Nutrient Pollution: A Wicked Challenge for Economic (and other) Policy Instruments

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Getting Prices Right

Using prices to “internalize” external costs will lead to better outcomes

- AC Pigou (1920) Price incentives created with taxes on externalities
  - A. Kneese (1964) Effluent charges
- R Coase (1960) Prices incentives created through property rights
  - J Dales (1968) Tradeable effluent permit markets

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Using prices to "internalize" external costs will lead to better outcomes

- Prices provide direct incentives for pollution
- Prices encourage least-cost solutions by individual sources
- Prices encourage "clean technology" innovation
- Prices can "coordinate" allocations of pollution reductions across source to minimize collective control costs

Prices for Water Pollution

With very few exceptions, there is nothing that Pigou, Kneese, Coase, or Dales would recognize as externality pricing

- Industrial and Municipal Sources
  - Regulated through effluent standards
  - Effluent taxes in some European countries but at low levels with small incentive effects to generate revenues
  - A few recent innovative schemes in the US and Canada (Trading in MN,NC, PA, VA; prices in CN, ONT)

Prices for Water Pollution

- Agricultural sources
  - Except for large animal operations, generally "lightly" regulated if regulated at all
  - Effluent taxes in some European countries but at low levels with small incentive effects to generate revenues
  - Extensive use of subsidies or payments for voluntary adoption of BMPs
  - Some use of payments for "performance"

How is it working out?

- Pollution Reductions
  - Substantial control of municipal and industrial sources
  - Agriculture largely unregulated
- Water Quality Conditions
  - Significant water quality gains, but water problems are pervasive in the US and most other OECD countries
  - Nutrient pollution a major threat to aquatic ecosystems around the globe

Impaired Uses (% total impaired)

	Fish, Shellfish, Wildlife Protection And Propagation	Aquatic Life Harvesting	Exceptional Recreational Or Ecological Significance	Recreation	Public Water Supply
Rivers and Streams	42	71	20	40	22
Bays and Estuaries	84	60		30	10
Lakes, Reservoirs Ponds	40	76	16	13	19
Coastal Shoreline	55	94		19	
Wetlands	42	99		7	

Top Five Sources

Type	1	2	3	4	5
Rivers Streams	**Agriculture**	Unknown	Atmospheric Deposition	Hydro-modification	Urban Stormwater
Bays Estuaries	Atmospheric Deposition	Unknown	Municipal Discharges	Other	Industrial
Lakes, Reservoirs Ponds	Atmospheric Deposition	Unknown	**Agriculture**	Other	Legacy Pollutants
Coastal Shore Line	Unknown	Atmospheric Deposition	Municipal Discharges	Urban Stormwater	Hydro-modification
Wetlands	Unknown	**Agriculture**	Atmospheric Deposition	Industrial	Municipal Discharges

Impaired Waters Listed By State

Description of this table

State Name	Number of Waters on 303(d) List
Alabama	283
Alaska	35
American Samoa	45
Arizona	91
Arkansas	225
California	1,021
Colorado	244
Connecticut	461
Delaware	101
District Of Columbia	36
Florida	2,292
Georgia	242
Guam	47
Hawaii	298
Idaho	741
Illinois	1,057
Indiana	1,836
Iowa	480
Kansas	1,372
Kentucky	1,433
Louisiana	236
Maine	114
Maryland	184
Massachusetts	720
Michigan	2,352
Minnesota	1,144
Mississippi	229
Missouri	257
Montana	480
N. Mariana Islands	24
Nebraska	342
Nevada	215
New Hampshire	1,449
New Jersey	716
New Mexico	209
New York	1,543
North Carolina	1,130
North Dakota	201
Ohio	267
Oklahoma	657
Oregon	1,397
Pennsylvania	6,957
Puerto Rico	231
Rhode Island	120
South Carolina	961
South Dakota	166
Tennessee	1,012
Texas	719
Utah	156
Vermont	104
Virgin Islands	87
Virginia	1,523
Washington	2,420
West Virginia	1,097
Wisconsin	593
Wyoming	107

Total: 42,459 impaired waters

How is it working out?

