Effects of Alcohol Prices and Taxes on Alcohol Consumption and Traffic Crash Rates: Meta-analyses of the Literature from 1960 – 2006

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Presenter Disclosures

Alexander C. Wagenaar

Kelli A. Komro

The following personal financial relationships with commercial interests relevant to this presentation existed during the past 12 months:

No Relationships to Disclose

Data Collection—Literature Search

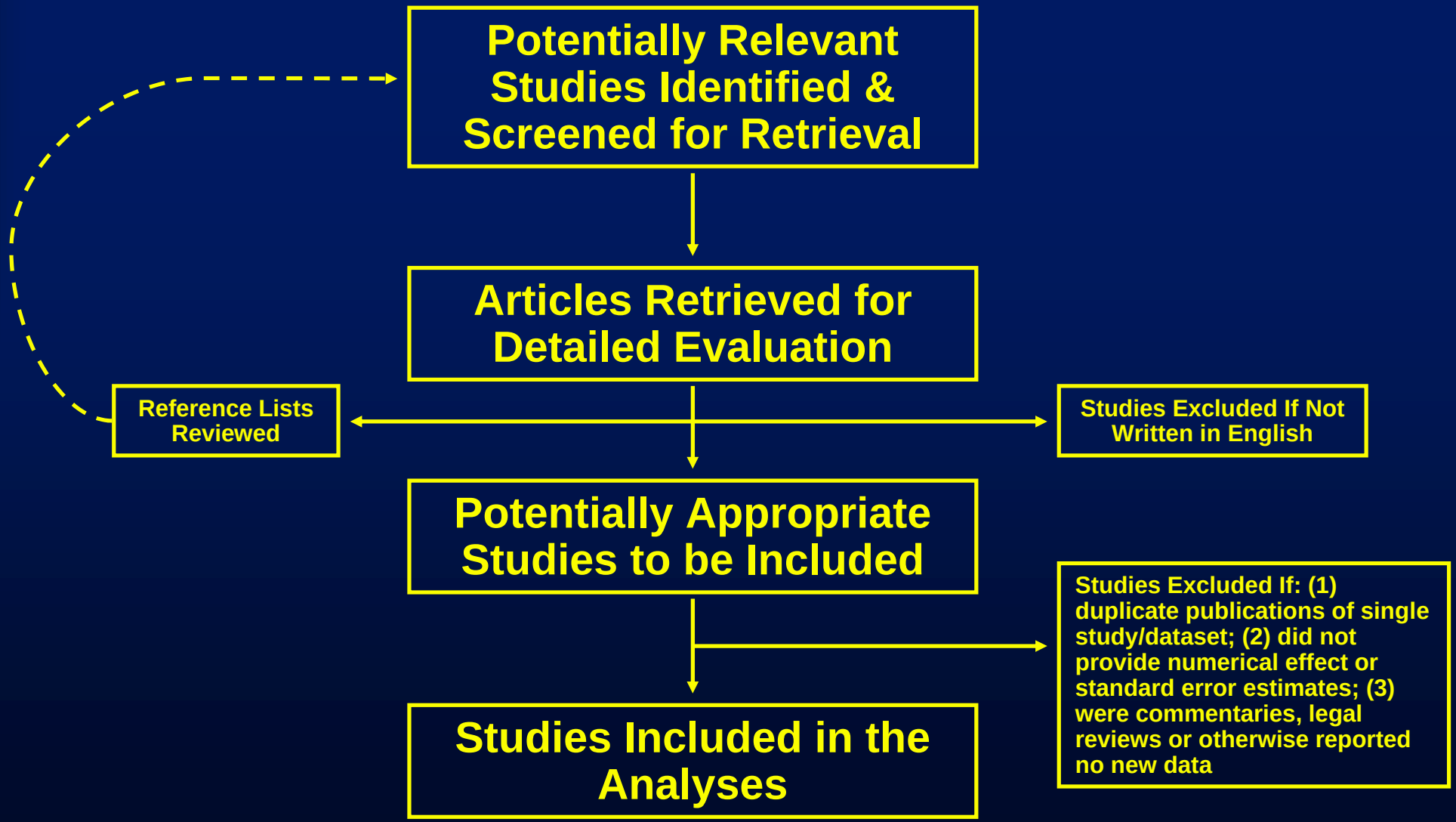
- Comprehensive search of nine databases:
  - AgEcon Search (1960-present)
  - Blackwell-Synergy (1879-present)
  - EBSCO Host (1922-present)
  - JSTOR (1838-present)
  - MEDLINE (1950-present)
  - Springer (1922-present)
  - ScienceDirect (1823-present)
  - ISI Web of Knowledge (1900-present)
  - Wiley (1960-present)

