



# **Regulatory Impact: The Rise and Fall of Arsenic**

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## What is Arsenic?

**It is an industrial “good”**

- A key *industrial input*:
  - Wood preservatives
  - Pesticides, cotton desiccants
  - Antifouling paints
  - Leaded gasoline
  - Glass
  - Electronics (e.g., supercomputers)



## What is Arsenic?

### It is also a public “bad”

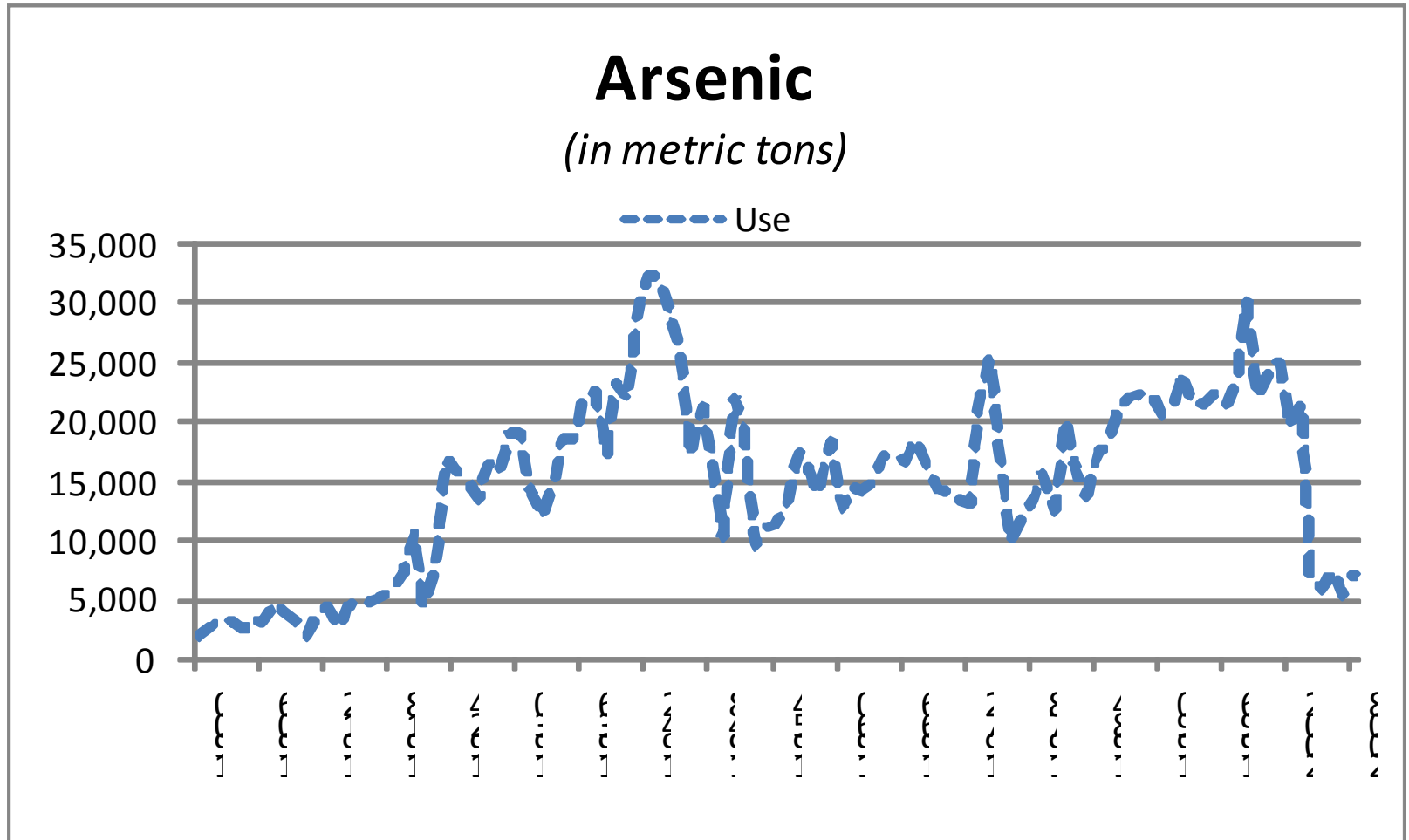
- A *carcinogen* that increases the risk of skin cancer & cancer in the liver, bladder, & lungs
- CRC Handbook of Chemistry & Physics (2008): top 10 list of the most toxic chemical to human & animal health
- #1 on EPA’s list of priority pollutants
- Top 10 “controlled” chemical by Basel Convention



