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# Economics Research for Waste Minimization

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Engineering to Minimize the Generation of Hazardous Waste

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Stuart L. Fribush
Senior Policy Analyst
Sobotka & Company, Inc.
2501 M Street, N.W.
Washington, D.C. 20037
(202) 887-0290

1. Methods for Predicting the Long-Run Costs of Hazardous Waste Regulation

2. Social Costs vs. Private Costs: Implications for Waste Minimization

# 1. Methods for Predicting the Long-Run Costs of Hazardous Waste Regulations

1.1 Background

1.2 Short Run vs. Long Run

1.3 Types of Long-Run Cost Savings (Waste Reduction)

1.4 Methods for Addressing Waste Reduction (Theory of Production)

1.5 Example - Wood Preserving

1.6 Support for Theory of Production Approach in Modelling Waste Reduction

1.7 Future Applications

## 1.1 Background

- Key Question

  To what extent can one expect waste generating industries and their customers to make changes in order to mitigate the cost increases due to RCRA regulations?

- Purpose

  To make improved forecasts of the real costs of the RCRA program.

- Phenomena to be Considered

  Waste Reduction Responses to Rising Waste Management Costs

  Long-Run Unit Costs of Waste Management

- Methods Development

  Theory of Production

  Treatment of Hazardous Waste as Input to Production

## 1.2 Short Run vs. Long Run

- Short Run: No Investment in New Facilities (Capital Equipment is Fixed) Minor Adjustments to Production Process Possible (some change in variable inputs).

- Long Run: Investment in New Facilities, GIVEN AVAILABLE TECHNOLOGY (Capital Equipment is Not Fixed).

- Longer-Run: CHANGES IN AVAILABLE TECHNOLOGY, Consumer Preferences.

## 1.3 Types of Long-Run Cost Savings

- <u>Waste Reduction</u>

  -- Input or process changes to reduce the volume or toxicity of the hazardous waste stream (substituting cleaning of copper sheets with pumice for chemical spraying in microelectronics).

  -- Reuse, reclamation, or recycling wastes for use in the production process (cumene reclamation and reuse in the manufacture of phenol).

  -- Reuse, reclamation, or recycling for use or sale in other markets (recovery of copper scrap in metal fabrication by modifying rinse steps).

  -- Substituting Waste-Efficient Products for Waste-Intensive Products (substituting water-based paint for oil-based paint).

- <u>Possible Long-Run Decline in the Unit Costs of Waste Management</u>

  -- Larger Units for Existing Technologies (Economies of Scale)

  -- Diffusion of Existing Technologies

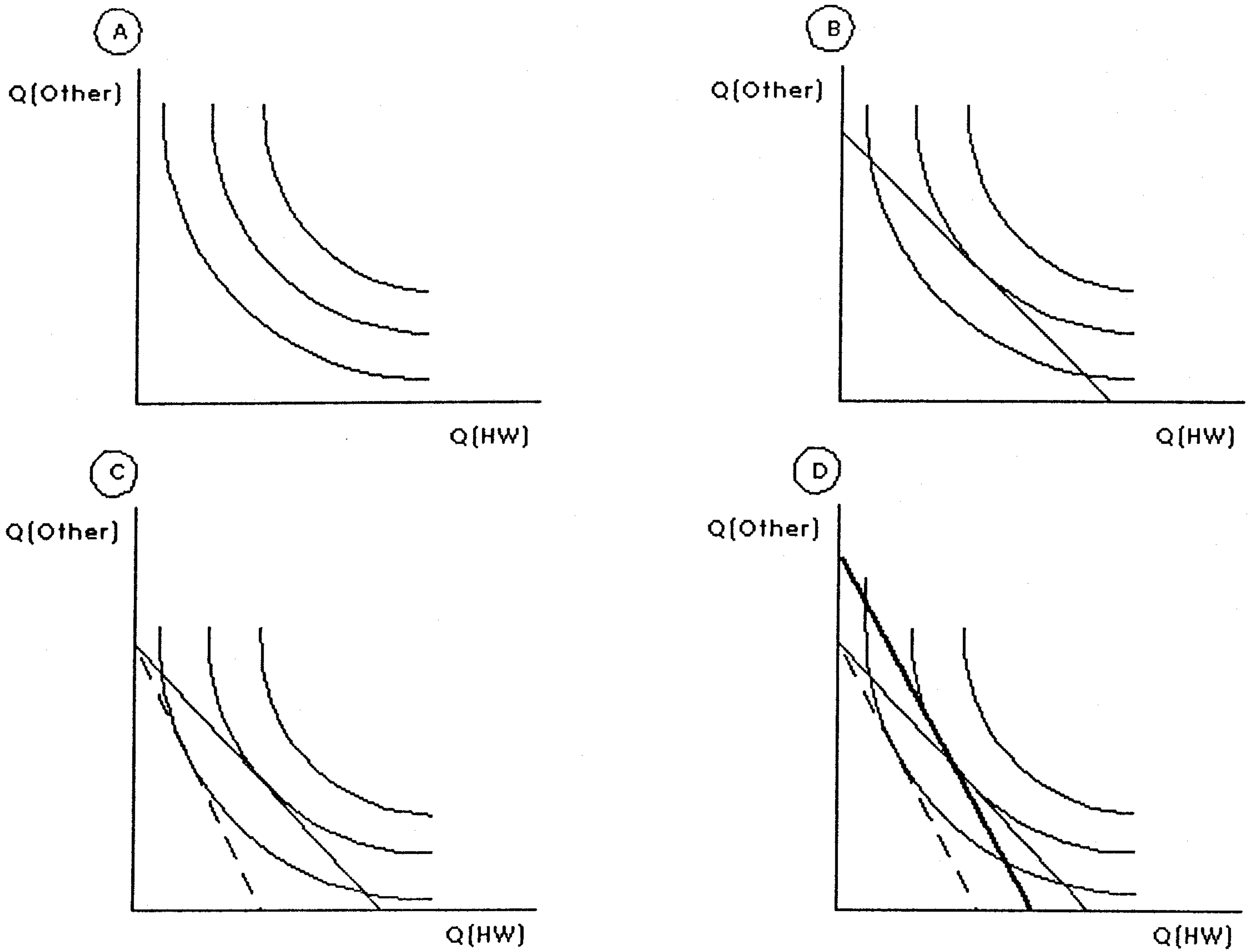
  -- New Technologies (Biotechnology)