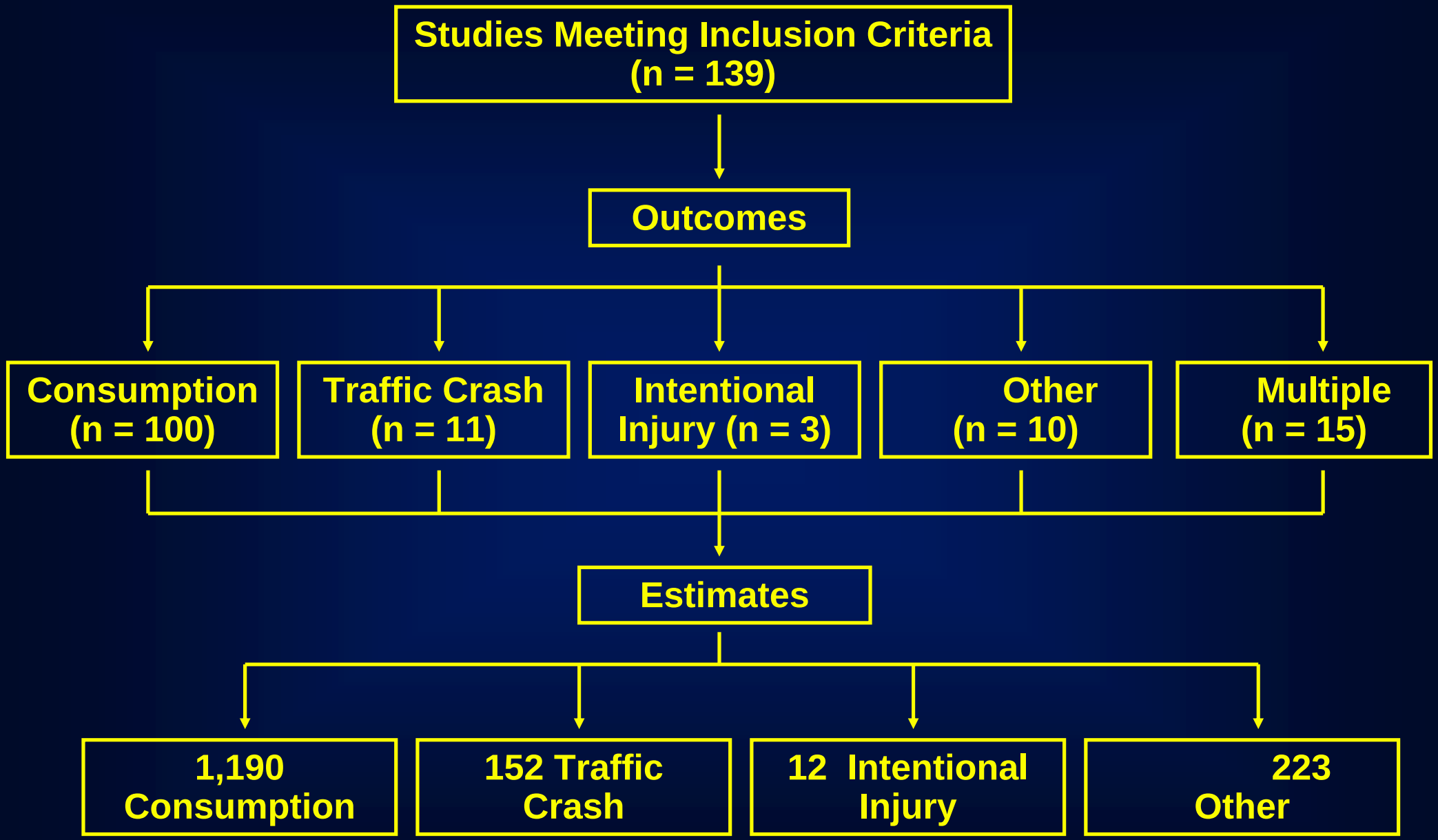
Data Collection—Literature Search

- **Search terms:**

  [(tax OR taxes OR taxation OR cost OR cost* OR price OR prices) AND (alcohol* OR drinking OR liquor OR drunk* OR beer OR wine OR spirits OR malt beverage*)]
- **Entire record for each document included in search**
- **“Snowball” sampling used to locate additional studies**

Data Collection—Literature Search

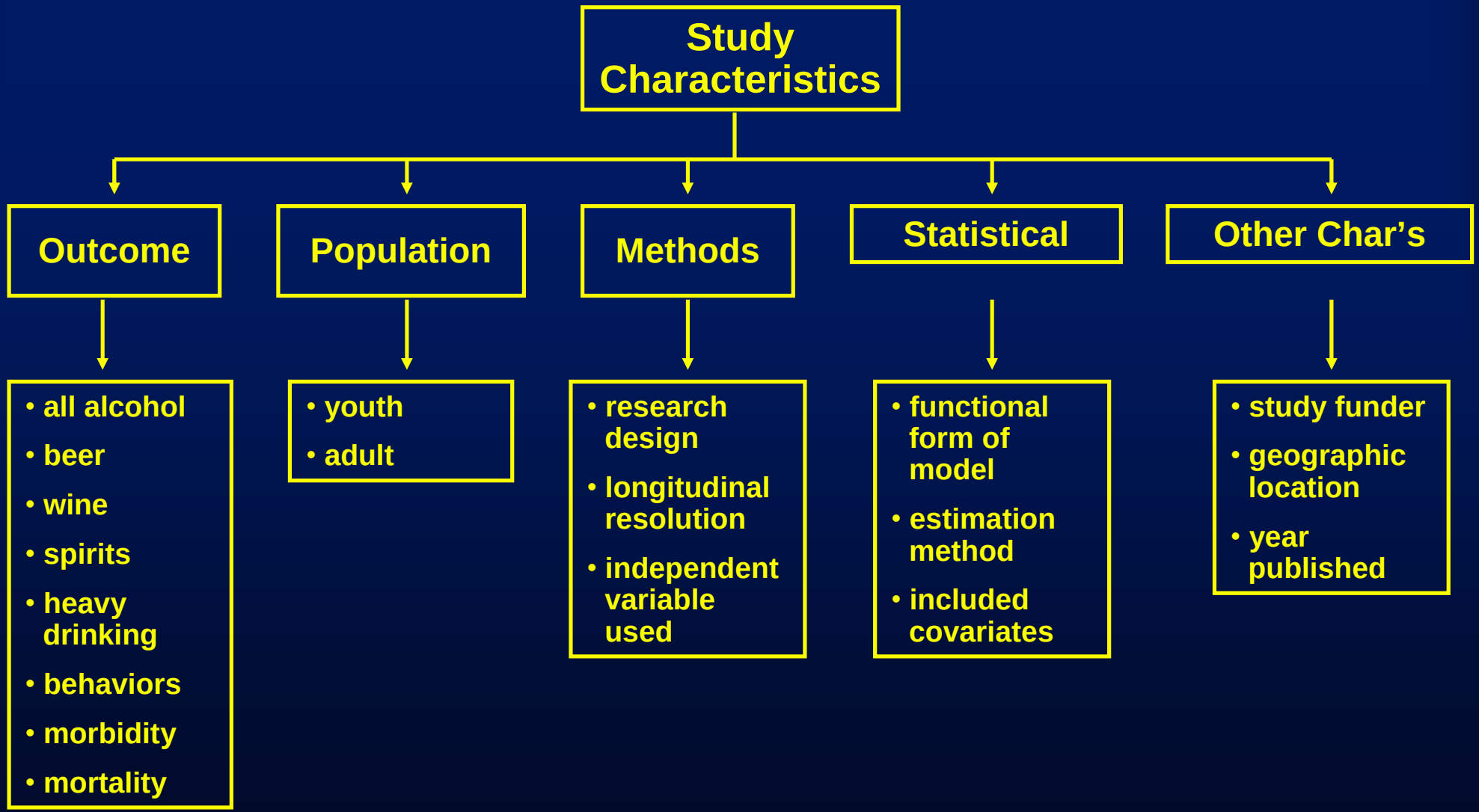



Studies Meeting Inclusion Criteria (n = 139)
Outcomes
Consumption (n = 100)
Traffic Crash (n = 11)
Intentional Injury (n = 3)
Other (n = 10)
Multiple (n = 15)
Estimates
1,190 Consumption
152 Traffic Crash
12 Intentional Injury
223 Other

Coding

- Study findings must be conceptually comparable and in a similar statistical form.
- Two step coding process:
  1. Study characteristics were examined and coded
  2. Estimates of effect coded and converted to uniform effect-size statistic

