Fishery Management and Information Sharing Networks: The Association between Sector Management and Social Capital

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Motivation

- Social capital may play an important part in fishery management
  - Benefits to fishermen and managing institutions
- Policy changes may also affect social capital
  - Incentives surrounding cooperative behavior
  - Very little discussion, no empirical study in fishery context
- We empirically examine the association between fishery policy and social capital
  - Northeast multispecies groundfish fishery
    - Days-At-Sea → Sector Management
  - Regression and network analysis
    - Network size and density
    - Quality of relationships

Definition and Measurement: Network, Cooperation, Trust

- "The connections among individuals…social networks and the norms of reciprocity and trustworthiness that arise from them." -Putnam, 2000
- "…trust, norms, and networks that enable collective action." -Bouma, Bulte and Soest, 2008
- Measurement
  - Network size: More links, more social capital

    → network size as a proxy for social capital
  - Measure social capital through fishermen's networks
  - The link between policy and social capital

Fishermen's networks

- Fishermen use networks to minimize risk
  - Increase catch
  - Lower costs
- There are incentives <u>not</u> to share information
  - Congestion
  - Rivalry
- Information sharing will take place if there is a net benefit to each individual
- Incentives affect the formation and maintenance of networks
- A change in fishing rights may affect social capital through incentives

Research Questions

Question 1: Did the change to sector management affect social capital?

Question 2: Does this effect differ across sectors?

Question 3: Are there differences in social capital between sectors?

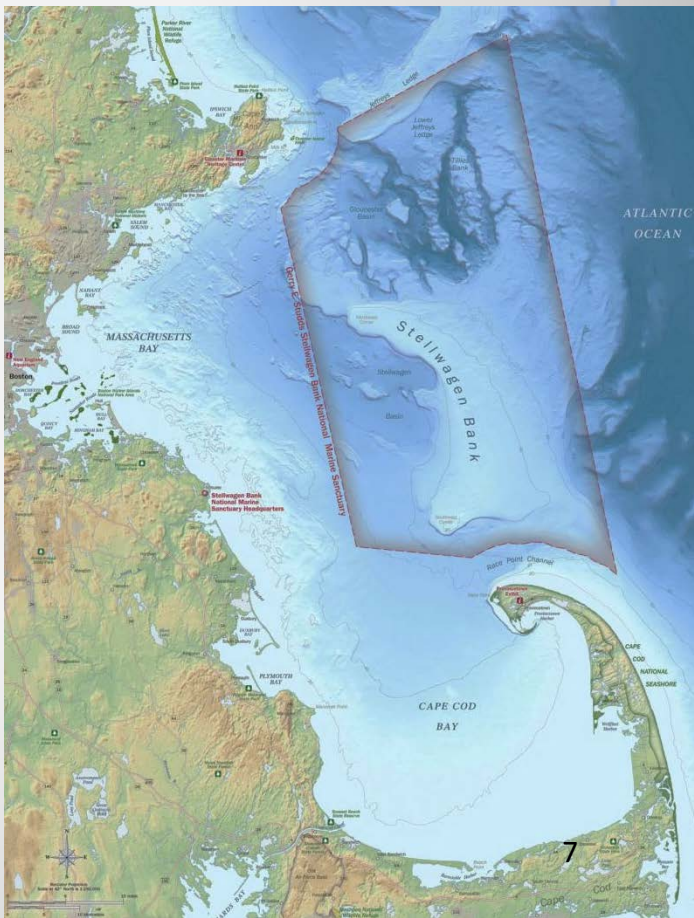
Methodology

- Survey data
  - 2009 and 2010
  - Discrete change in management
- Network analysis
  - Visual representation of social networks
  - Generate additional variables
- Individual fixed-effects in seemingly unrelated regression models
  - Use selected measures of social capital as dependent variables

Data

- Surveyed 69 Massachusetts groundfish fishermen
  - North shore: Gloucester
  - South shore: Duxbury, Scituate