## Research Question

What is the history of arsenic use/emissions in light of extensive government regulation since the 1970s?

# Arsenic Use in the U.S., 1900-2008



Source: USGS. Use = Apparent Consumption = Production + Imports – Exports ± Stock Changes.



## Federal Regulations

1. 1970 Occupational & Safety Health Act
2. 1972 Clean Water Act
3. 1974 Safe Drinking Water Act
4. 1976 Resource Conservation & Recovery Act
5. 1980 Resource Conservation & Recovery Act/Superfund Act

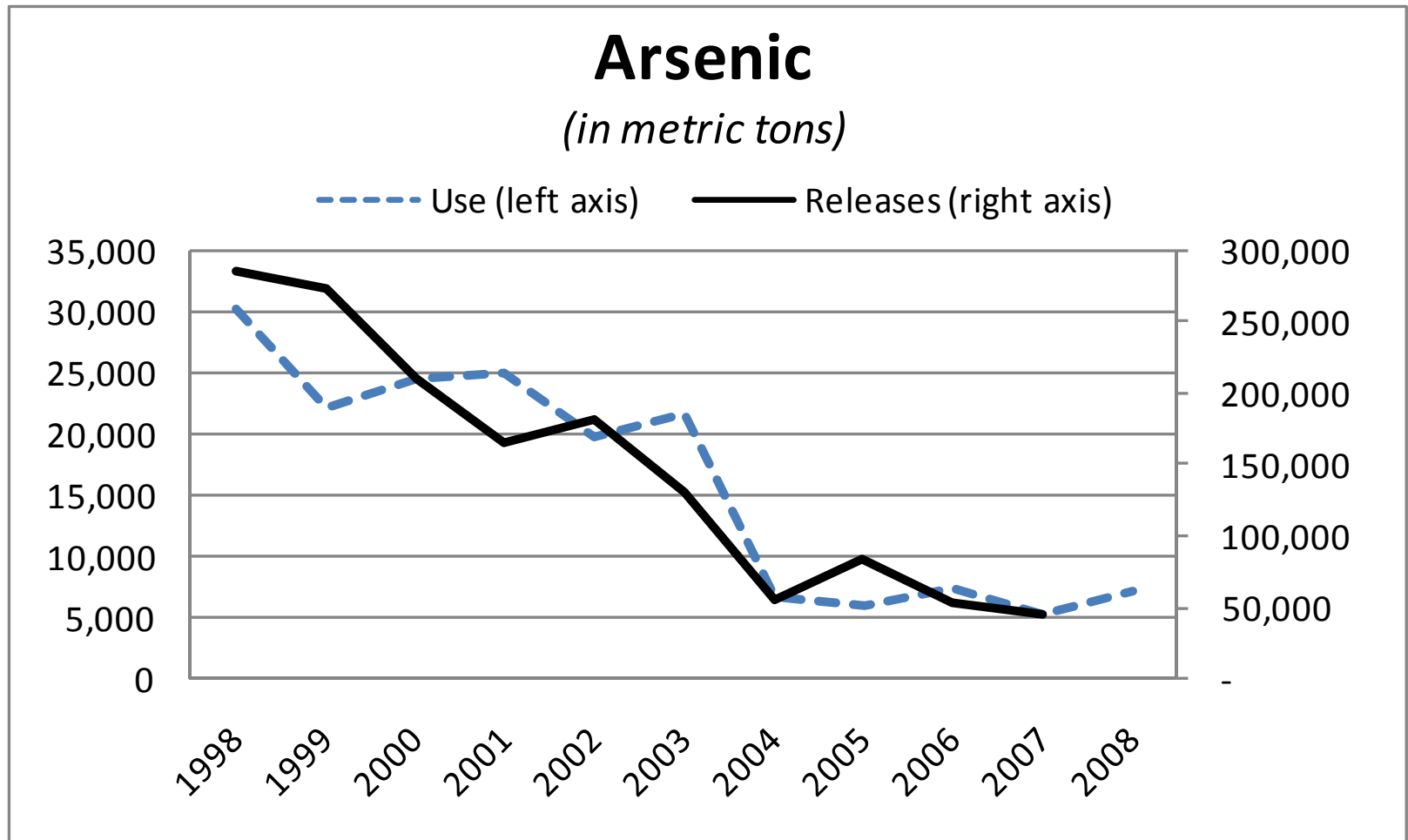
