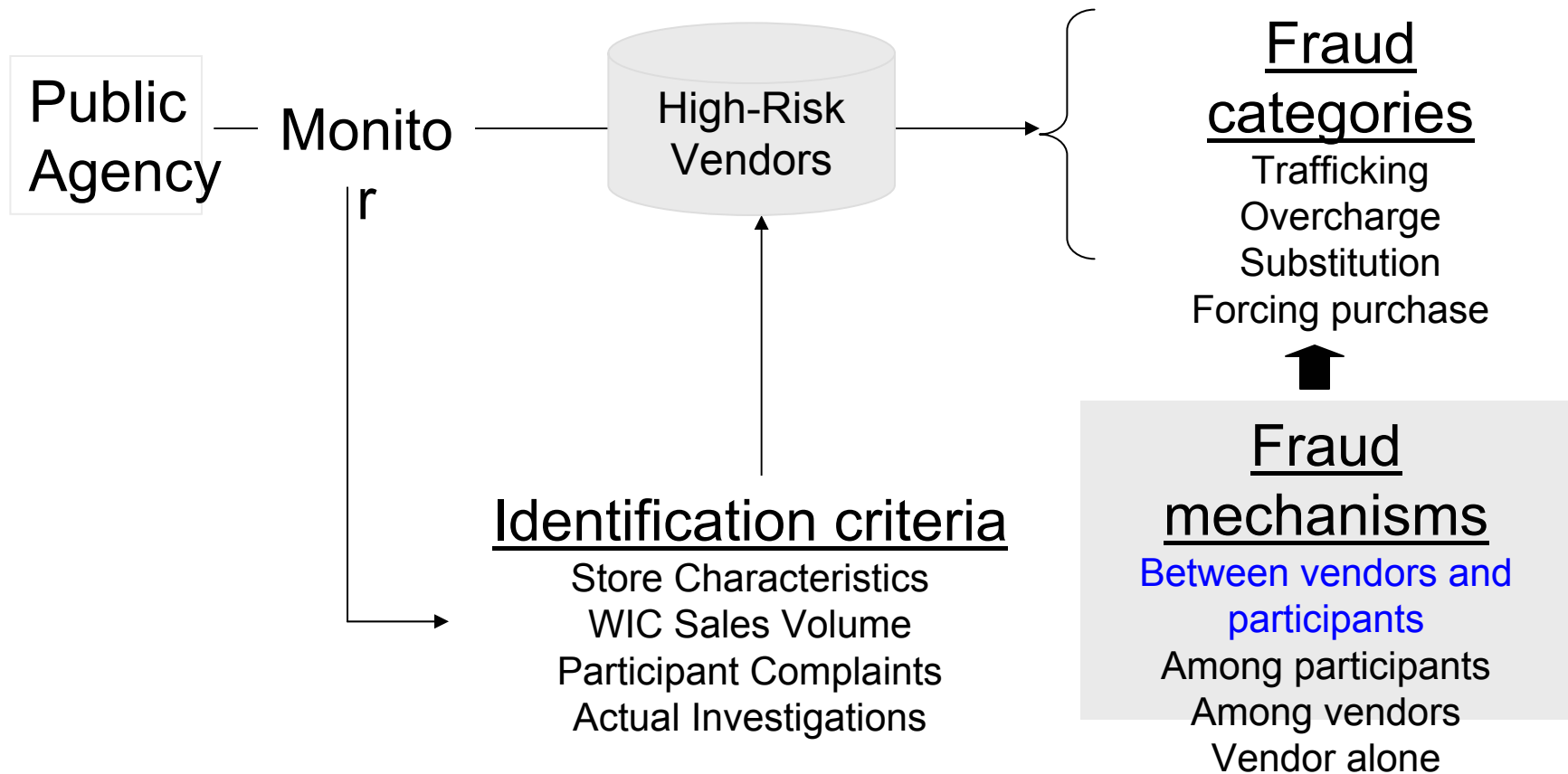
- Modeling dynamic spatial patterns of fraudulent behaviors combining Geographic Information Systems (GIS) and Agent-Based Models (ABM)?