## 1.4 Methods of Addressing Waste Reduction

- o Production Functions (Isoquants)
  - -- Relationship between inputs and outputs, given existing technology
  - -- Assume two inputs (hw, all other) and one output
  - -- Any given level of output can be achieved through a locus of input combinations
  - -- A budget line can be drawn, given available resources and input prices
  - -- Optimal input mix is where budget line is tangent to outermost isoquant

- o Substitution Elasticities
  - -- Sensitivity of the quantity of an input used in response to small changes in its price, holding everything else constant.
  - -- High Elasticity of Substitution -- significant change in the use of factor X for small changes in the price of factor X.
  - -- Low Elasticity of Substitution -- insignificant changes in the use of factor X for small changes in the price of factor X.

# GRAPHICAL EXAMPLE



## 1.5 Example -- Wood Preserving

### 1.5.1 Baseline Waste Management Practices

### 1.5.2 RCRA Requirements and Their Estimated Costs

-- The Approach in EPA's Economic Analysis
-- Revisions for Differences in Waste Generation Rates by Process Type

### 1.5.3 Waste Reduction Response

### 1.5.1 Baseline Waste Management Practices

Assumed in EPA's Economic Analysis

- o Organic treatment systems (creosote, pentachlorophenol) produce wastewater from the treatment system--requires oil/water separation, treatment, sludge management (Economic analysis assumed 0.0095 MT of hw/$m^3$ of product).

- o Inorganic treatment systems (CCA) were assumed to generate hw at the same rate as organic treatment systems.

Actual Practice

- o Inorganic treatment systems are closed because the treatment chemical is water soluble--only a small amount of sludge accumulates, which may or may not be hazardous under existing rules.

- o Waste from organic treating systems is listed whereas waste from inorganic systems may be a characteristic waste (possibly subject to revision).

- o Organic treatment systems generate 10-100 times as much waste as inorganic treatment systems (we assume inorganic waste generation rate is 1/10 of organic rate).

### 1.5.2 RCRA Requirements and Their Estimated Costs

Requirements Considered in the Analysis

- o Land Ban on Wood Preserving Wastes--will require treatment in compliance with EPA standards before land disposal.
- o Minimum Technology Requirements--liner requirements.
- o Assumed roughly 10 times increase in unit costs of compliance for above requirements (pre-RCRA to post-HSWA).