- Economic
  - Significant economic benefits from water quality improvements since late 1970s (mainly from recreation)
  - But incremental costs exceed incremental benefits
  - The US has been spending more than it gets in return for water quality protection since the mid-1980s (Olmstead 2010)

Why the imbalance?

- Small water quality benefits? No!
- High costs from efficiently achieved water pollution reductions? No!
- High costs from inefficiently achieved water quality reductions? Yes!

Why the imbalance?

- National technology-based effluent limits for industrial and municipal sources are grossly inefficient
  - Prevent utilization of the lowest cost abatement methods
  - Prevent allocation across those source to minimize collective costs
- Over-reliance under the Clean Water Act on high cost point sources versus lower cost nonpoint sources

Why the imbalance?

- Mechanisms for subsidizing agricultural abatement
  - Focus on practices rather than outcomes
  - Do not incentivize least cost controls at the farm level
  - Do not target payments to high priority places
- Based on expenditures for the US EQIP the EU Nitrate Directive, the OECD (2012) estimates total public spending across the OCED to be $100s of billions annually for ag pollution controls that show modest impacts

Back to prices

- The inefficiency we see today is what advocates of prices predicted
- Experiments with prices have shown merit in other contexts
  - EPA acid rain program
  - Fisheries quotas
  - The more they look like textbook models, the better they work
- Much interest in innovation using incentives
  - Water quality trading and tax/subsidy schemes

WIP Costs vs "Cost Effective Portfolios(CEP)" For Chesapeake Bay TMDL (excluding land-retirement BMPs)

State	Annualized Cost		CEP Cost Saving
	WIP	CEP	
Delaware	$19.4m	$4m	80%
Maryland	$83m	$12.8m	85%
New York	$71.2m	$51.8m	27%
Pennsylvania	$378.3m	$241.3m	36% **
Virginia	$307.4m	NF (P)	NF (P)
West Virginia	$44m	$16.8m	62%
Total	$903m	$634.1	30%

**PA Phosphorous limit slightly exceeded

What would getting the prices right for nutrients require?

- Price structures
  - What to price?
  - Variations over space and time?
- Information requirements
- Pricing mechanisms
  - Administered (Pigou)?
  - Markets (Coase)?
  - Mix?

Textbook Model Assumptions

Biophysical

- A single pollutant and receptor
- Discharges
  - Deterministic
  - Uniformly mix to determine ambient concentrations
- Simple flow paths from sources to receptor
- Dynamics
  - No significant time lags between discharge and delivery
  - No stock accumulation
  - No nonlinear feedbacks (no hysteresis)

Textbook Model Assumptions

Economic

- Dischargers
  - Cost minimizers
  - Perfectly informed about technologies and costs
  - Perfectly competitive
- Dynamics
  - No capital adjustment costs
- Regulator
  - A single authority with strong technical and economic capacities

A Wicked Problem

- In the textbook model, a price that is applied to individual discharges and equal across sources and time will achieve lead to social cost minimization
  - E.g., a carbon tax
- Relaxing assumptions complicates the price structures across sources, space, and time
- Efficient nutrient pricing is wickedly complex because nearly all the assumptions of the basic model are violated

Wicked Problems (Rittel and Webber 1973)

- Imperfectly-understood
- Complex ecological and anthropogenic interactions contributing to the problem
- Complex spatio-temporal interactions, operating at different scales
- Require unique solutions over space and time;
- Entail economic, political, and institutional complexity

Moving from a Fantasy World to a Wicked Reality

Case	Assumptions	Price Structure	Maximum Optimal Number of Prices
1	Text Book Assumptions	Single price rule	1
2	Multiple pollutants	Single price rule applied to each pollutant – Uniform across sources	N (N= number of pollutants)
3	Non-uniform mixing: Spatial heterogeneity of Impacts	Price for each pollutant for each sources to reflect differences in marginal impacts	Assuming all discharge each pollutant and each source has a unique impact M x N (M= number of polluters)
4	Multiple receptors	Case 3 repeated for receptor	Assuming each discharger affects each receptor M x N x R (R = number of receptors)
5	Lags, stock accumulation, adjustment costs	Case 4 with prices varying systematically over time	M x N x R x T (T = number of time periods to steady state)
6	Multiple pathways	Case 5 with prices for each pathway	Very Many