Policy Context

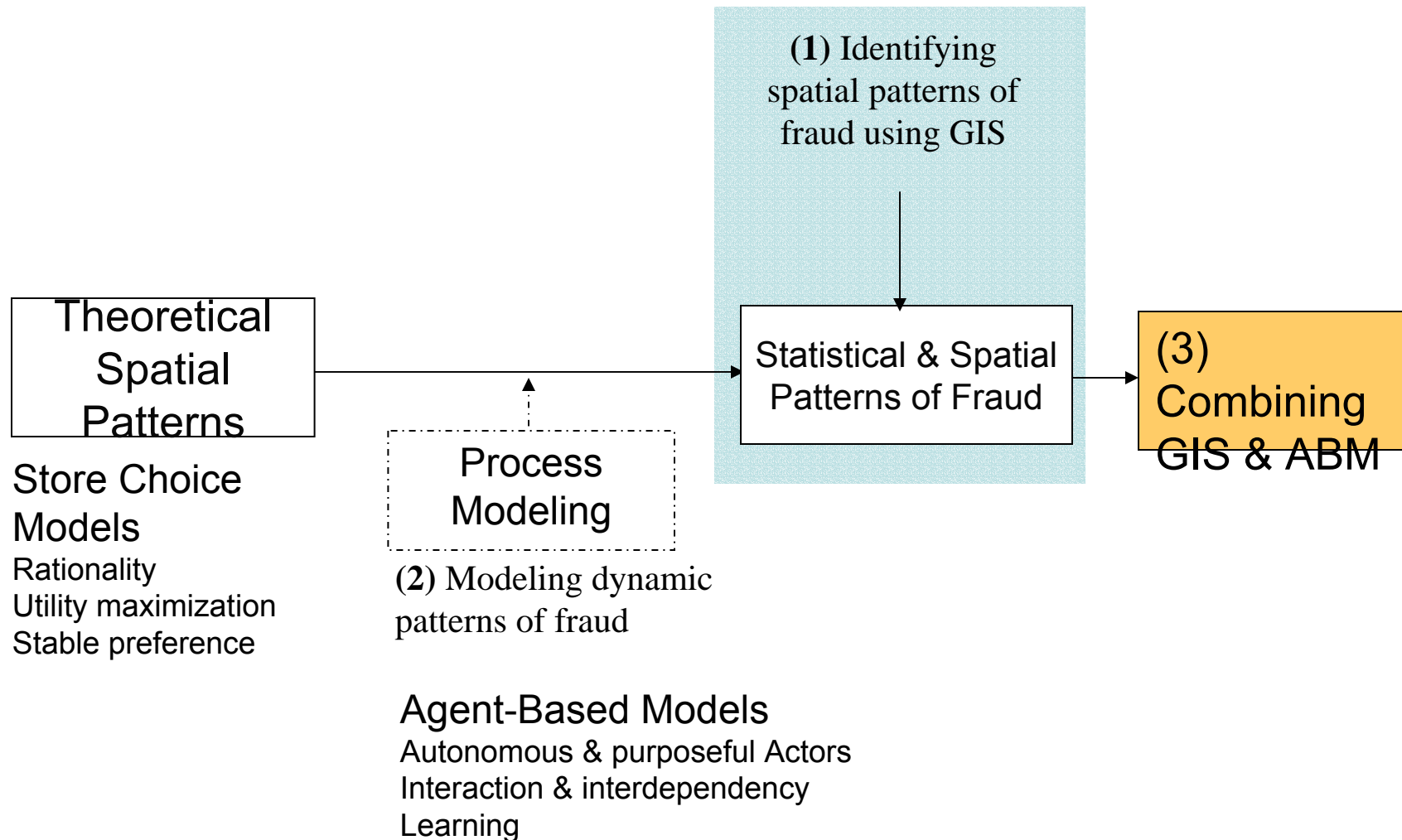
- Women, Infants, and Children (WIC) in Ohio



