

## The Complex Interactions of Markets for Endangered Species Products

Carolyn Fischer  
Resources for the Future

EAERE-FEEM-VIU Summer School, 2007



## Spending for Species?



## Motivation

- Major international policy tool to protect endangered species (CITES) is trade restriction
- International trade in ivory has been banned since 1989, after poachers in Africa halved the continent's population
- Since elephant populations recovered, some countries have asked for special authorization to sell stockpiled ivory
- First exception permitted Botswana, Namibia and Zimbabwe to sell Japan about 110,000 pounds; another one-off sale approved in 2002



## Controversy

- According to the Environmental Investigation Agency (EIA), elephant poaching increased with the 1999 sales
- According to the UNEP and the TRAFFIC network, legal sales did not elicit an apparent poaching response
- According to simple economic theory, however, poaching should have decreased.



## Crime and Confiscation

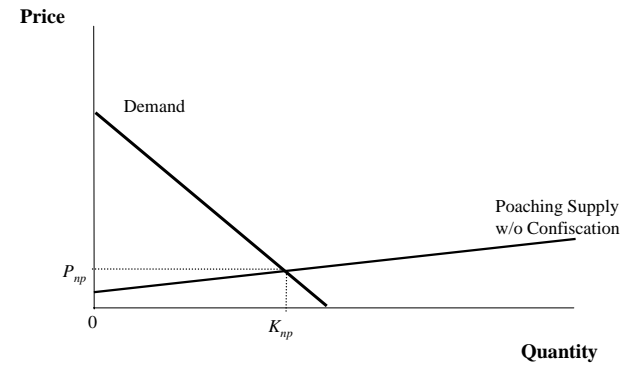
- Simple example by Bergstrom  
("Puzzles" in JEP, Summer 1990)