Population & Study Characteristics



Estimating Standardized Effect Size

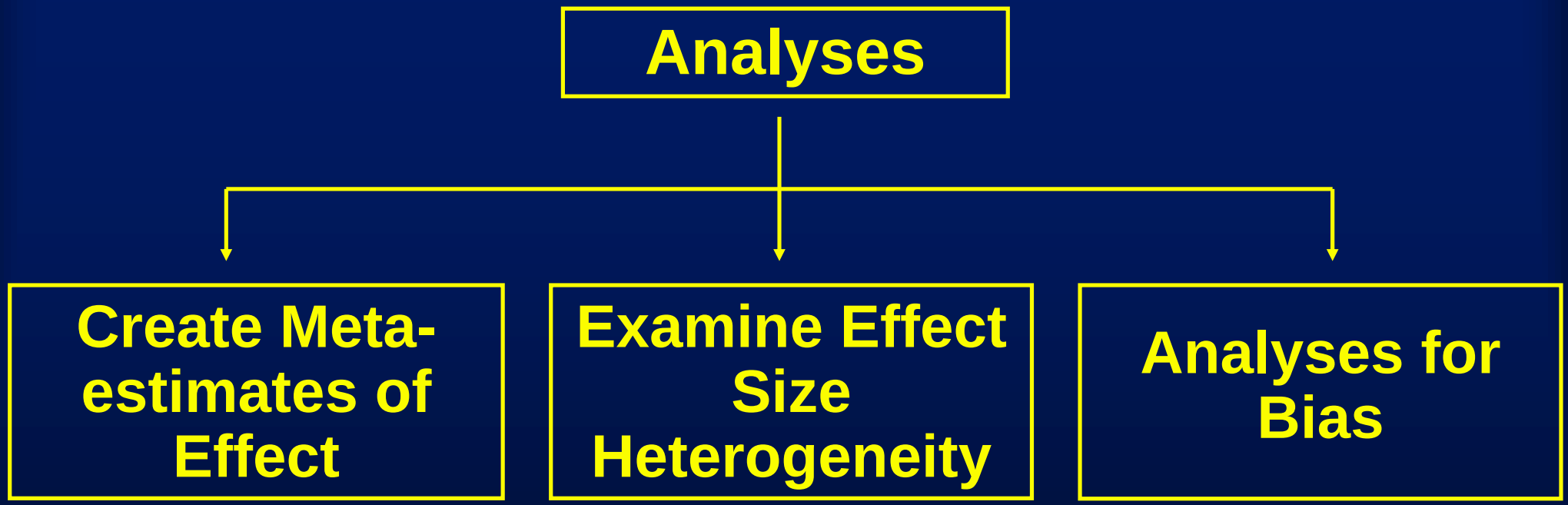
- Estimate standardized effect size *r* for each separate estimate and the standard error

$$r = \sqrt{t^2/(t^2 + (N - 2))} \qquad SE_r = (1 - r^2)*SE_z$$

- Estimate associated Fisher's *Z* transformation for each

$$ES_z = .5\log_e[(1 + r)/(1 - r)] \qquad SE_z = 1/\sqrt{n - 3}$$

Statistical Analyses



Creating Meta-estimate of Effect

- Identify sets of statistically independent and non-independent estimates
  - Intra-study non-indep effect sizes were averaged
  - Inverse variance weight applied to each independent effect size:

$$w_i = \frac{1}{v_i} \qquad \text{where} \qquad v_i = SE_i^2$$

Creating Meta-estimate of Effect

- **Evaluated effect size distribution for outliers and determined need for trimming or Windsorizing.**
- **Computed weighted mean effect size by:**

$$\overline{ES} = \frac{\sum (w_i * ES_i)}{\sum w_i}$$

ES_i : values of the individual effect sizes

w_i : inverse variance weight for each effect size I

i : equal to 1 to k, with k being the number of effect estimates

Test for Homogeneity

- **Based on the Q statistic:**

$$Q = \sum w_i (ES_i - \overline{ES})^2$$

ES_i: individual effect size for i = 1 to k

$\overline{ES}$: weighted mean effect sizes over k effect sizes

w_i : individual weight for effect for ES_i

- **Distributed as a chi-square with $df = k - 1$**
- **Statistically significant Q indicates a heterogeneous effect size distribution**

Random Effects Model

- **Observed significant study-level heterogeneity (Q=63, df=15, p<.001), therefore adopted a random-effects model**
- **Variance becomes a function of study-level sampling error and random, between-studies variance**

$$v_i^* = v_i + \tau^2$$

$$\tau^2 = Q - (k - 1) / \Sigma w_i - (\Sigma w_i^2 / w_i)$$

v_i : subject level sampling error

τ^2 : random variance component

Q : value of homogeneity test

k : number of effect sizes

w_i : inverse variance weight for each effects size defined under fixed-effects model

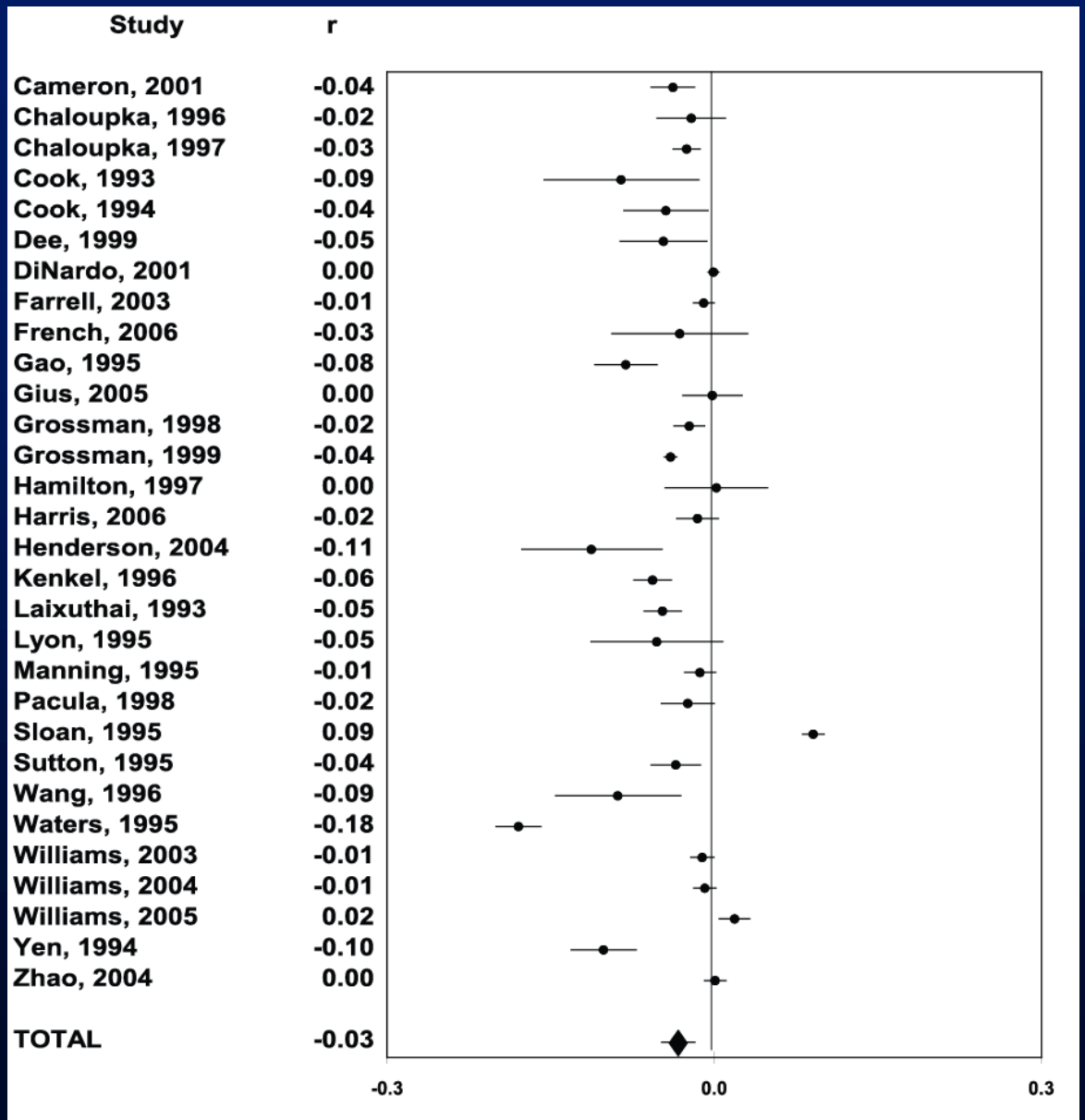
Random Effects Model

- Inverse variance weight applied becomes $w_i^* = 1 / v_i^*$ and $\overline{ES}$ is recomputed
- Standard error of $\overline{ES}$ computed as $SE_{\overline{ES}} = \sqrt{1 / \sum w_i^*}$
- 95% confidence interval constructed as