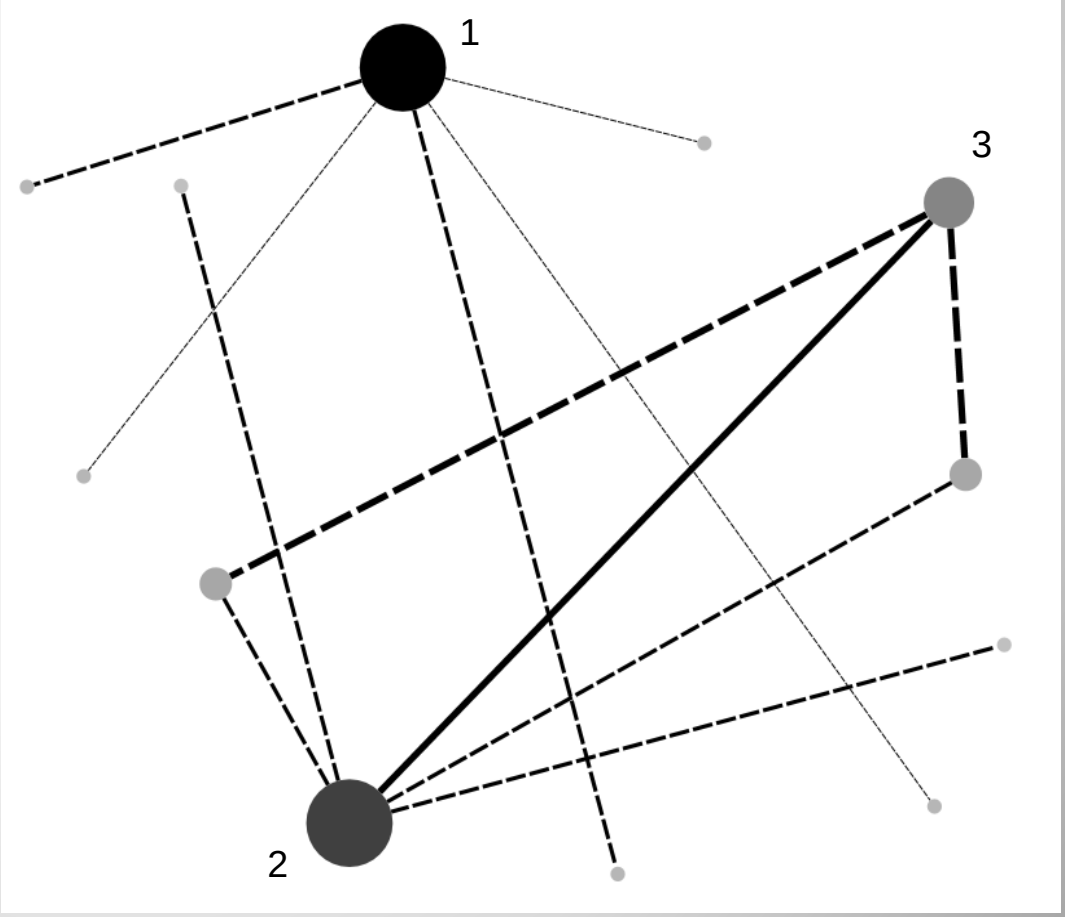
- Questions on fishermen's networks
  - 2009 and 2010
  - Specific v. General information
  - Network details (names)
  - Frequency of information sharing
  - Type of information shared
  - Level of detail
- Explanatory capability is limited
  - We use pre-sector behavior as the counterfactual
  - Interpret the relationship between fishery management and social capital as association, not causality