Let poaching =  $K$

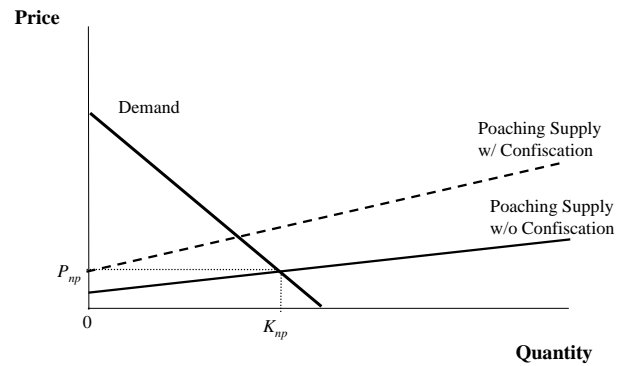
Rate of confiscation =  $1 - \alpha$



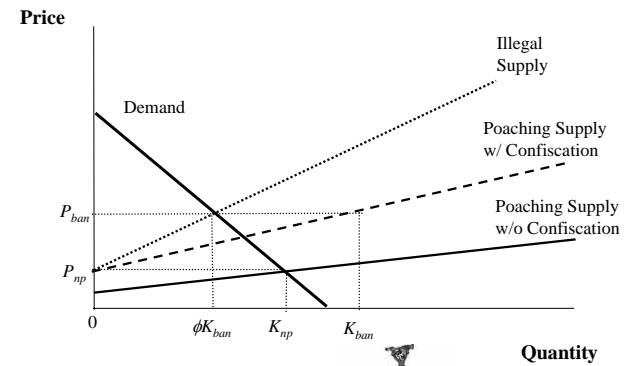
## Bergstrom Model



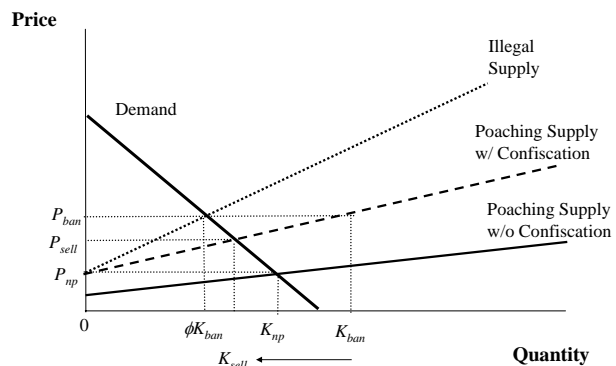
## Bergstrom Model



## Bergstrom Model



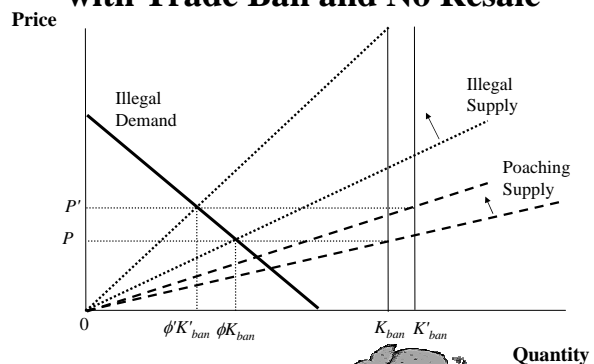
## Bergstrom Model



## With Single Demand

- Legal sales drive down prices...  
... and reduce the return to poaching (but increases consumption)
- Without reselling confiscated goods, increasing the rate of confiscation will raise prices...  
... and *may increase* poaching

## Enforcement Change with Trade Ban and No Resale



## Other Models

- Heltberg (EE 2001) recognizes that international consumer demand may shift in switch from free trade to trade ban
- Barbier and Swanson (1990) examine major sources of demand for ivory and consider effect of limited legal sales, but focus on raising ivory values for conservation
- Bulte and van Kooten (AJAE 1999) consider separate domestic and international markets for ivory
- Another long economics literature exists on competition among imperfect substitutes.
- Consumers are assumed to care only about product prices

## What did those models forget?

1. Separate Markets  
Legal sales bring law-abiding consumers to market
2. Stigma  
Affects their WTP; reduced by legal sales
3. Laundering  
Can bring illegal goods to legal markets
4. Endogenous Supply Costs  
Legal sales can make enforcement harder



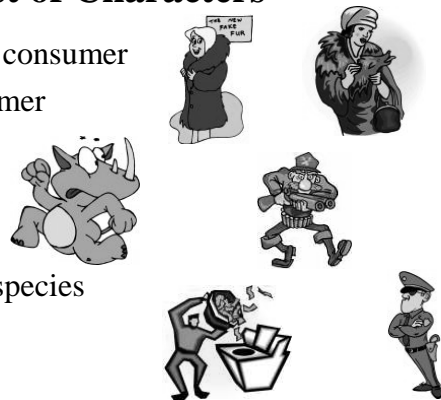
## Some Evidence for Stigma

- Data on illegal sales are poor
- In two decades prior to ivory ban, Japanese prices remained at 18,000–20,000 yen/kg for large tusks. Shortly after the ban, prices rose to 180,000 yen and then gradually fell to 60,000 yen (\$450) /kg.
- Pattern consistent with an initial restriction of legal supply and then growing stigma as legal stocks dwindled relative to illegal supplies.
- 1999 prices averaged 10,904 yen per kg, half the pre-ban prices, which could reflect stigma effects.
- NGOs worried aloud that legal trade would confuse consumers



## Cast of Characters

- Law-abiding consumer
- Illegal consumer
- Poacher
- Enforcer
- Launderer
- Endangered species



## Law-Abiding Consumer

Will only buy certified products

Utility a function of

1. Consumption:  $Q_L^c$
2. “Stigma”:  $\mathcal{S} = Q^u / (Q^u + Q^c)$   
perception that illegally obtained
3. “Outrage”:  $K$   
negative existence value from poaching

Maximizes  $V(Q_L^c, \mathcal{S}, K) - P^c Q_L^c$



## Illegal Consumer



Utility only from total consumption

$$U(Q_N^c + Q^u) - P^c Q_N^c - P^u Q^u$$

Buys wherever cheaper

- If illegal cheaper,  $Q_N^c=0, Q^u>0$ .
- If legal cheaper,  $Q_N^c>0, Q^u=0$ .
- Only if same price,  $Q_N^c>0, Q^u>0$ .