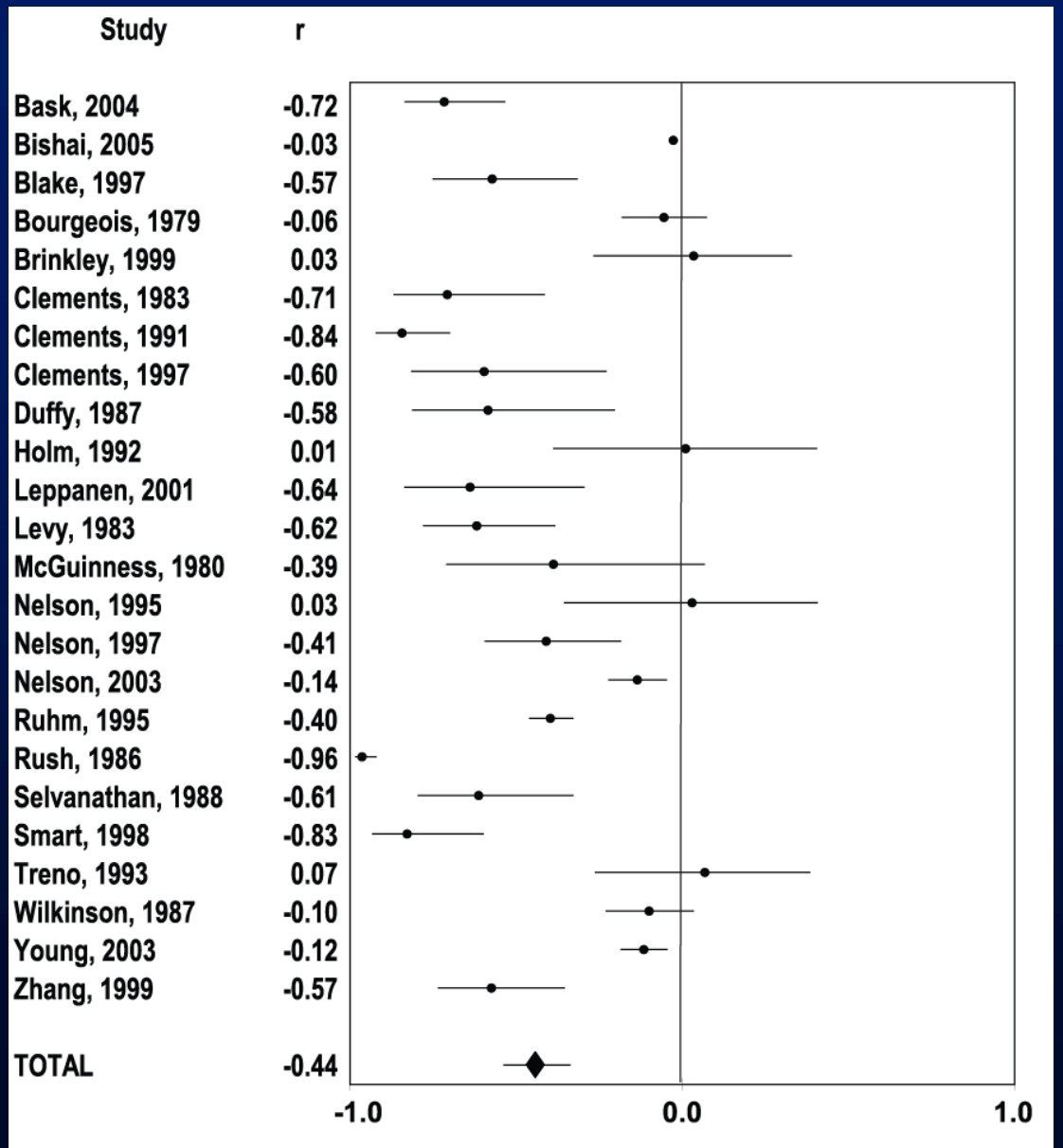
$$\overline{ES} \pm Z_{(.95)}(SE_{\overline{ES}})$$

- Significance of $\overline{ES}$ obtained by $z = |\overline{ES}| / SE_{\overline{ES}}$