Current Approach to Fraud

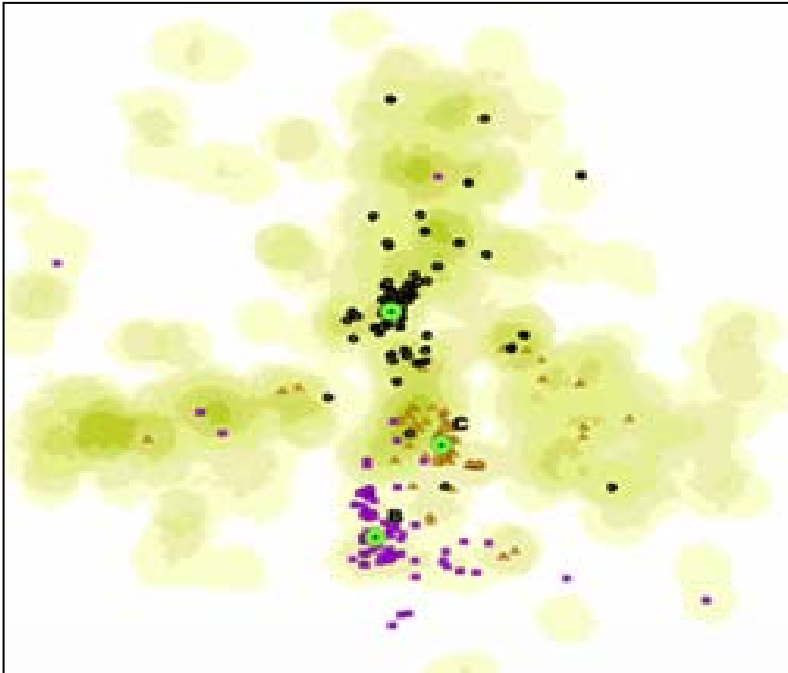


Research Framework

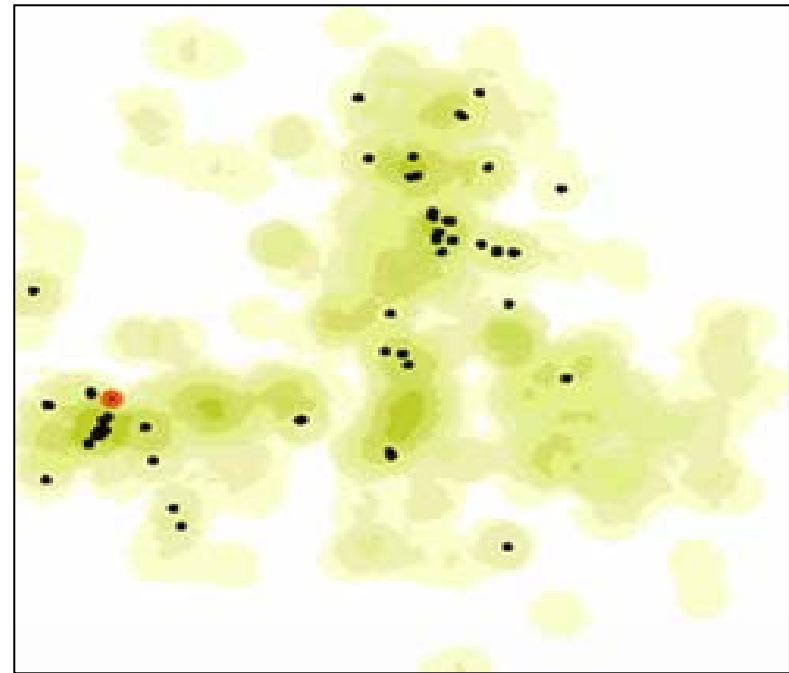


(1) Spatial Patterns

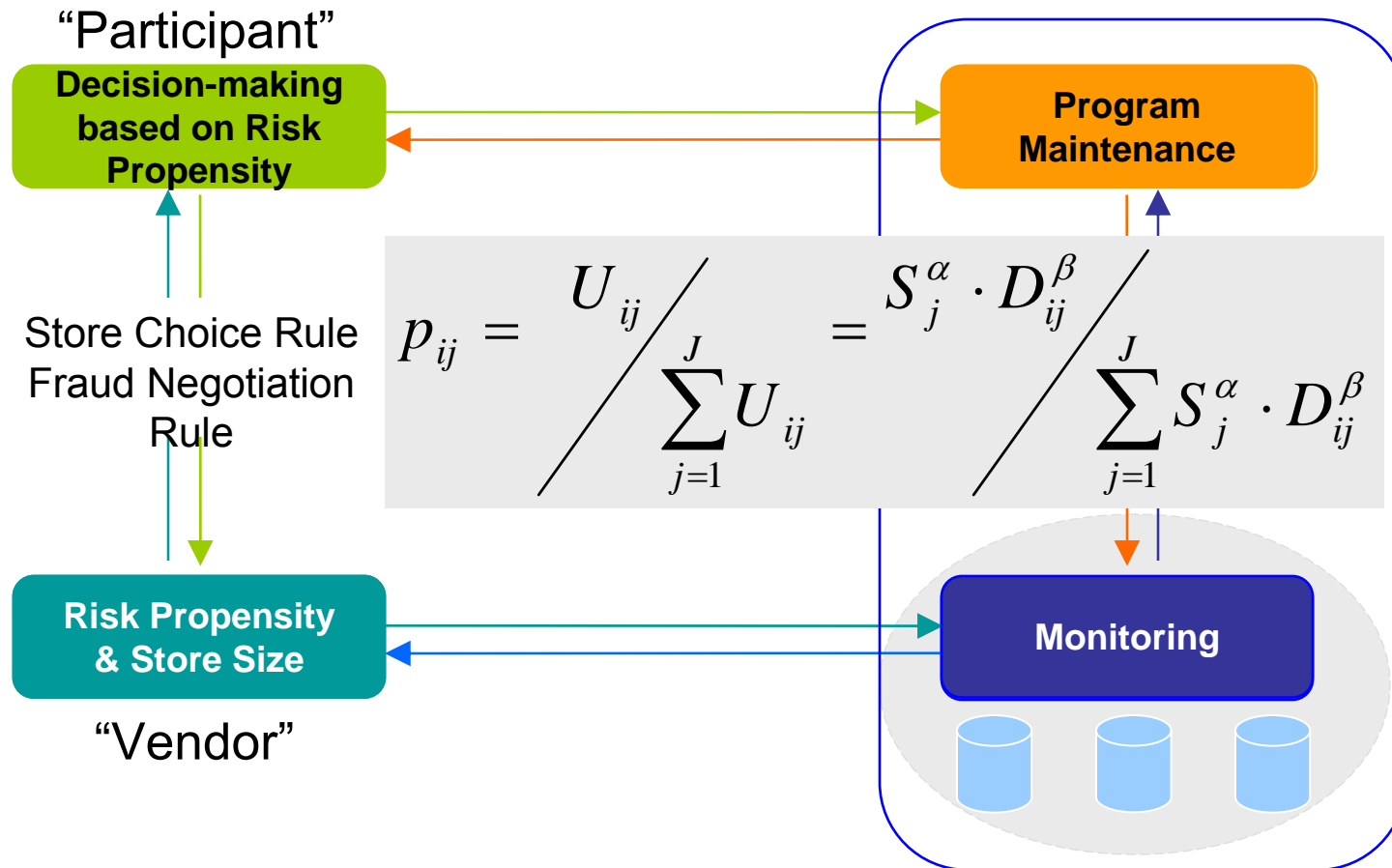
Non High-Risk Vendors



High-Risk Vendors