From Wicked to Seriously Wicked

- Nonpoint sources
  - – Unobservable emissions
  - – What to apply prices to if not discharges?
    - Inputs -> Case 4 multiplied by the number of priced inputs
    - Performance proxies
- Stochastic processes
  - – Prices must manage variability
  - – Managing variability multiplies what must be managed
  - – Discharges
  - – Average discharges
  - – Average + variance

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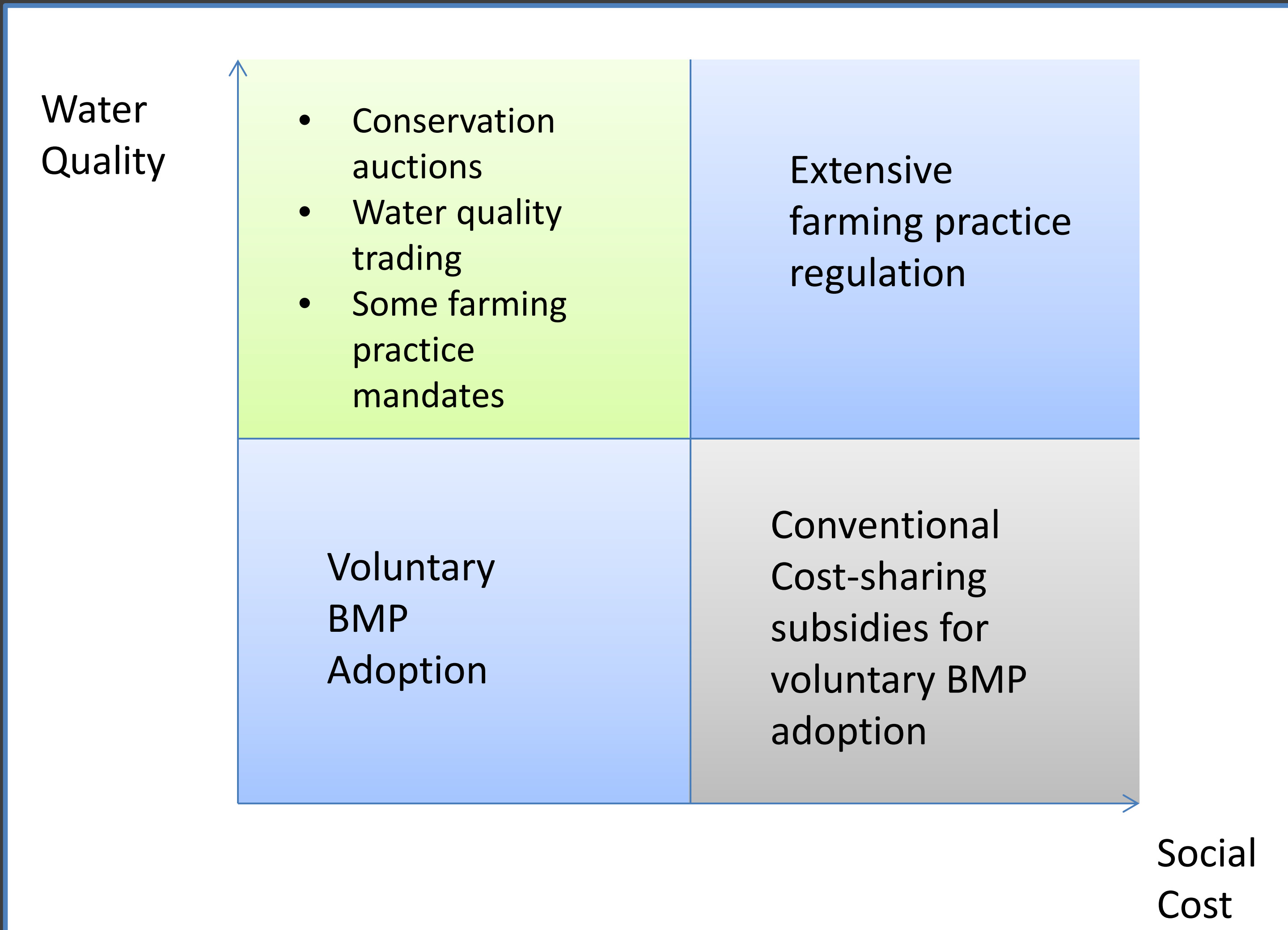
Getting Pragmatic