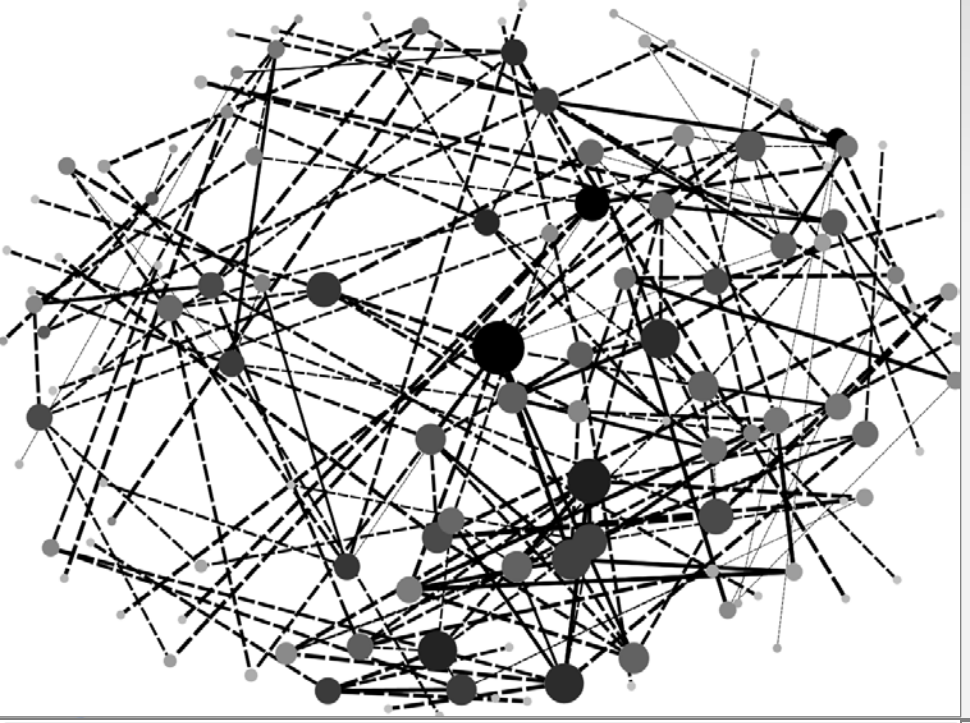


Network Analysis

NodeXL software

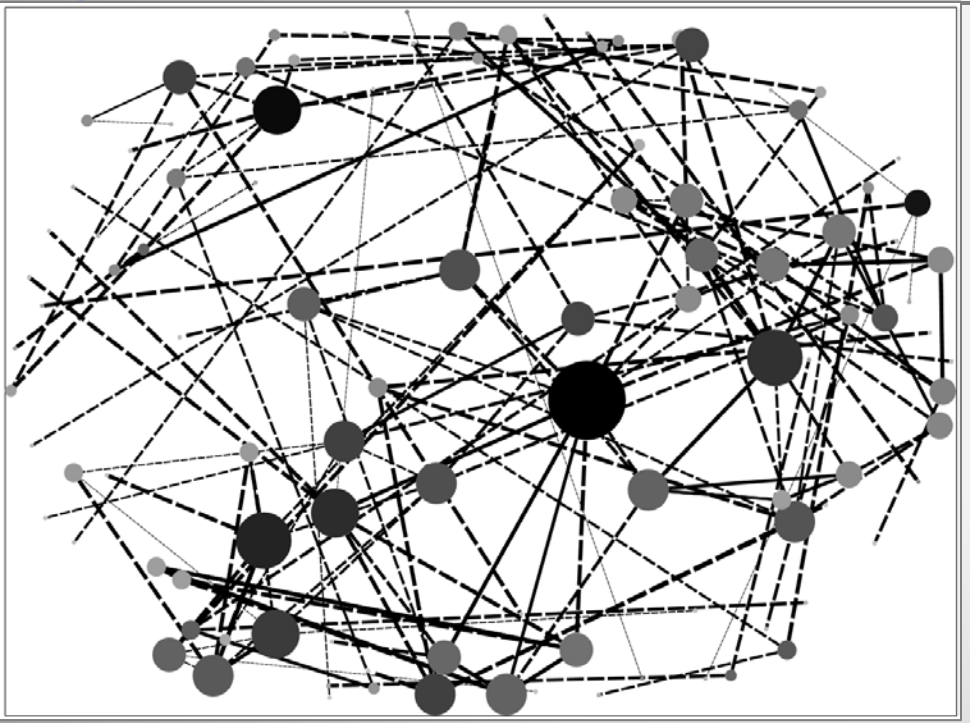
- Nodes
  - Number of links: size
  - Centrality: shade
- Links
  - Frequency: thickness
  - Reciprocity: solid v. dashed
- Force-directed layout
  - Detail: distance between nodes
- Network density
  - Existing / possible relationships