(2) Agent-Based Modeling



“FRAUDSIM”

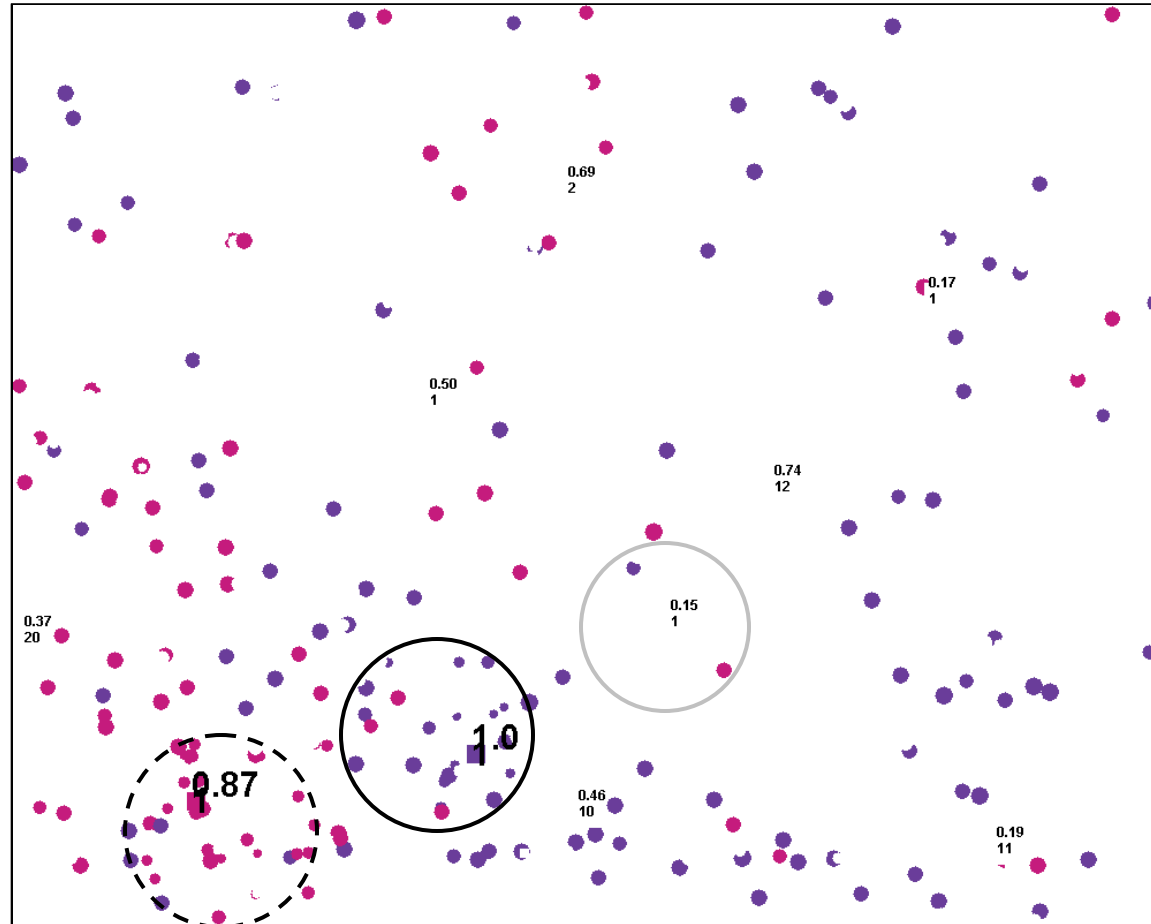
- MASON version 11.0
- Vendors: 20
- Participants: 1,000
- Public agency: 1
- Simulation time: Month
- 10 times simulated
- Patterns
 - Spatial patterns
 - Statistical patterns