## Federal Regulations

6. 1986 Emergency Planning & Community Right-to-Know Act/*Toxic Release Inventory*
7. 1990 Clear Air Act
8. 1993 EPA's ban on arsenic acid
9. 2001 EPA's ruling on arsenic limit

## Paper's Contributions

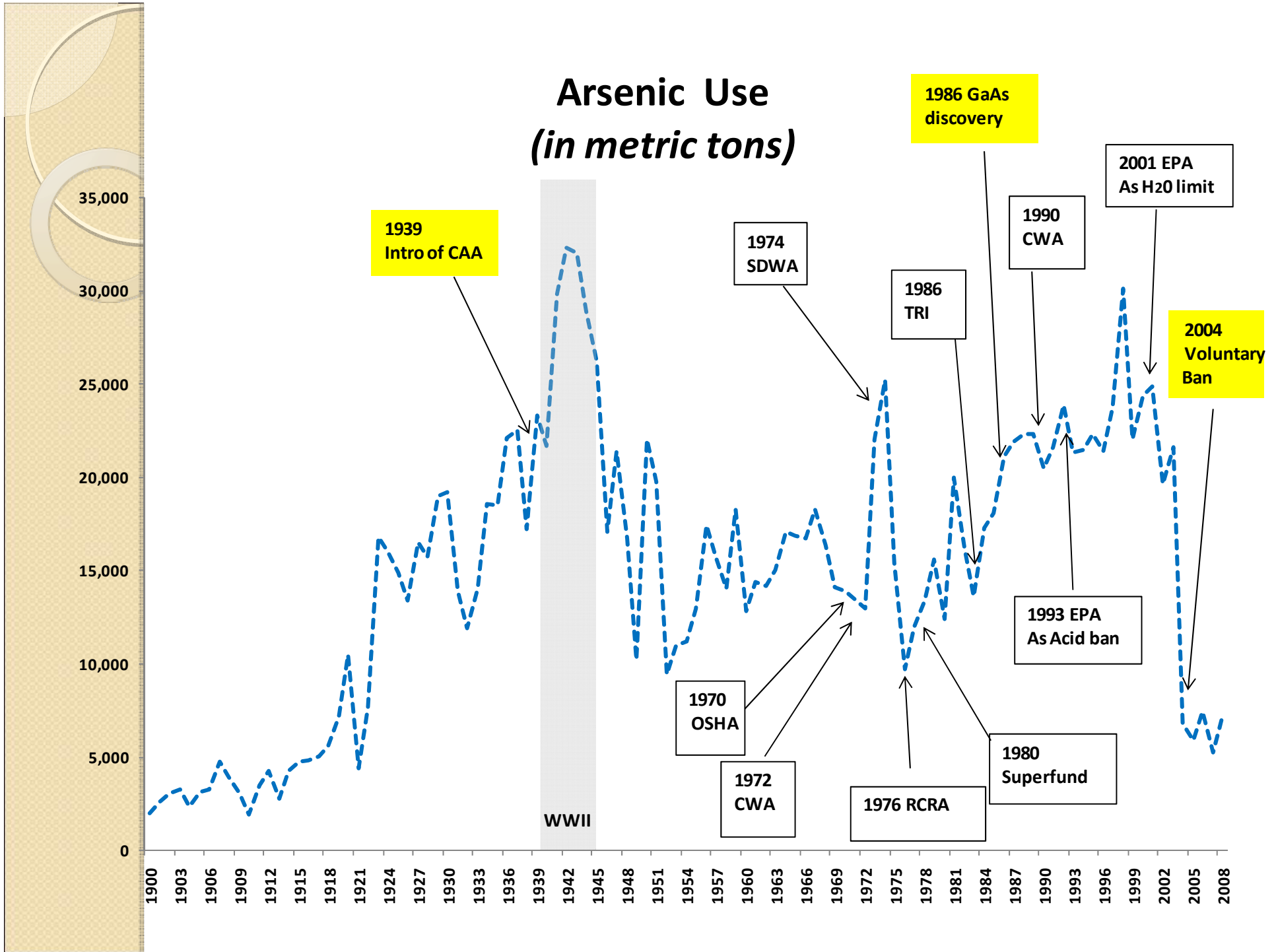
- Time series & sector panels to identify the impact of:
  - Federal regulations
  - Industrial innovations
  - Voluntary bans
- 2. Difference-in-difference:
  - Lead is a “control”
  - “Treatments” are 2001 EPA ruling & 2004 industry voluntary ban