- Costs and complexity will require simpler prices structures
  - Tradeoff between social costs of pollution abatement and social costs of administration and enforcement
  - Increase likelihood of unintended consequences
- Smart regulations in addition to prices have an important place!!

Choices

	Carrots (Payments/financial assistance that reduce the private costs of BMPs	Sticks (penalties, restrictions on eligibility for other benefits that increase the costs of non-adoption)	Mandates
Practice Based	Cost-Sharing (EQIP) Tax preferences	Cross-compliance Input taxes (e.g., fertilizer, phosphorous in feed)	CAFO permits Stream set backs Winter manure application bans Nutrient & manure management plans
Performance Based	Baseline-and-credit trading Conservation performance auctions	Pollution taxes Product taxes to fund conservation programs	
Mixed	Conversion of highly erosive lands to permanent vegetative cover based on “benefits index” (CRP)		

Which to choose?



Economics and Environmental Markets: Lessons from Water-Quality Trading

James Shortle

Water-quality trading is an area of active development in envir
Unlike iconic national-scale air-emission trading programs, wa
programs address local or regional water quality and are l
innovations in water-pollution regulation by state or substa
than by national agencies. This article examines lessons fr
about the "real world" meaning of trading and its mechanism
of alternative institutional designs, utilization of economi
development, and research needed to improve the suc
markets for water quality.

Key Words: environmental markets, water-quality tradir

Policy Instruments for Water Quality Protection

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Reforming Agricultural Nonpoint Pollution Policy in an Increasingly Budget-Constrained Environment

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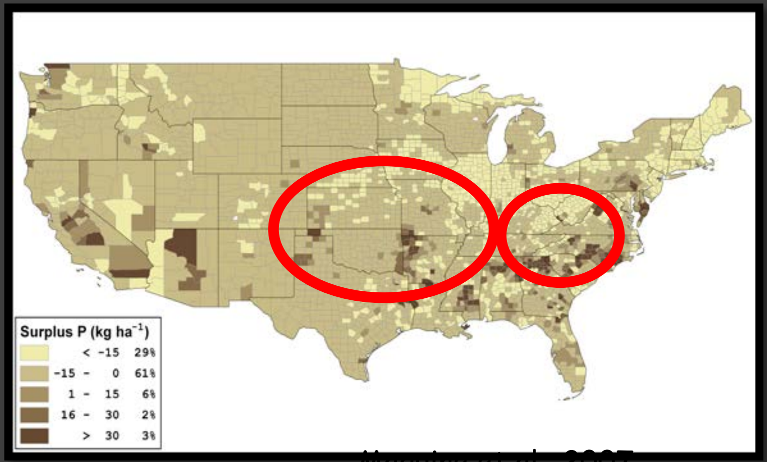
A little more wickedness

Regional mass imbalances



Maguire et al., 2007

The nutrient problem is driven by landscape scale economic processes that link disconnected watersheds - getting prices right had landscape scale dimensions

A little more wickedness

Agriculture and energy policy distortions

- Water pricing
- Ethanol subsidies
- Missing carbon prices

Systematic good use of prices can simplify and rationalize environmental management with multiple interacting stressors

Systematic misuse of prices can have unintended consequences