Effects of Price on Alcohol Consumption: Individual-level Studies



Effects of Price on Alcohol Consumption: Aggregate-level Studies



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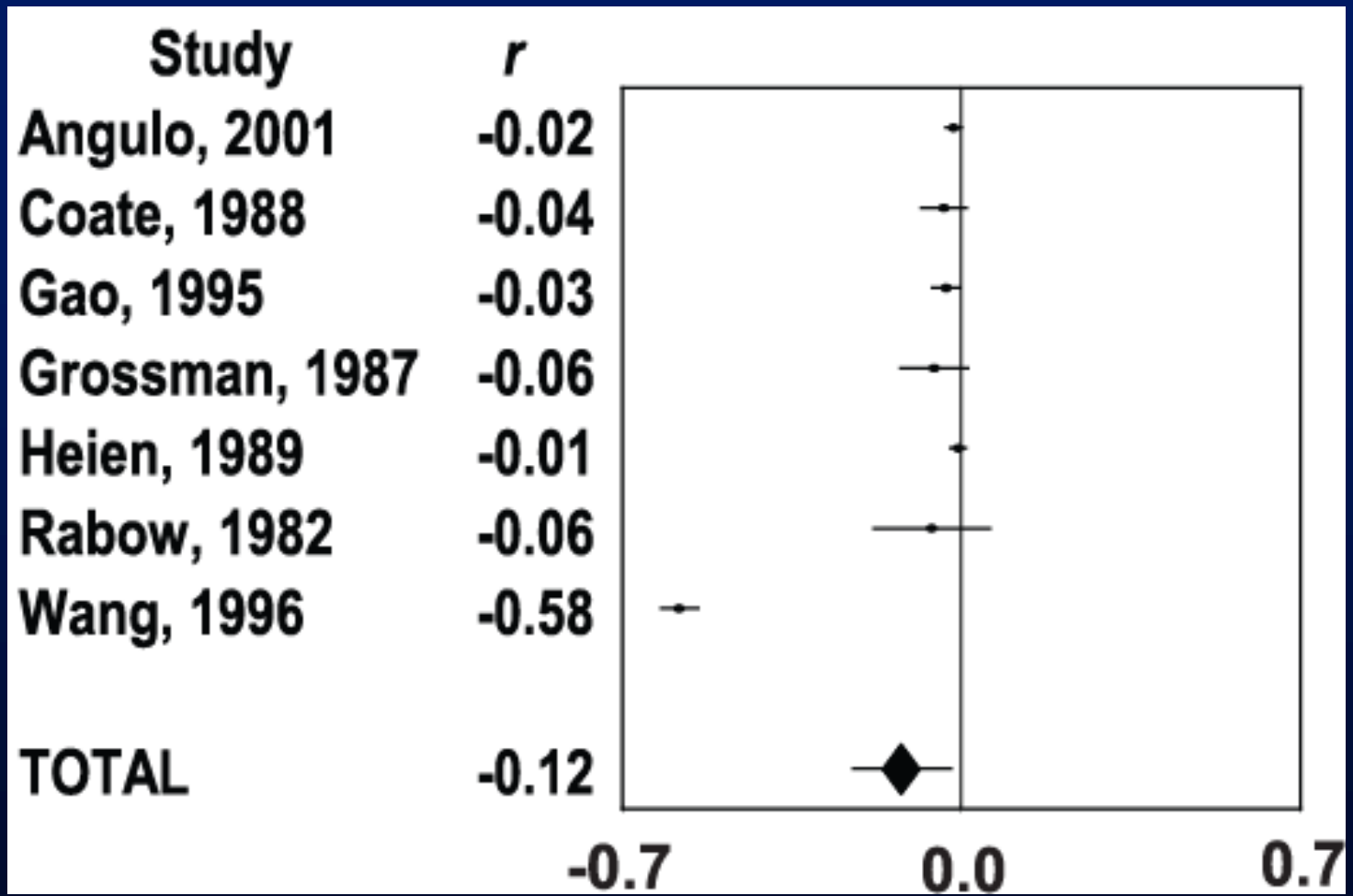
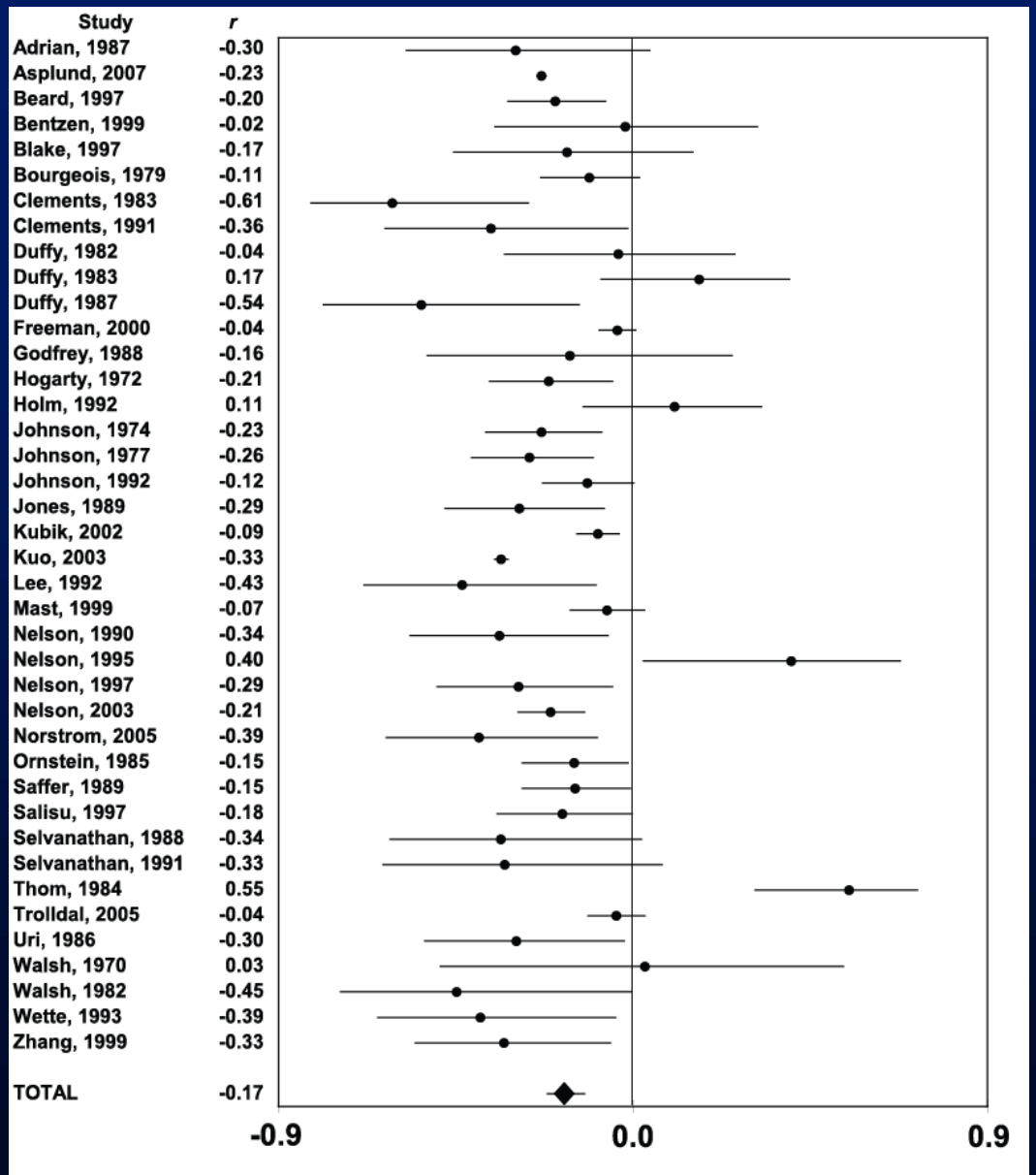
Effects of Price on Beer Consumption: Individual-level Studies