Initial Parameters

	Mean	SD	Min	Max
Vendor Risk Propensity	0.4	0.4	0.0	1.0
Participant Risk Propensity	0.4	0.3	0.0	1.0
Voucher (\$)	45.0	40.0	2.0	100.0
Voucher Usage (%)	0.75	0.10	0.04	1.0

Spatial Patterns

Time 308

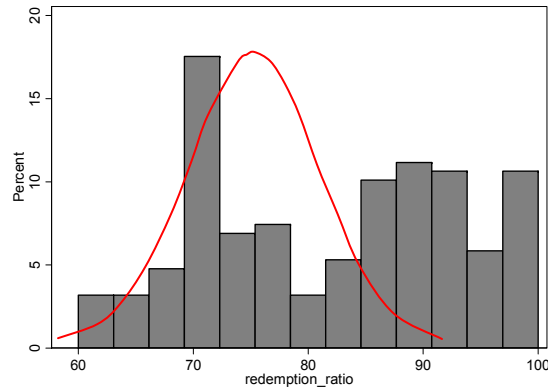


Statistical Patterns: Identifying High-Risk Vendors

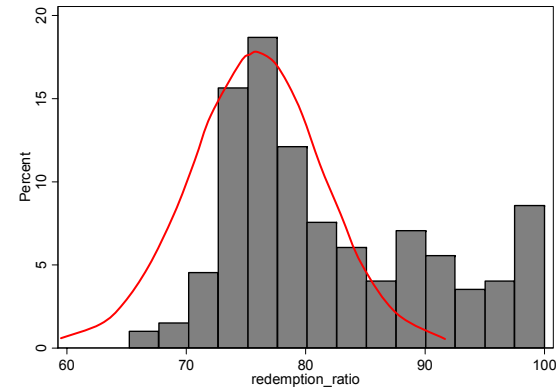
- Assumptions on WIC sales and random choice
 - Vendor's sales recording (75% vs. 100% of coupon value)
 - Participant's random store choices
- Identifying high-risk vendors at Time 299
 - Risk indicators based on WIC sales > 90th percentile
 1. Vendor Redemption Ratio
 2. WIC Sales per Lane
 3. Food Package Costs per Participant at Vendor
 - High-Risk Vendors: Risk indicator met ≥ 2

1. Vendor Redemption Ratio

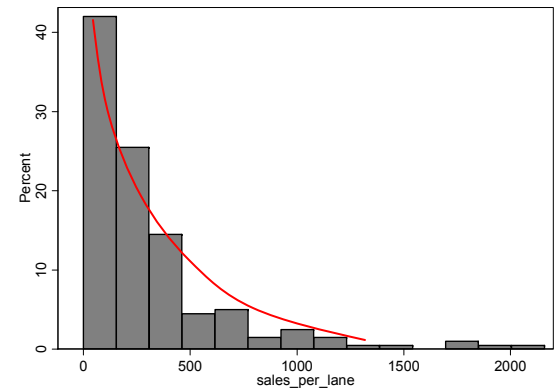
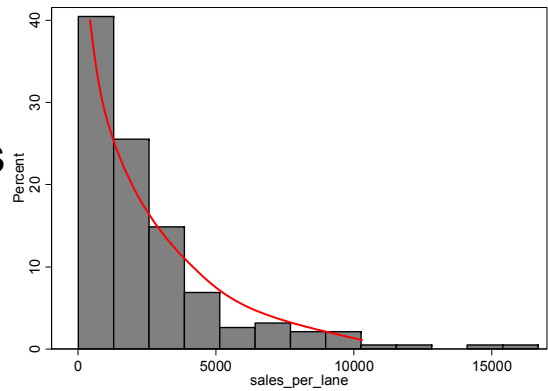
Empirical Data (April 2004)