2009

- Nodes: 121
- Links: 224
- Frequency: 2.73
- Detail: 1.31
- Density: .00285



2010

- Nodes: 107
- Links: 175
- Frequency: 2.28
- Detail: 1.04
- Density: .00342

Regression analysis

Dependent variables to describe networks:

- *Frequency & Detail Index*
  - sum of standardized frequency and detail variables
- *Type Index*
  - standardized sum of each type of information shared
- *Network Density*
  - existing relationships / possible relationships
- *Network Size*
  - number of individuals listed by respondent

Model specification

- Multiple inference → Seemingly unrelated regression (SUR)
- Unobserved heterogeneity → Individual fixed-effects

$$SC_{imt} = Year_{it}\beta_{1m} + Efficiency_{it}\beta_{2m} + Region*\text{Year}_{i}\beta_{3m} + Education*Year_{i}\beta_{4m} + \alpha_{im} + \mu_{imt}$$

- Where
  - *SC* represents each dependent variable
  - *Year* dummy: 0 if 2009 and 1 if 2010
  - *Efficiency* is the log of income per unit of effort
  - *Region* dummy: 0 for South shore, 1 for North shore
  - *Education* represents level of education attained
  - α represents individual fixed effects
  - μ_{imt} is the error term for individual *i* in model *m,* time *t*

Frequency & Detail, Type Index

VARIABLES	Frequency & Detail Index			Type Index		
	(1)	(2)	(3)	(4)	(5)	(6)
Year	-0.388*	-0.379*	-0.817***	-0.484	-0.516	-1.170***
	(0.208)	(0.205)	(0.311)	(0.344)	(0.332)	(0.341)
Log of Efficiency		0.0702	-0.119		-0.231	0.150
		(0.104)	(0.130)		(0.168)	(0.143)
Year*Region			0.468**			0.310
			(0.214)			(0.235)
Year*Education			0.0427			0.210*
			(0.103)			(0.113)
Region		0.173			0.315	
		(0.218)			(0.353)	
Education		0.166			0.447***	
		(0.101)			(0.164)	
Constant	2.127***	1.345***	2.789***	2.623***	2.242***	3.366***
	(0.147)	(0.521)	(0.490)	(0.243)	(0.843)	(0.894)
Fixed Effects	No	No	Yes	No	No	Yes
Observations	124	124	124	124	124	124
Adjusted R-squared	0.027	0.054	0.939	0.016	0.088	0.960

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Network Density, Network Size

VARIABLES	Network Density			Network Size		
	(1)	(2)	(3)	(4)	(5)	(6)
Year	0.000603**	0.000609**	0.000417	-0.118**	-0.117**	-0.379***
	(0.000294)	(0.000293)	(0.000316)	(0.056)	(0.055)	(0.069)
Log of Efficiency		0.000114	3.36e-05		0.018	0.026
		(0.000155)	(0.000167)		(0.029)	(0.036)
Year*Region			0.000436**			0.203***
			(0.000217)			(0.047)
Year*Education			-3.74e-05			0.056**
			(0.000103)			(0.022)
Region		-9.90e-06			0.087	
		(0.000309)			(0.059)	
Education		-0.000109			-0.014	
		(0.000145)			(0.027)	
Constant	0.00311***	0.00293***	0.00314***	0.824***	0.730***	0.986***
	(0.000208)	(0.000743)	(0.000587)	(0.0401)	(0.142)	(0.128)
Fixed Effects	No	No	Yes	No	No	Yes
Observations	98	98	98	98	98	98
Adjusted R-squared	0.041	0.051	0.981	0.042	0.074	0.982