Effects of Price on Beer Consumption: Aggregate-level Studies



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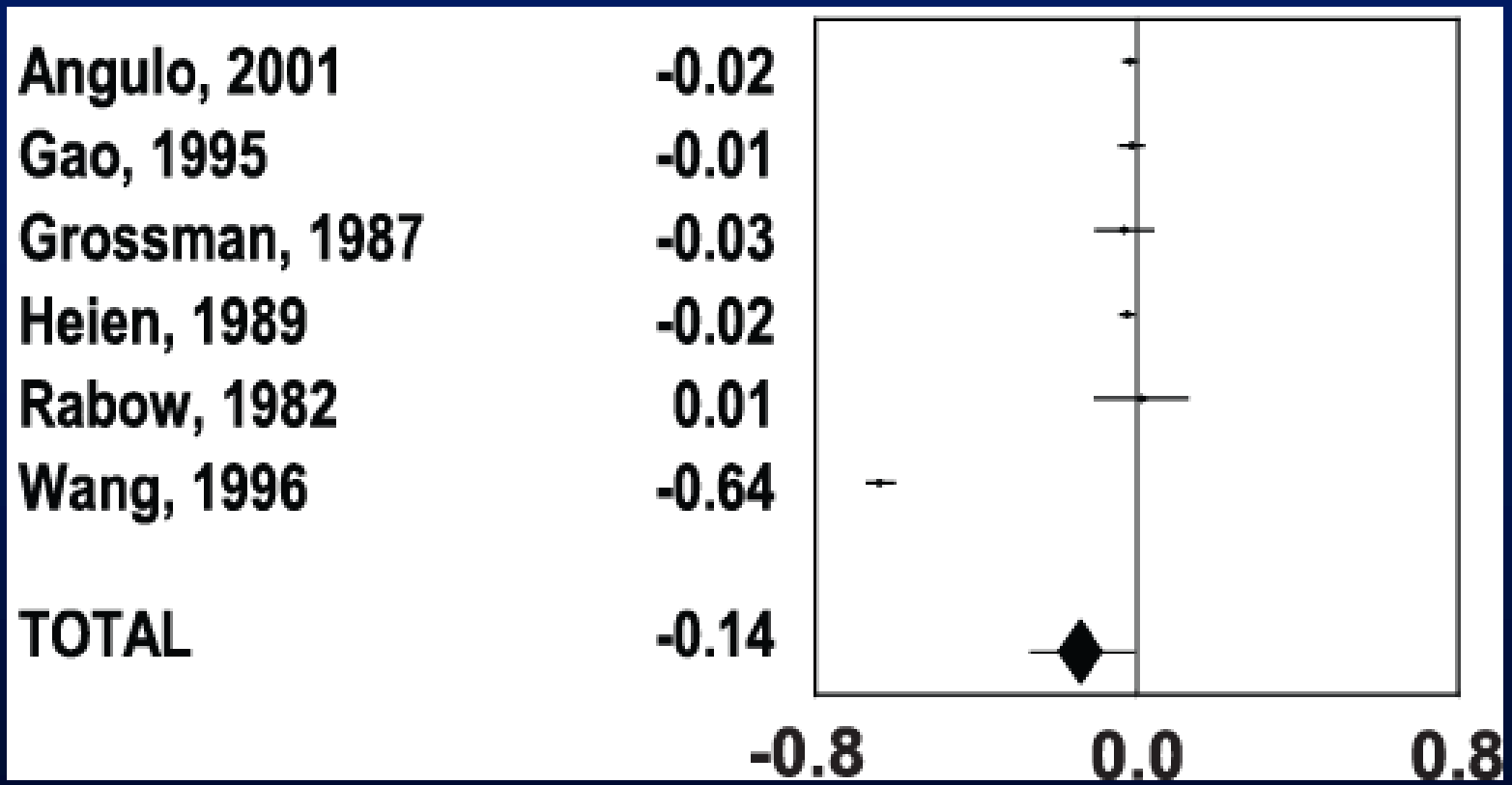
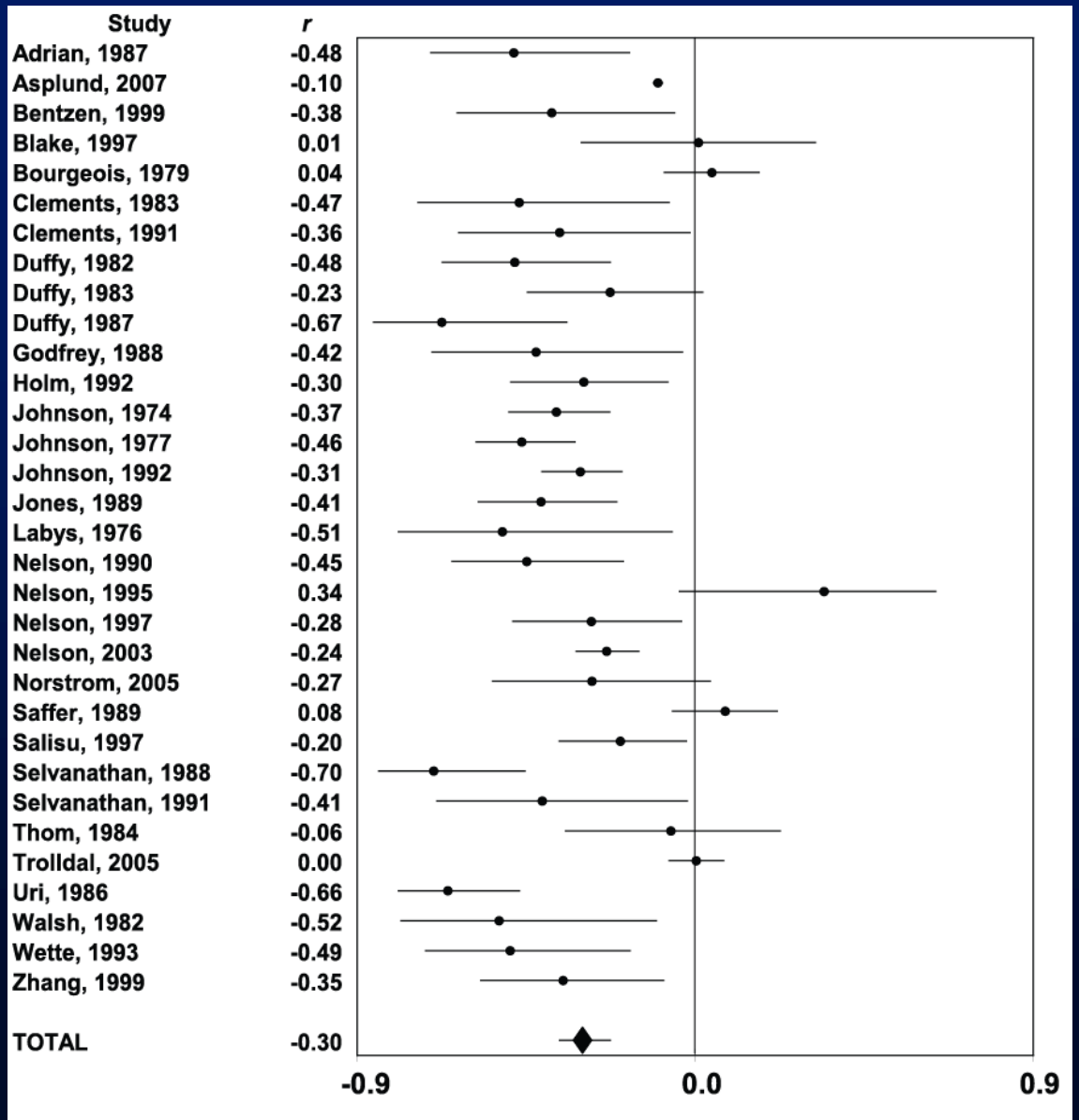
Effects of Price on Wine Consumption: Individual-level Studies