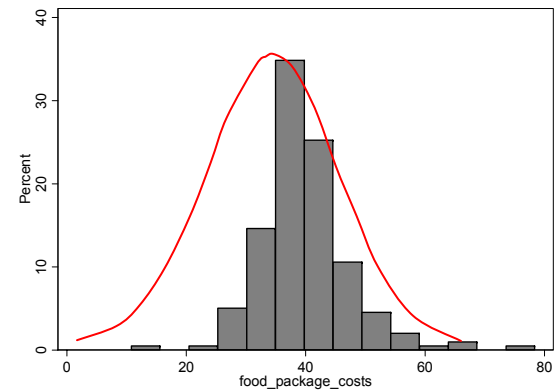
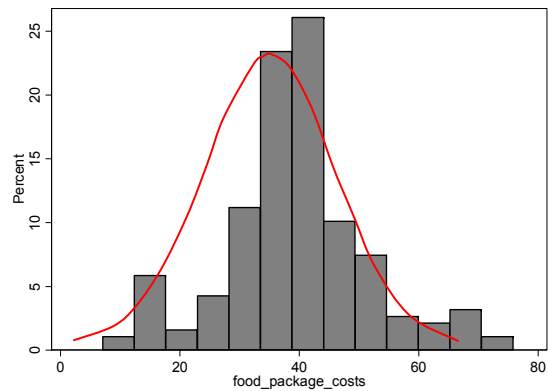
Simulated Data (Time 299)



2. WIC Sales per Lane



3. Food Package Costs per Participant

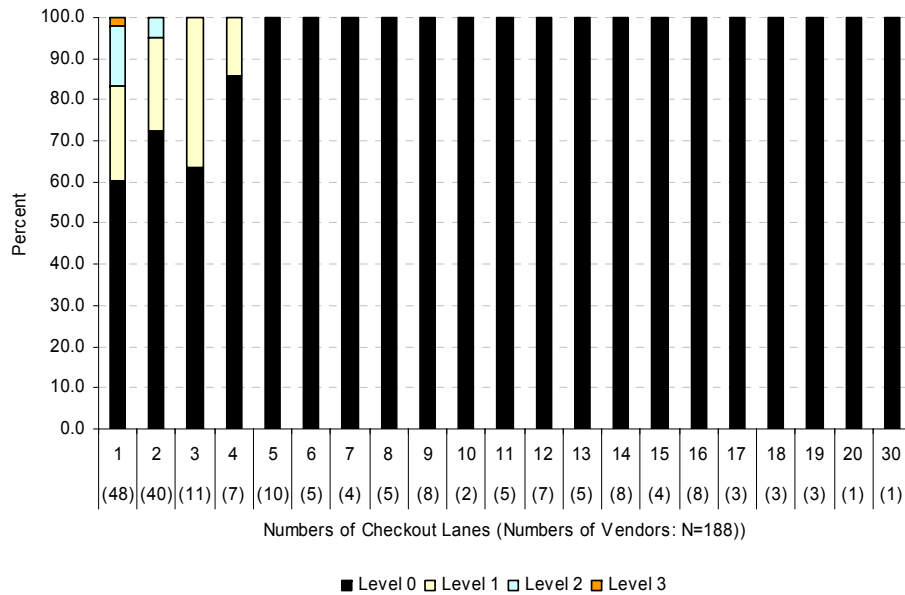


Distribution of Vendors by Risk Level

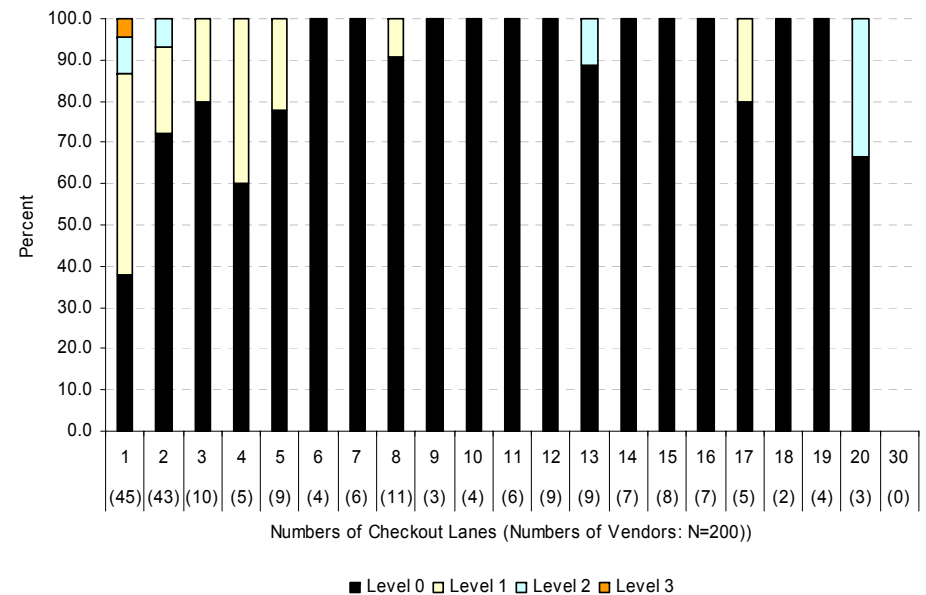
Risk level of vendors	Empirical data (N=188)	Simulated data (N=200)
	Percent	Percent
0	81.4	75.0
1	13.3	19.5
2	4.8	4.5
3	0.5	1.0