# Arsenic Use and Emissions, 1998-2008

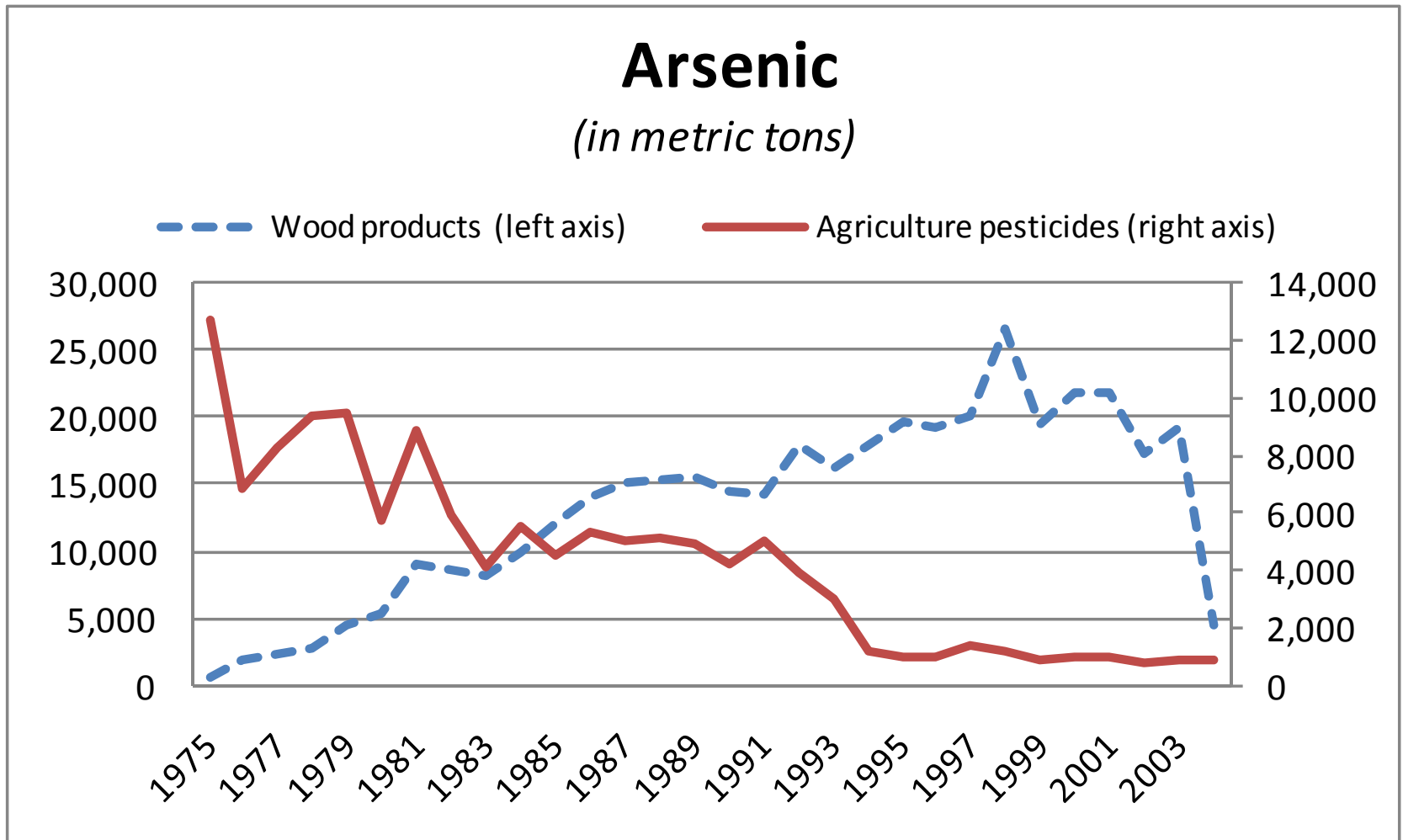


Source: USGS and EPA Toxic Release Inventory.