Effects of Price on Wine Consumption: Aggregate-level Studies



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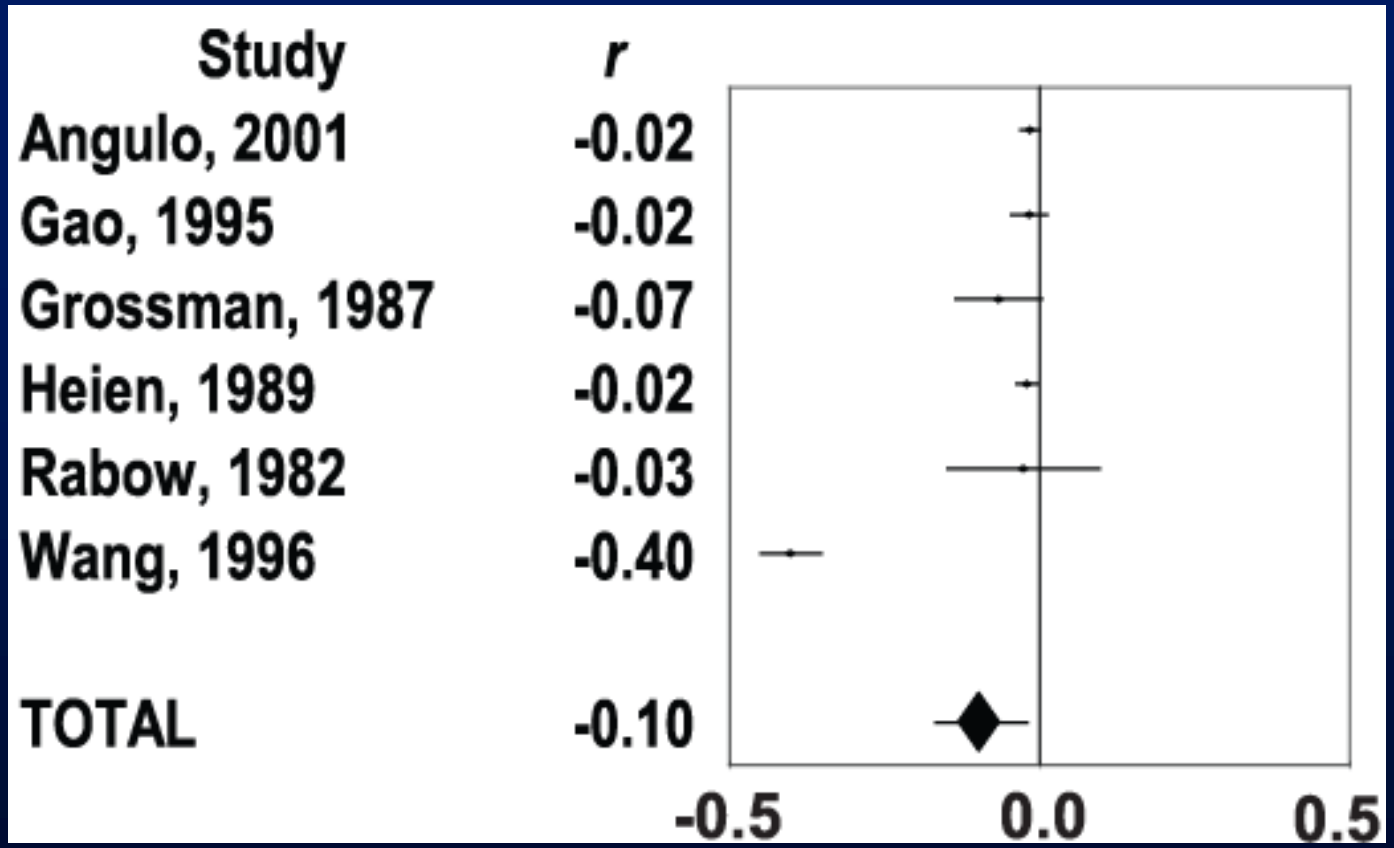
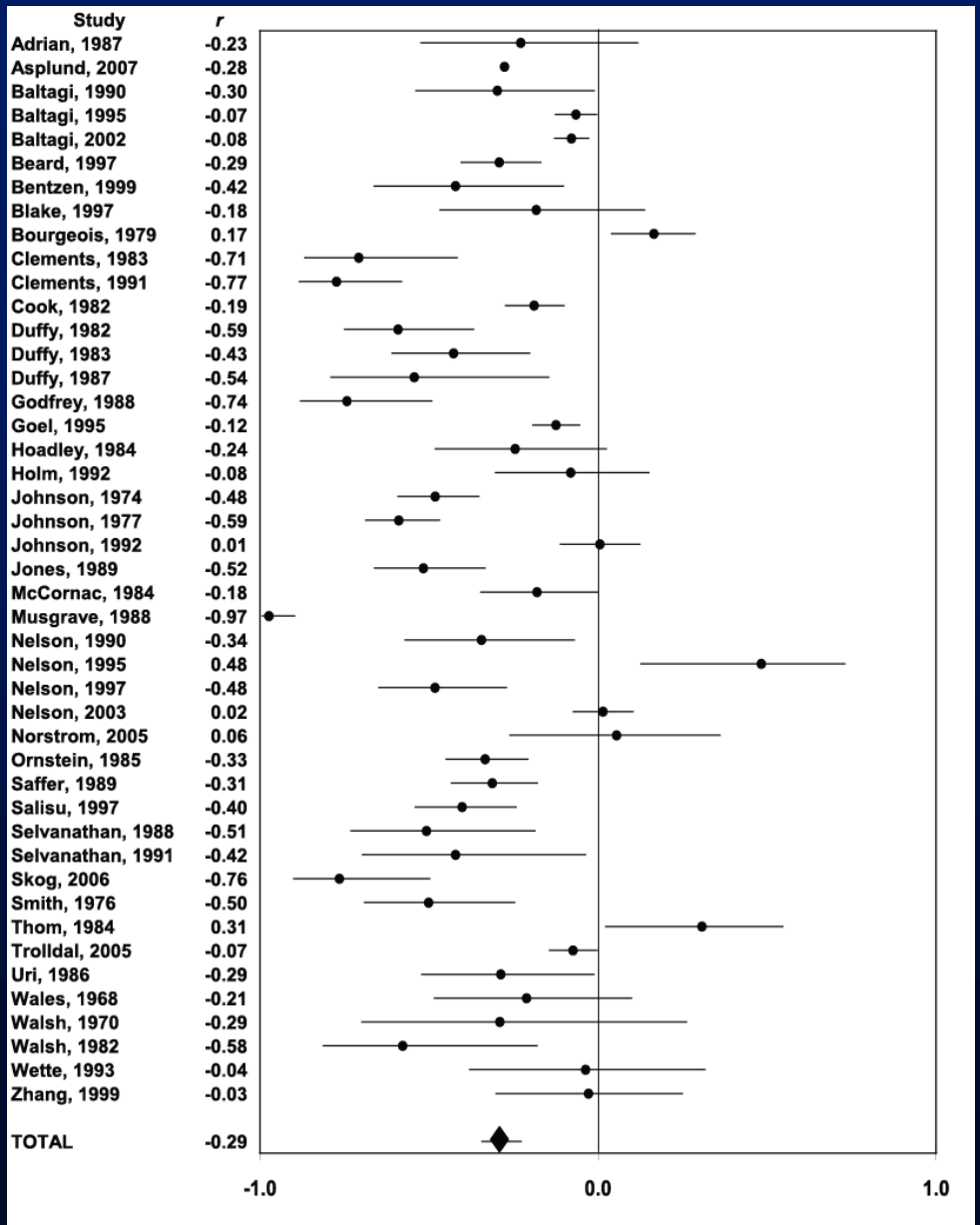
Effects of Price on Spirits Consumption: Individual-level Studies