## Illegal Supply

Poacher



Policymaker/  
Enforcer



Maximizes profits

$$P^u \bar{x} K - C(K)$$

So if  $K>0$ ,

$$P^u = C'(K)/\bar{x}$$

Confiscates  $(1 - \bar{x})K$

Harvests  $H$

Sells  $S \bullet (1 - \bar{x})K + H$



## 3 Equilibria with Trade

0. Trade Ban
1. Single Legal Market
  - Everyone buys only certified goods
2. Separate Markets
  - Illegal consumers buy only uncertified
3. Perfect Arbitrage
  - Illegal consumers buy some certified



## Single Legal Market

Legal price lower than poaching threshold

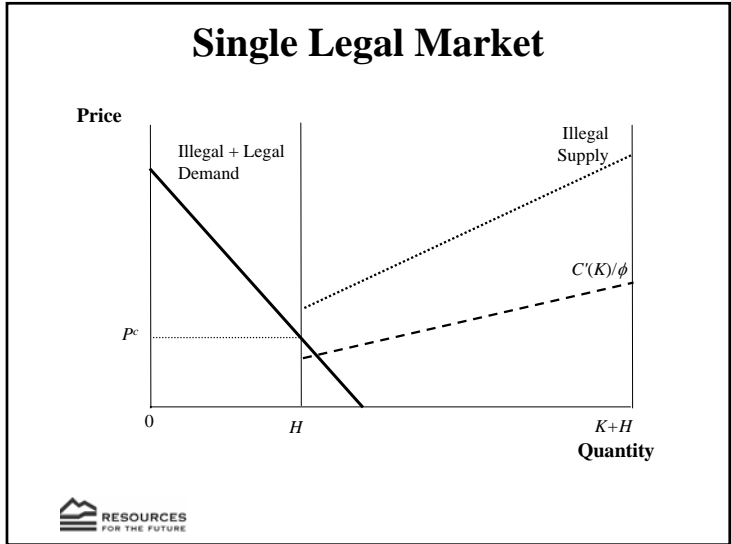
$$U'(Q_N^c) = V_1(Q_L^c, \bar{x}, K) < C'(K)/\bar{x}$$

Harvesting satisfies both consumers

$$Q_N^c + Q_L^c = H$$

- No poaching
- Banning trade necessarily increases poaching





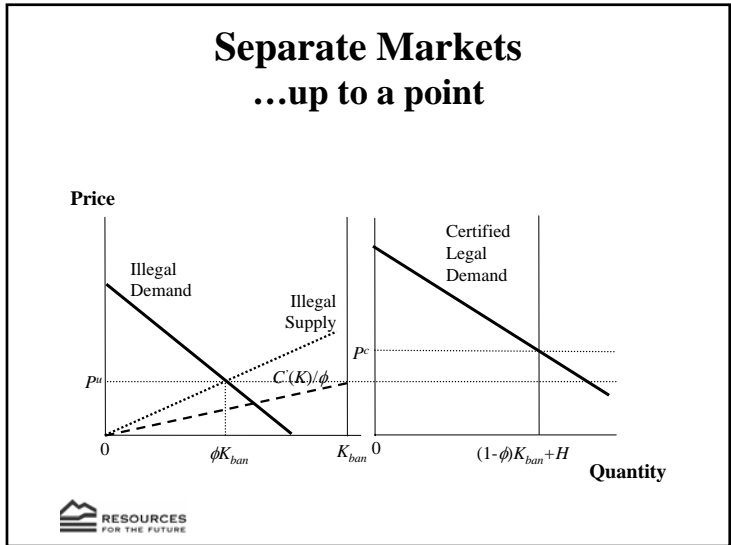
### Separate Markets

Price for certified goods higher  
 $C'(K)/\lambda = U'(Q^u) < V_1(Q_L^c, \phi, K)$