# Arsenic Use (in metric tons)

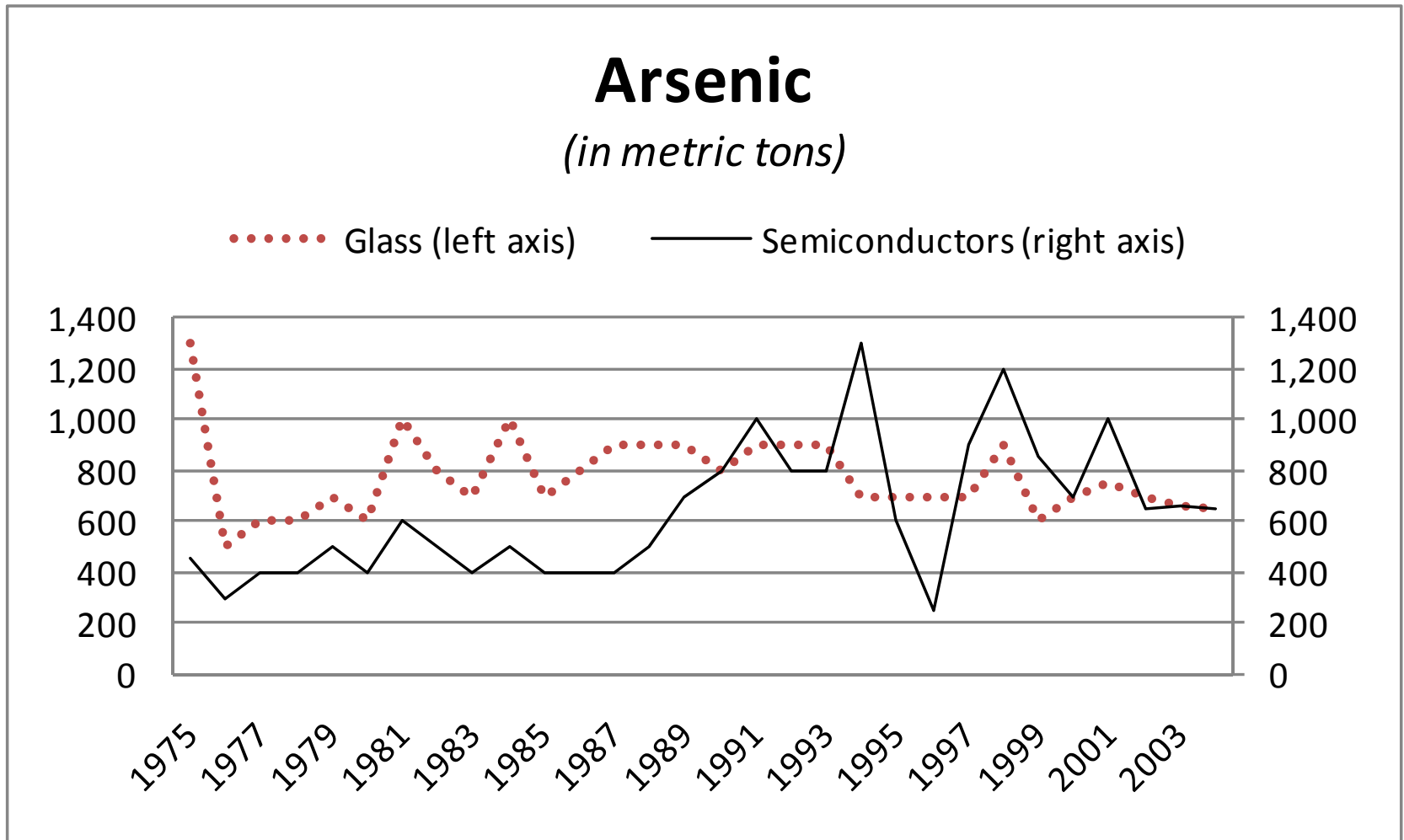


# Arsenic Use Across Sectors, 1975-2004



Source: USGS.

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Source: USGS.

## Time Series and Panel Data Analyses

- LHS variable: log arsenic use
- Key RHS variables: lagged term of each of the 9 federal regulations
- Controls: lagged terms of the following...
- *Economics*: industry structure, recession, prices
- *Industry developments*: introduction of CCA\_C, discovery of GaAs, voluntary ban
- *Other*: WWII, medial attention/political salience
- Sector fixed effects, time fixed effects