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Total effect of *year*

H_0: $\beta_1 + \beta_3$*region + β_4*education = 0

Dependent variable	Region	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Frequency & Detail Index	0	-.714	.174	-4.10	0.000	-1.056	-.373
	1	-.246	.124	-1.97	0.048	-.491	-.001
Type Index	0	-.667	.191	-3.49	0.000	-1.043	-.292
	1	-.357	.137	-2.61	0.009	-.626	-.088
Network size	0	-.244	.037	-6.54	0.000	-.318	-.171
	1	-.042	.028	-1.49	0.137	-.098	-.013
Density	0	.000328	.000171	1.91	0.056	-7.84e-06	.000664
	1	.000764	.000130	5.87	0.000	.000509	.001020

- Indicates heterogeneity between regions

Sector Analysis

VARIABLES	Frequency & Detail Index (1)	Type Index (2)	Network Size (3)	Network Density (4)
Year	-0.761**	-1.402***	-0.291***	0.000558
	(0.376)	(0.418)	(0.0757)	(0.000355)
Log of Efficiency	0.0606	0.378**	0.0172	1.98e-05
	(0.173)	(0.193)	(0.0360)	(0.000169)
Year*Region	0.215	0.788**	0.163**	0.000553*
	(0.345)	(0.383)	(0.0672)	(0.000315)
Year*Education	0.00214	0.130	0.0643***	-1.72e-05
	(0.110)	(0.122)	(0.0229)	(0.000107)
Sector 12*Year	0.360	-0.163	-0.0830	-0.000373
	(0.319)	(0.355)	(0.0657)	(0.000308)
Sector 13*Year	0.302	0.0493	-0.0279	-0.000329
	(0.393)	(0.437)	(0.0894)	(0.000419)
Sector 15*Year	-0.0268	0.590	-0.168**	-0.000255
	(0.393)	(0.437)	(0.0740)	(0.000347)
Constant	4.414***	2.043*	0.945***	0.00430***
	(0.524)	(1.151)	(0.106)	(0.000495)
Fixed Effects	Yes	Yes	Yes	Yes
Observations	116	116	98	98
Adjusted R-squared	0.938	0.959	0.983	0.982