 High-Risk

Distribution of Vendors by Risk Level & Store Size



Empirical Data

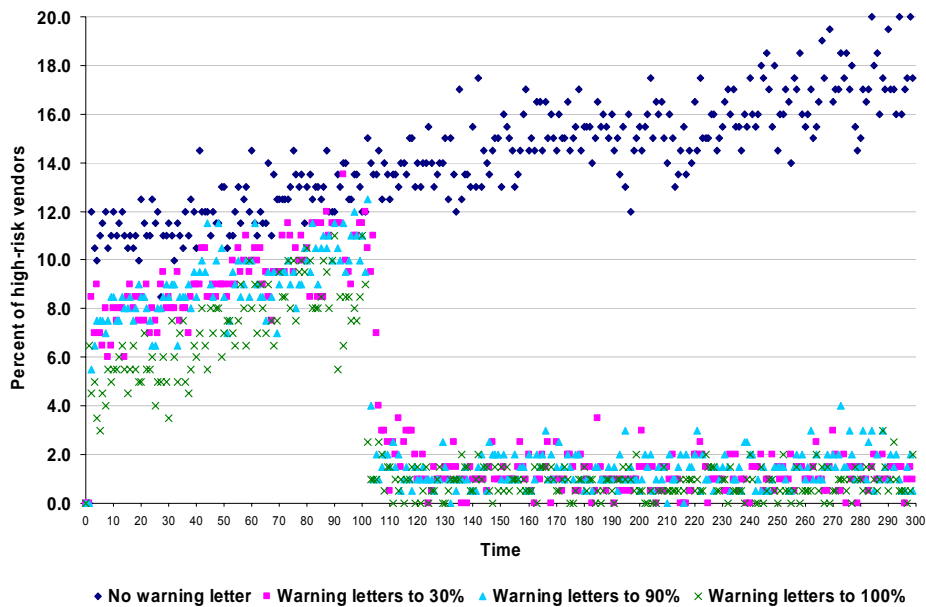


Simulated Data at Time 299

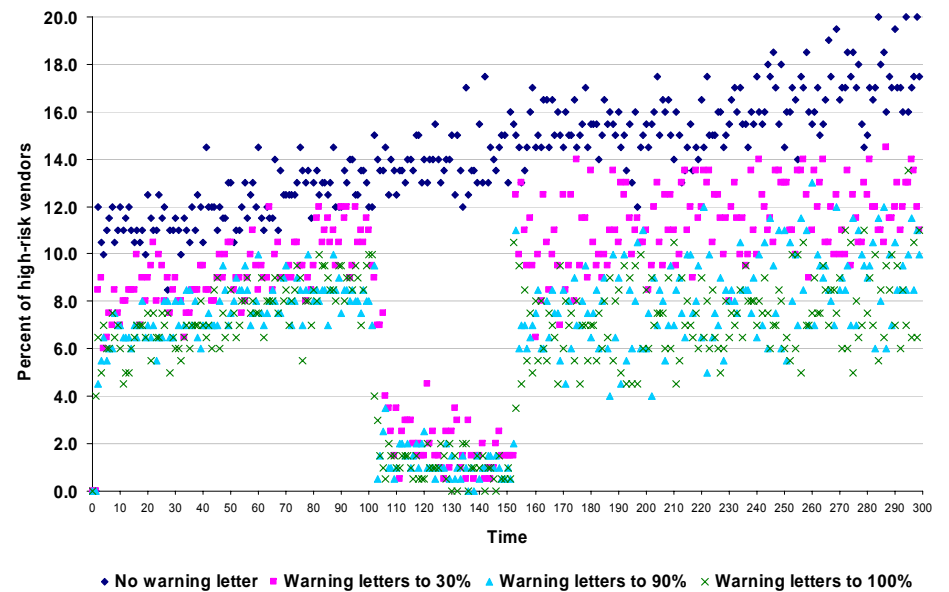
Use of the Simulation Model

- Deterrence hypothesis: the probability of being caught
- Policy option (Warning letters to high-risk vendors (0%, 30%, 90%, 100%))
- Assumptions
 - Vendor's response to the warning letter
 - Sales recording behavior (approximately 90% of coupon value)
- Risk criterion: High-risk, when the vendor redemption ratio > 90%
- Outcome: The percent of high-risk vendors in the WIC system over time
- Scenarios
 - Scenario 1: Policy intervention at Time 100
 - Scenario 2: Policy intervention between Time 100 and Time 150