Illegal consumers buy only uncertified goods  
 $Q_L^c = S, Q^u = \lambda K.$

- Poaching same as under trade ban
  - Small changes in sales won't affect poaching
  - Same enforcement effects as with trade ban

RESOURCES FOR THE FUTURE



### A Pause to Discuss Stigma

Law-abiding demand is downward sloping, given stigma

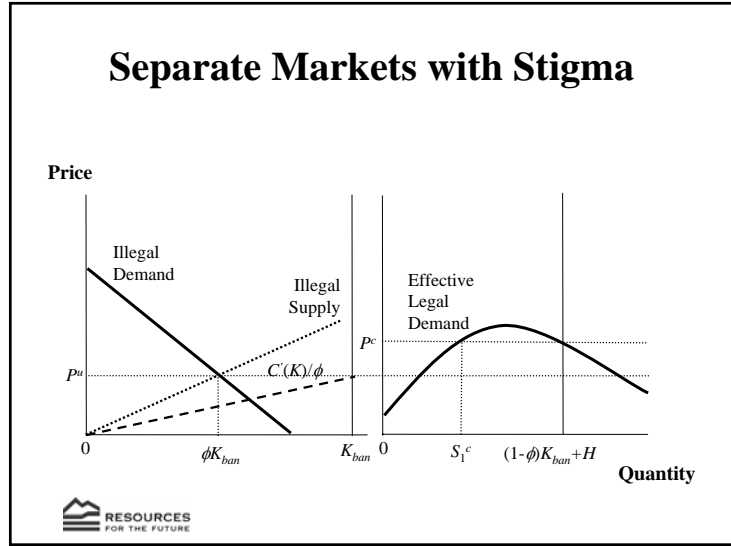
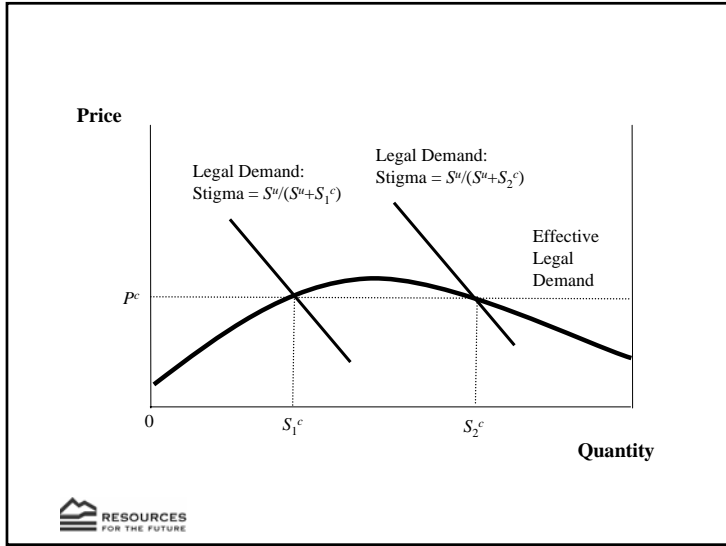
Changes in stigma shift that demand