## Time Series - Regulatory Impact

1970 Occupational and Safety Health Act

1972 Clean Water Act

1974 Safe Drinking Water Act

1976 Resource Conservation & Recovery Act

1980 Superfund Act

1986 Toxic Release Inventory

1990 Clean Air Act

1993 EPA's Ban of Arsenic Acid

2001 EPA Arsenic Limit for Drinking Water



## Time Series - Regulatory Impact - Panel

1970 Occupational and Safety Health Act

1972 Clean Water Act

1974 Safe Drinking Water Act

1976 Resource Conservation & Recovery Act

1980 *Superfund*

1986 Toxic Release Inventory

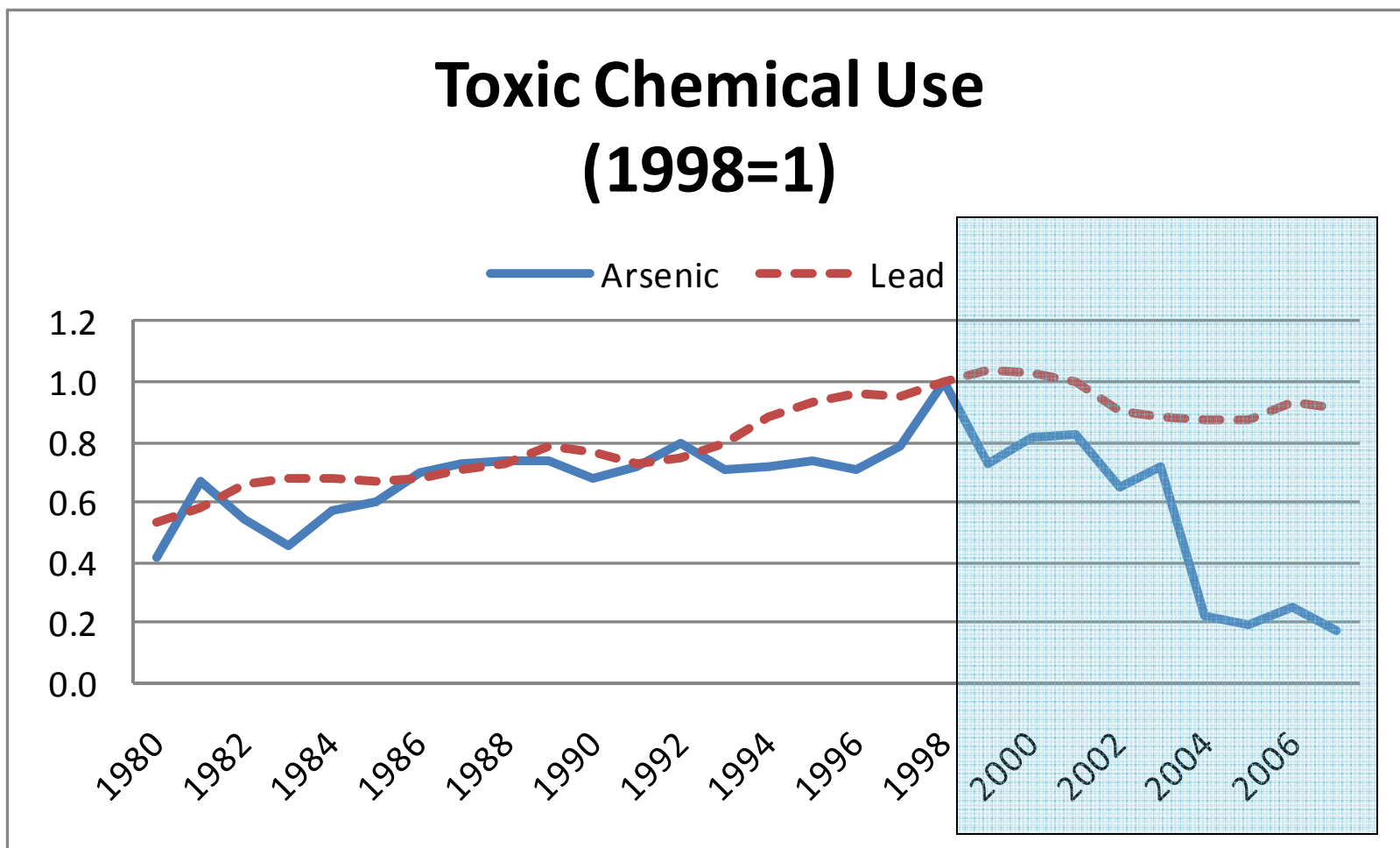
1990 Clean Air Act