Requirements Not Considered in the Analysis

- o Small Quantity Generator Changes (1,000 - 100 kg/month)
- o Burning and Blending (new requirements not clear)
- o Corrective Action (sunk costs, not affected by future production changes)

## The Approach in EPA's Economic Analysis

294 organic wood preserving plants x 219 MT of hw/year x $376/MT for incremental treatment and disposal costs = $24.2 million = $82,000/plant = 2.3% of price

44 inorganic wood preserving plants x 219 MT of hw/year x $252/MT for incremental treatment and disposal costs = $2.4 million = $55,000/plant = 1.5% of price

NOTE: $376/MT for organic treaters includes evaporation and asphalt solidification as treatment, plus increased transportation and disposal costs.

$252/MT for inorganic treaters includes on-site vacuum filtration and chemical stabilization plus increased transportation and disposal costs.

## Revisions for Differences in Waste Generation Rates by Process Type

- Differences in waste generation rates

  organic: 290 MT/year     inorganic: 29 MT/year

- Revisions to incremental unit costs based on economies of scale

  organic: $338/MT     inorganic: $534/MT

- Revised costs

  294 organic plants x 290 MT of hw/year x $338/MT = $28.8 million = $98,000/plant = 2.5% of price

  44 inorganic plants x 29 MT of hw/year x $534/MT = $0.7 million = $15,000/plant = 0.1% of price

NOTE: These adjustments merely reflect differences in waste generation rates between inorganic and organic treatment systems. Long-term phenomena are discussed subsequently.

### 1.5.3 Waste Reduction Response

- Organic treaters currently undertaking many steps (including conversion from open to closed steaming, separation of effluent streams and recovery of preservatives, reuse of cooling and process water, and substituting inorganic systems for organic systems)--suggests factor substitution is feasible.

- Organic treaters assumed to face hazardous waste management costs of 2.7% of total costs (post-HSWA) up from 0.23% (pre-RCRA).

- Cost of hw "factor of production" has increased by a factor of 11.7 (2.7% / 0.23%).

- If elasticity of substitution (ES) = 1, and hw management costs rise by a factor of 11.7, the volume of hazardous waste to be managed per unit of output will drop to $(11.7)^{-1}$ = 8.5% of its short-run level.

- Other costs will rise as other inputs are substituted for hw. On balance, if ES=1, costs will rise by about 0.6% instead of 2.5%, or roughly 25% of short-run levels.

- If ES = 0.5, long-run waste volumes fall to $(11.7)^{-0.5}$ or 30% of short-term levels. Cost increases will equal 1.1% after use of other factors rise, or 45% of short-run levels.

- If ES = 0.25, long-run waste volumes fall to $(11.7)^{-0.25}$ or 54% of short-term levels. Cost increases will equal 2.0% after use of other factors rise, or 80% of short-term levels.

- KEY RESULT--quantity of hw produced may decline significantly, even though overall costs will not decline at the same rate.

## 1.6 Support for Theory of Production Approach in Modelling Waste Reduction

1. The Energy Crisis of the 1970s

   10-fold increase in oil prices from early 1970's to early 1980's resulted in a 34% decrease in quantity consumed, relative to what oil consumption would have been given real GNP growth and no substitution away from oil.

2. EPA Estimates

   10-fold increase in hazardous waste management costs over the last decade has resulted in a 60% decrease in quantity of hazardous waste produced per unit of product -- with still more reduction possible given current technology.

3. The 1985 CMA Hazardous Waste Survey

   For 301 plants reporting in 1981, 82, 83, 84, 85:

   50% decrease in hazardous solid waste generation 1981 to 1985
   20% decrease in hazardous wastewater generation 1981 to 1985

## 1.7 Future Applications

- Requirements on States to provide capacity assurances for hazardous wastes expected to be generated within the next 20 years as required under SARA §104(k).

- Long-Run Economic Impact Analyses of RCRA Rules

- The OSWER Strategic Planning Model

## 2. Social Costs vs Private Costs -- What Happens When There Are Gaps? Implications for Waste Minimization

### 2.1 Background

1. Role of Regulatory Agencies -- Reduce Gaps Between Private Costs and Social Costs in Least Burdensome Manner

2. Private Costs -- Costs Faced by Individual Entities
   Social Costs -- Costs Borne by Society (Environmental Effects)

### 2.2 Private Costs Less Than Social Costs -- The Need for Intervention

1. Classic Case -- Government intervention internalizes externalities

2. Cost burden is quantifiable, distribution depends on elasticities

### 2.3 Private Costs Greater Than Social Costs -- The (Possible) Result of Intervention

1. Can There Be Too Much Waste Minimization?

   a. Do performance characteristics of products get compromised?

   b. Do products get taken off the market even if risks aren't significant?

2. If so, who pays and how much?