- More legal sales shift demand *up*

Net effect: Legal demand may slope upward, downward, or be non-monotonic

**Outrage:** as poaching falls, demand shifts up

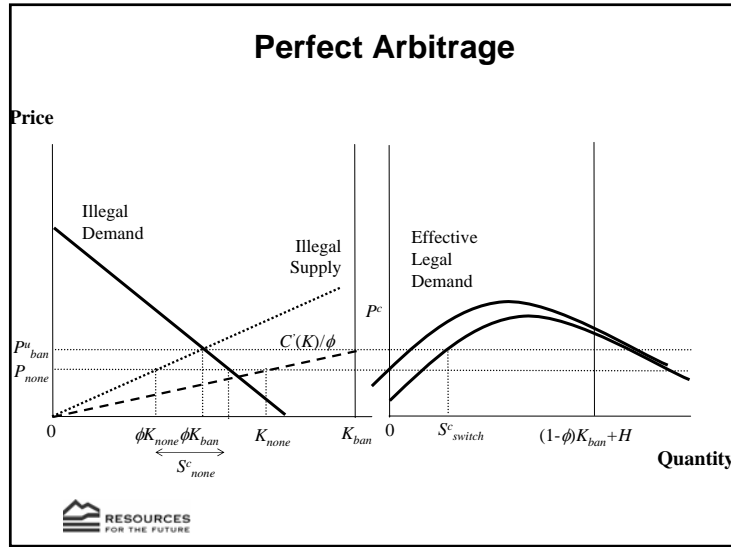
RESOURCES FOR THE FUTURE



### Perfect Arbitrage

- Prices equalized  
 $C'(K)/\lambda = U'(Q_N^c + Q^u) = V_1(Q_L^c, \phi, K)$
- Illegal consumers cross over into certified goods market  
 $Q_L^c = S \leftarrow Q_N^c, Q^u = \lambda K.$
- Lower price, less poaching than with ban

RESOURCES FOR THE FUTURE



## Summary: One-Way Arbitrage

- Allowing legal sales can only reduce poaching compared to a ban
- With stigma, selling all available certified products may not minimize poaching
- Enforcement changes can have ambiguous effects, even with reselling



(Caveat: no laundering or supply effects!)



## Laundering



- Provides arbitrage link from illegal to legal market

Profits:  $(P^c - P^u) \lambda^f Q^f - F(Q^f)$

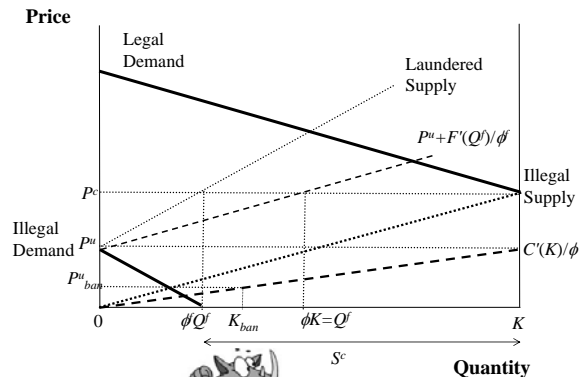
So if  $Q^f > 0$ ,  $P^c - P^u = F'(Q^f) / \lambda^f$

- Occurs when markets would be separate

$$Q_L^c = S + Q^f, \quad Q^u = \lambda K - Q^f.$$



## Single “Legal” Market With Laundering (no Stigma)



## Summary with Laundering

- Two-way arbitrage
- Occurs when markets would be separate
- High legal prices pull up illegal ones, increasing poaching

Policy question:

- Is the price for certified goods, minimized w.r.t. sales, less than the illegal price under a trade ban?



## Enforcement Policy and Poaching

Simple simulations with linear everything.

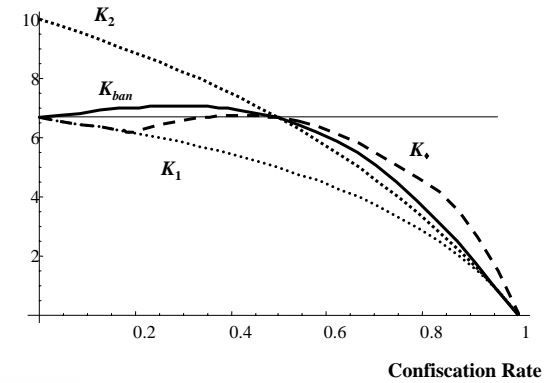
Scenarios:

1. **Trade1:** just illegal consumers and resale
2. **Trade2:** both consumer types in single market with identical demand curves, all confiscations resold (no ban)
3. **Ban:** full trade ban
4. **Stigma:** perfect arbitrage equilibrium with stigma and all confiscations resold (no ban)