1993 EPA's ban of arsenic acid

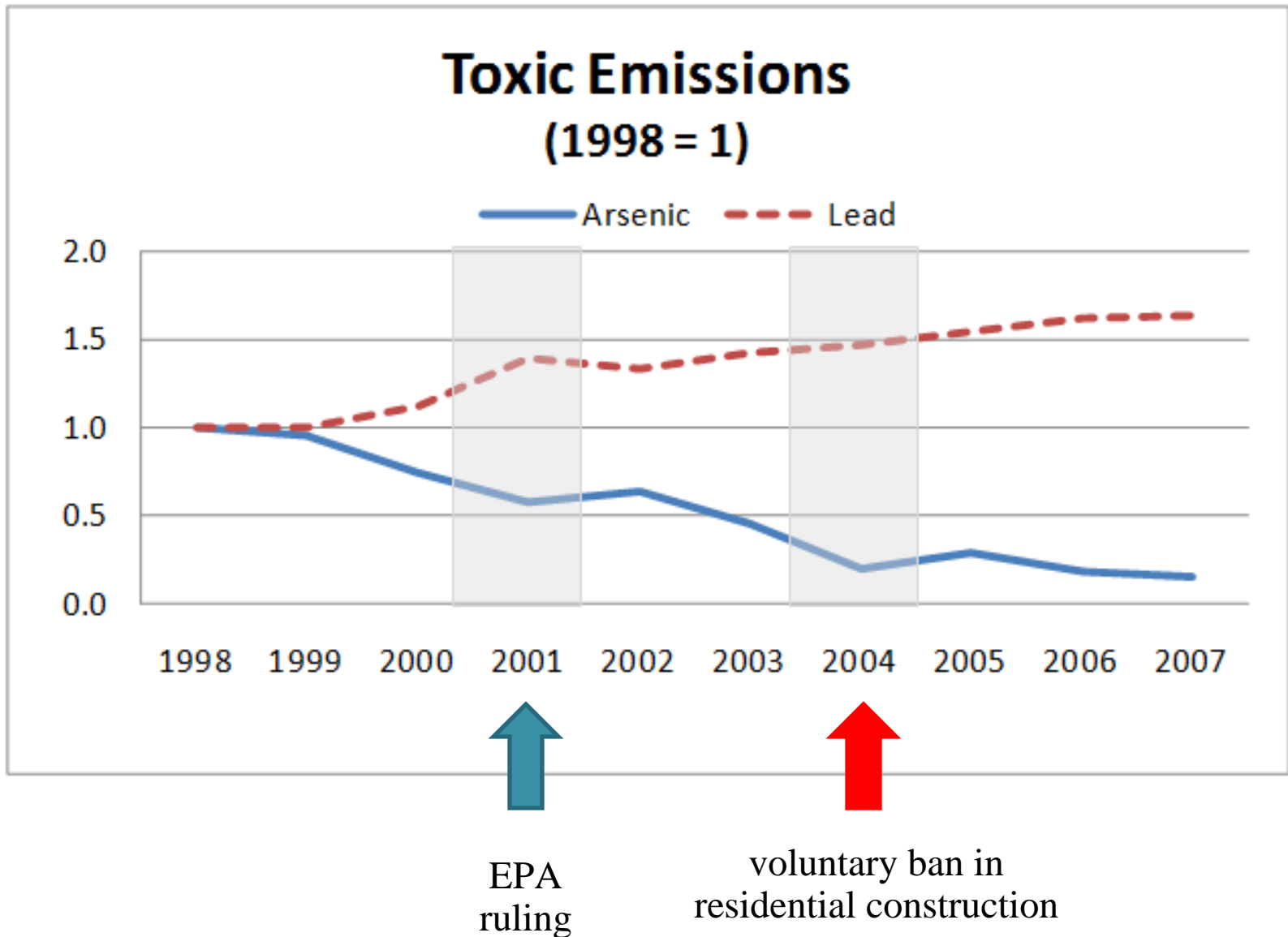
2001 EPA arsenic limit for drinking water



# Arsenic and Lead, 1980-2007



# Arsenic and Lead, 1998-2007



# Estimation Equations

## 1. Treatment: 2001 EPA

$$\ln emissions_t = \beta_0 + \beta_1 \text{postEPA2001}_t + \beta_2 \text{EPA2001}_i + \beta_3 \text{EPA2001treat}_i + \varepsilon_{it}$$

- EPA2001: dummy for being arsenic
- postEPA2001: dummy for intro date
- EPA2001treat: interaction of EPA2001 and postEPA2001

## 2. Treatment: 2004 voluntary ban

$$\ln emissions_t = \beta_0 + \beta_1 \text{postvoluntaryban}_t + \beta_2 \text{voluntaryban}_i + \beta_3 \text{voluntarybantreat}_i + \varepsilon_{it}$$

- voluntaryban: dummy for being arsenic
- postvoluntaryban: dummy for intro date
- voluntarybantreat: interaction of voluntaryban & postvoluntaryban

# D-in-D Results

	$\beta_3$
1. EPA2001treat	-1.416408*** (.245)
2. voluntarybantreat	-1.526137*** (.196)

\*\*\*statistical significance at  $p = 0.001$ .

## Conclusion

- Political economy had more impact than government regulation.
  - WWII
  - Voluntary Ban
- The Safe Drinking Water Act of 1972 & the 2001 EPA ruling decreased arsenic use/emissions.
- All other Federal regulations had little effect!