Effect of a Policy Option

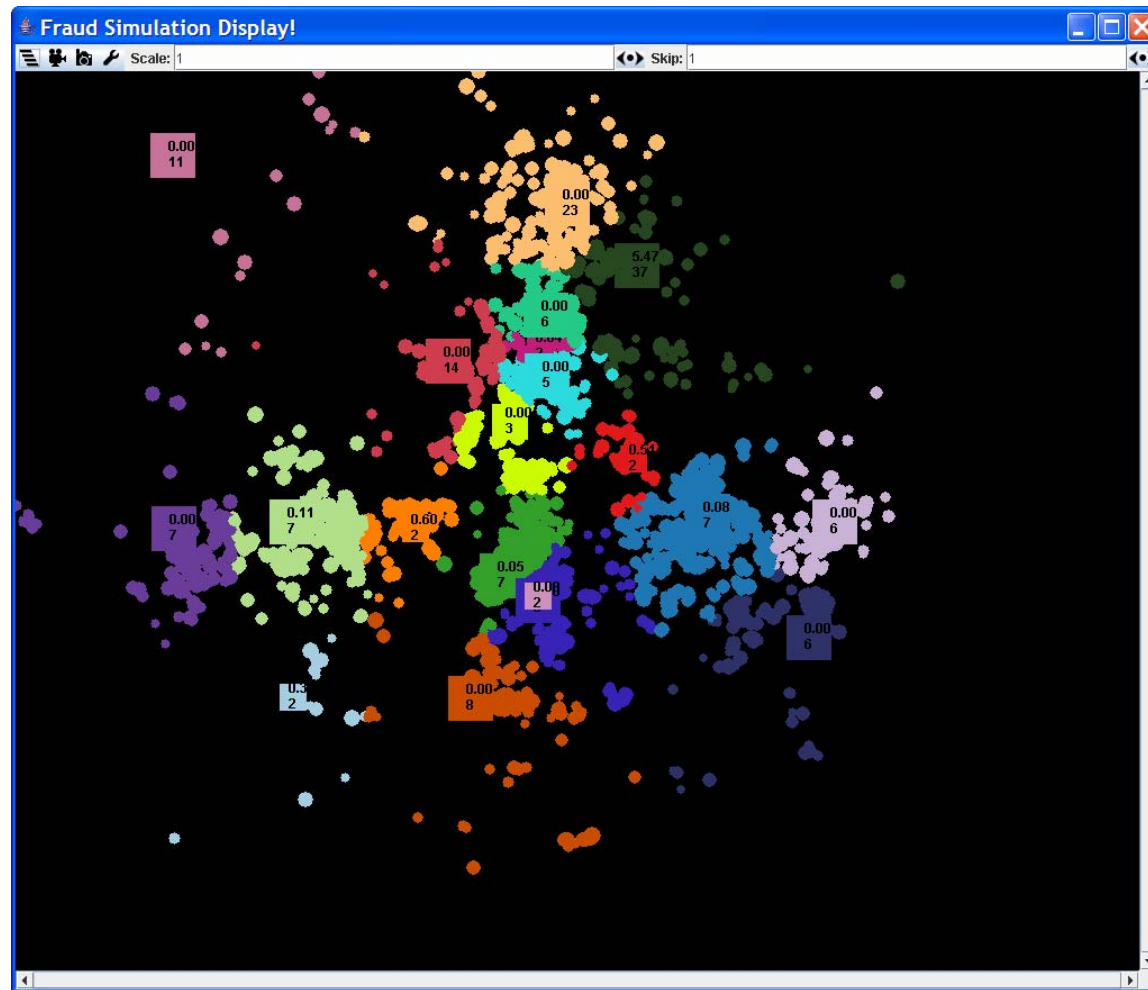


Policy Option 1
(N=200)



Policy Option 2
(N=200)

(3) Combining GIS & ABM



Limitations

- Study in progress
- Verisimilitude of the simulation
- Equifinality problems
- Easy decisions made by agents
- Utility framework
- Parameters based on heuristics

Thank You!