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

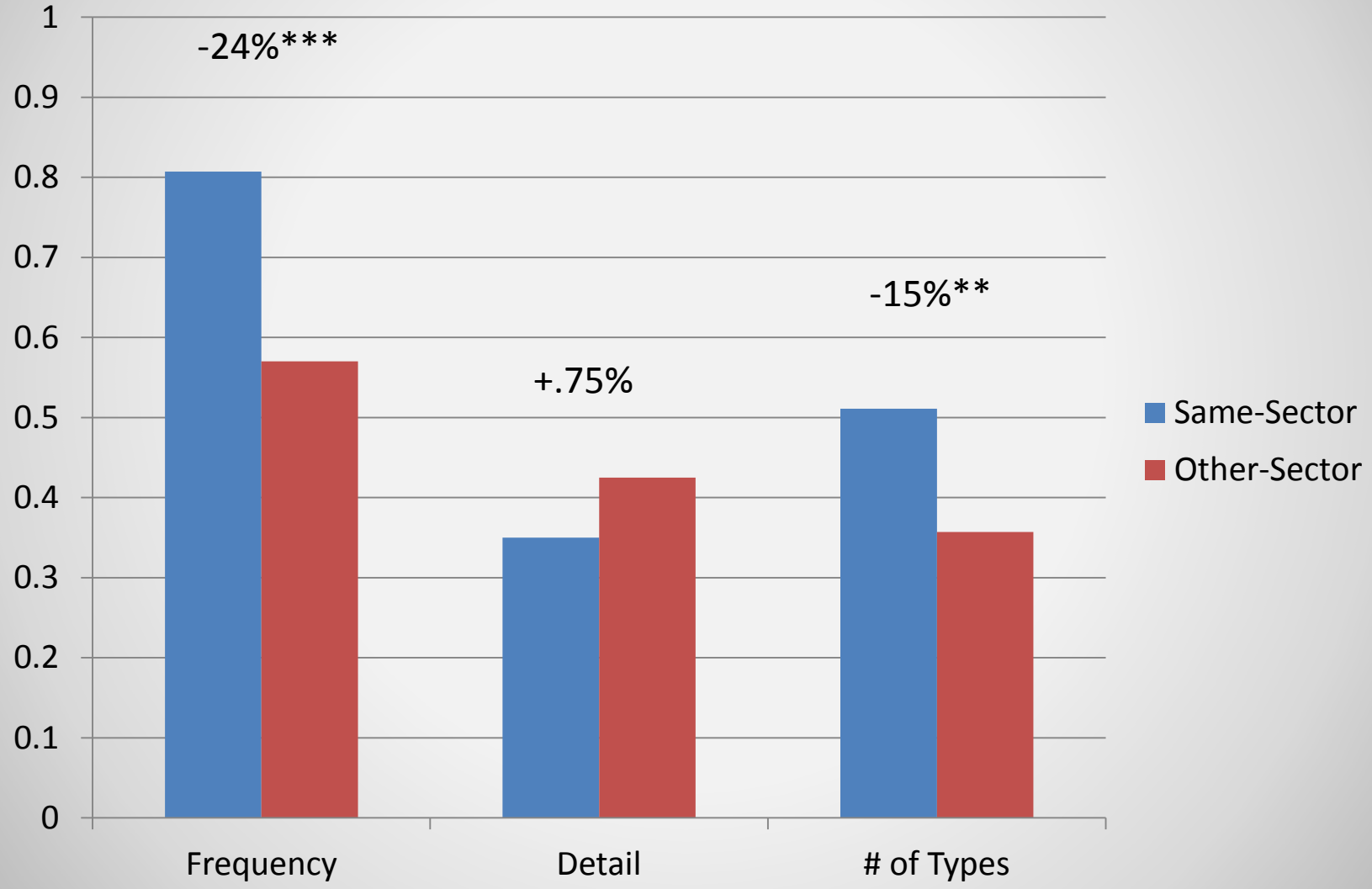
Question 1: How did the change to sector management affect social capital?

- *Frequency & Detail Index:* Fishermen shared information less often and in less detail
- *Type Index:* Fishermen share fewer types of information
- *Network Density:* Networks are more dense
- *Network Size:* The size of fishermen's networks has decreased
- Total effect of *Year* is significant and heterogeneous depending on *region* and *education*