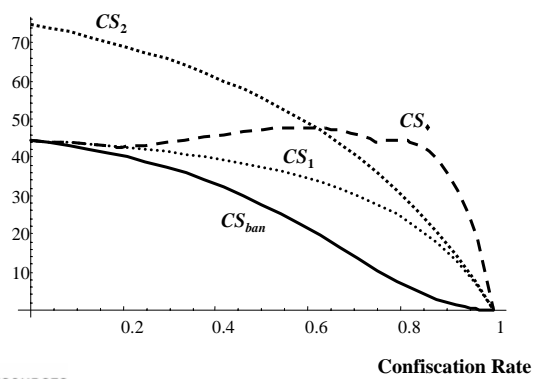
## Enforcement and Poaching

Poaching



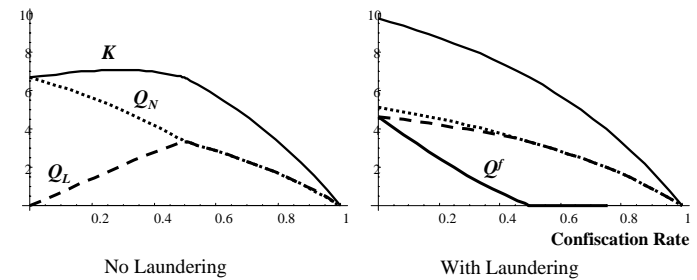
## Enforcement and Consumer Welfare

Consumer Surplus

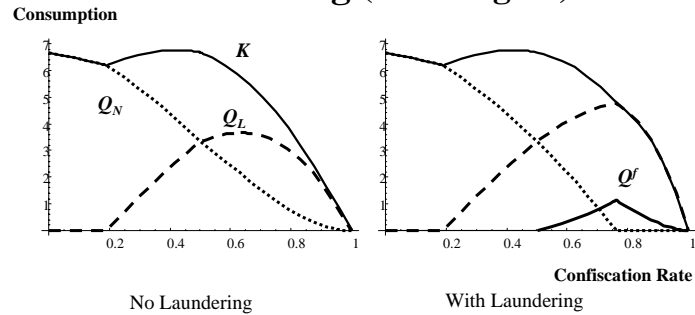


## Enforcement, Resale, and Laundering (without Stigma)

Consumption, Poaching



## Enforcement, Resale and Laundering (with Stigma)



## Summary

Regime	Equilibrium	Effect of Sales on Poaching	Effect of More Enforcement
Trade Ban	Single illegal market	N.A.	Ambiguous
All Harvesting	Single legal market	No poaching	N.A.
Legal price higher	Separate markets Imperfect arbitrage or single "legal" market	Same as trade ban More poaching than with ban, but effect of additional sales ambiguous	Same as trade ban Ambiguous, though confis- cation and resale will lower return to poaching
No laundering Laundering			
Legal price lower	Perfect arbitrage	Less poaching than with ban, but effect of additional sales ambiguous	Ambiguous

## Supply Externalities

Form is important for equilibrium effects.

Does it:

1. make poaching cheaper?
2. lower the confiscation rate?
3. lower marginal costs of laundering?
4. lower the confiscation rate for laundering?

## Conclusion

To sell or not to sell?

- Will legal demand generate higher prices and induce laundering?
- How strong are stigma effects?
- What are the supply externalities? (counter-intuitive)

To confiscate more or less?

- What is demand elasticity?
- What are stigma effects, given sales policy?

## More Questions

What is the policy goal: illegal activity or welfare?

- How to measure welfare with stigma?

Should policy try to influence stigma?

- When does demand-side management make supply-side policy more effective?

What if legal consumers will buy uncertified goods, but they're imperfect substitutes?



## Extensions

- Add renewable resource dynamics
- Equilibrium supply could be backward bending, along with demand...



## Other Applications

- Blood diamonds
- GMO-free, cruelty-free or organic products
- Certified timber
- Drugs
- Guns