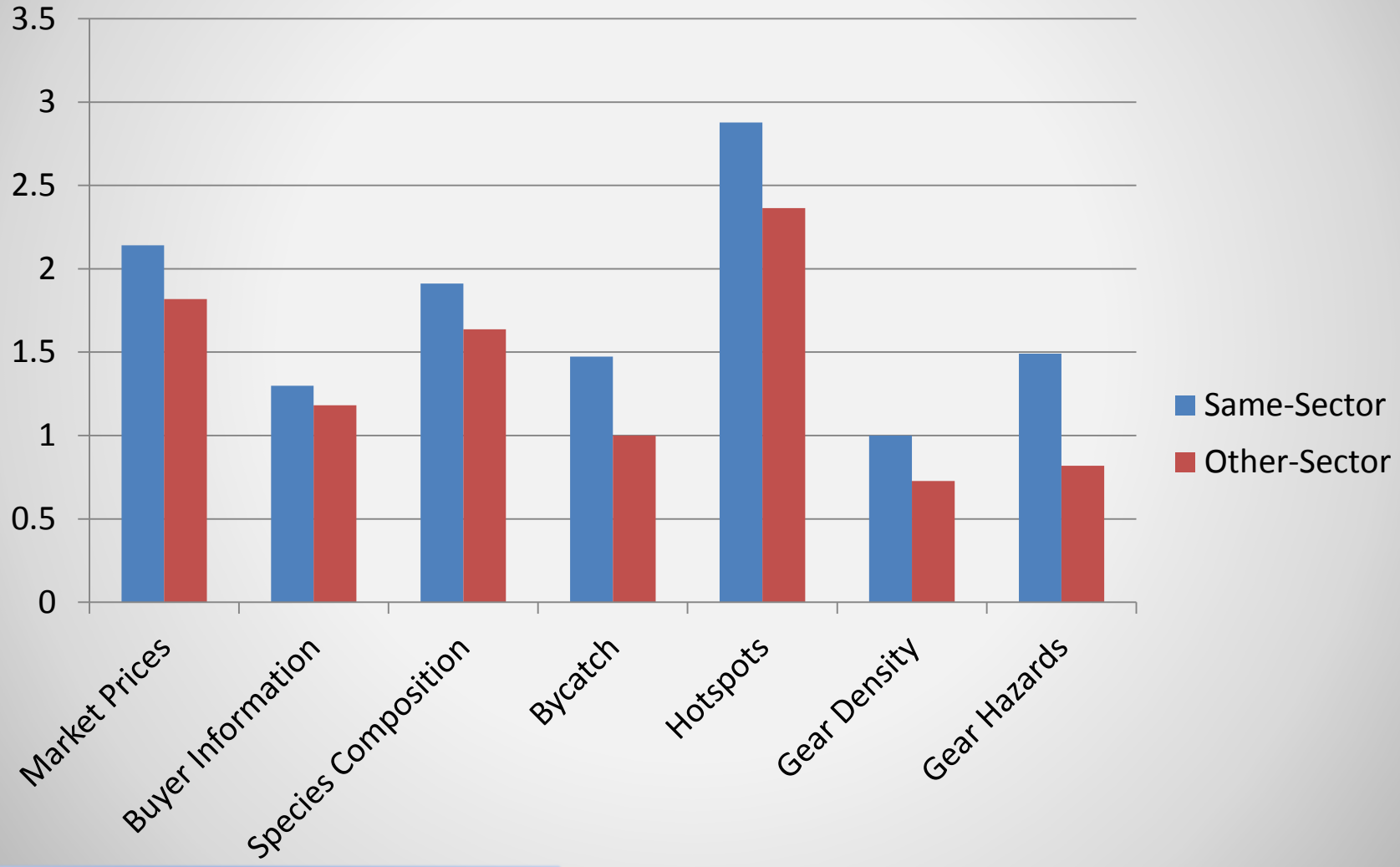
Question 2: Does this effect differ across sectors?

- *Network Size* is less for at least one sector

Frequency, Detail, # of Types of Information Shared: Same-Sector vs. Other-Sector (2010)



Types of Information Shared: Same-Sector vs. Other-Sector (2010)



Question 3: Are there differences in social capital between sectors?

- *Frequency:* Fishermen communicate less often
- *Detail:* About the same level of detail
- *Type:* Fishermen communicate fewer types of information

- Distribution in types of information shared
  - Overall decrease
  - Differs between types

Conclusion & Next Steps

- A change in fishery management is associated with a change in social capital
- These effects are heterogeneous: a policy change may not affect all individuals (or groups) the same
- Differences in social capital between sectors

- Policy implications
  - Heterogeneous effects of policy on social capital

- Next Steps
  - Expand analysis of individual social capital: D&D