Effects of Price on Spirits Consumption: Aggregate-level Studies



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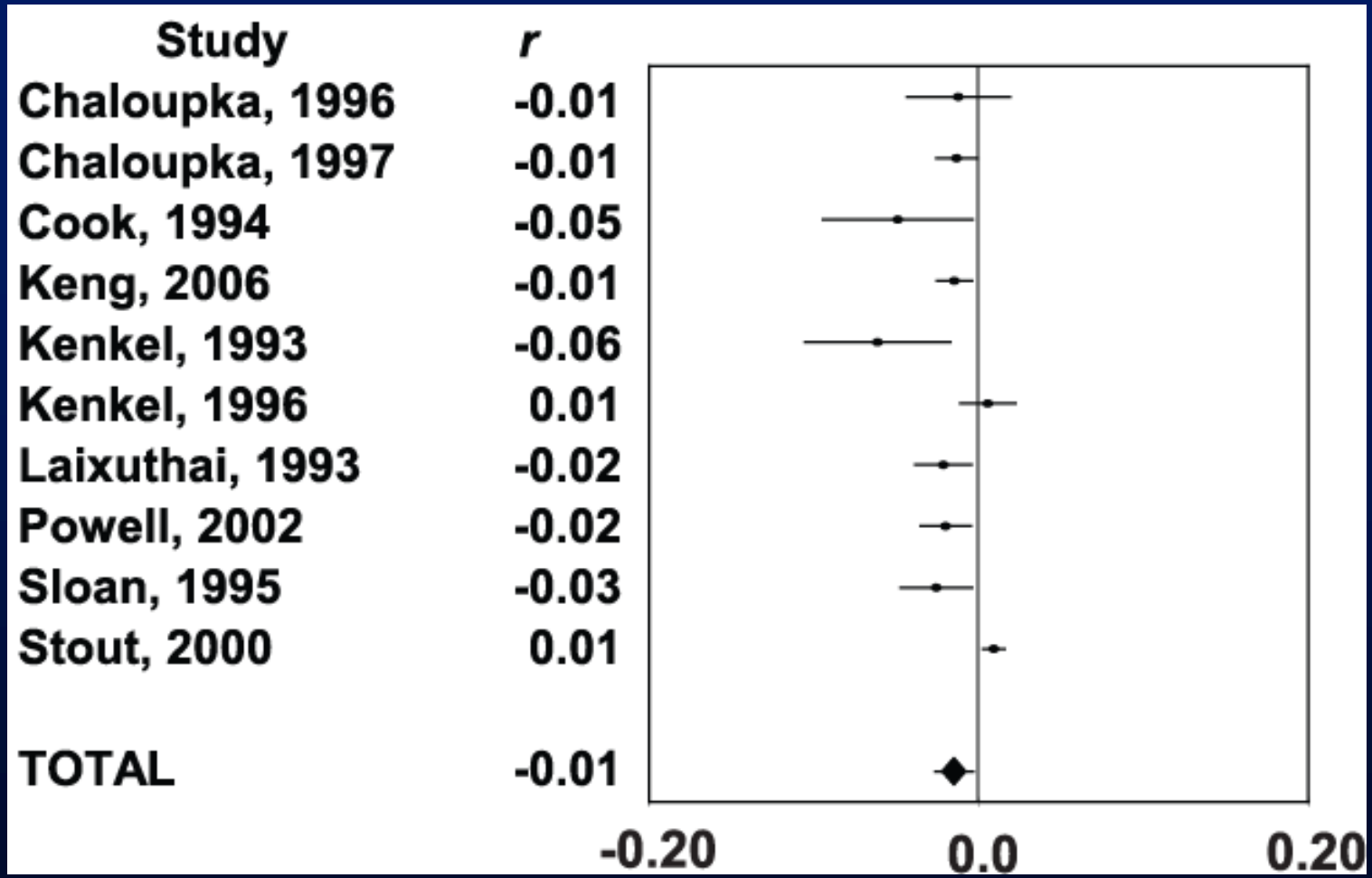
Effects of Price on Heavy Alcohol Use (All Individual-level Studies)



Conclusions—Alcohol Consumption

- Evidence for inverse relationship between alcohol taxes/prices and drinking is *very* strong
- 10% increase in price reduces drinking by 5%
- Magnitude of observed effects is large
- Many more studies than on other prevention efforts
- Larger, more consistent effects than other prevention efforts
- Taxes/prices affect drinking by all groups:
  - Youth as well as adults
  - Heavy as well as moderate drinkers
- Large effects and universal coverage of such policies mean they are important for public health and social well-being

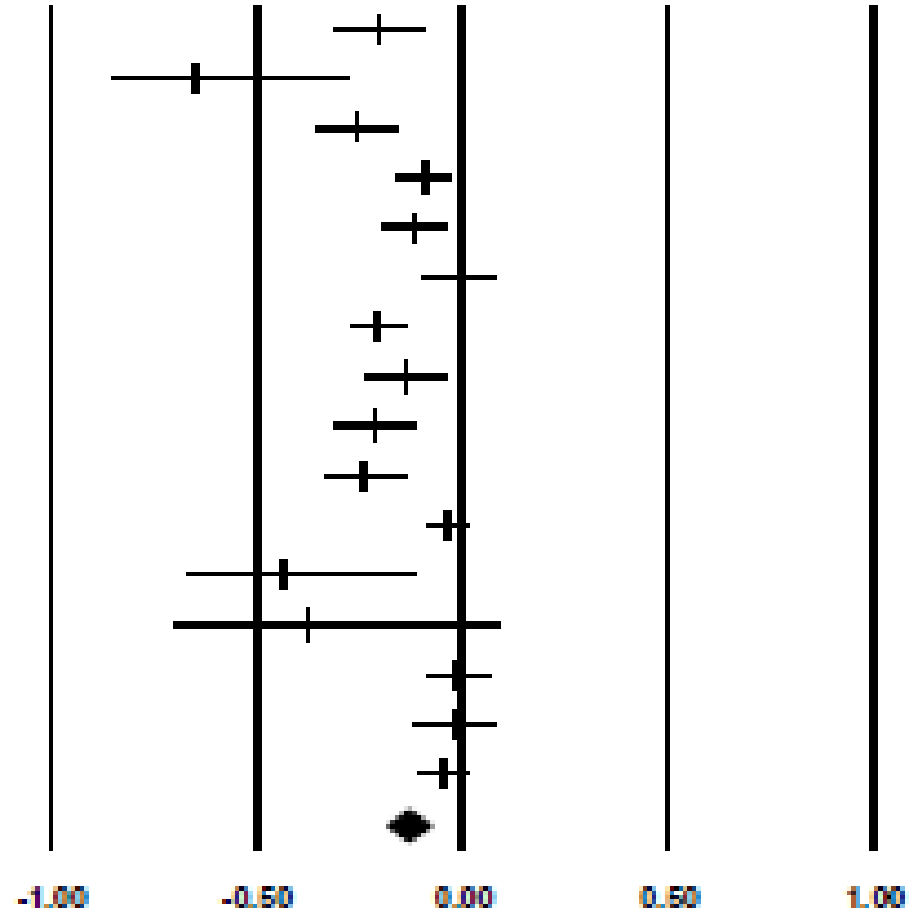
Study Details

Study	IV	Outcome	Long. N	Cross-sect'l N	Years
Saffer, 1989	Tax	Nighttime MV fatality	6	14	1970-1983
Adrian, 2001	Price	A-R driver MV fatality	19	1	1972-1990
Chaloupka, 1993	Tax	A-R driver MV fatality	7	48	1982-1988
Dee, 1999	Tax	A-R driver MV fatality	16	48	1997-1992
Evans, 1991	Tax	SVN	12	50	1975-1986
Mast, 1999	Tax	A-R driver MV fatality	9	48	1984-1995
Ruhm, 1995	Tax	Total MV fatality	14	48	1975-1988
Ruhm, 1996	Tax	Total miles MV fatality	7	48	1982-1988
Saffer, 1987a	Tax	Total MV fatality	7	48	1975-1981
Saffer, 1987b	Tax	Total MV fatality	7	48	1975-1981
Sloan, 1994	Price	Total MV fatality	7	48	1982-1988
Smart, 1998	Price	A-R driver MV fatality	19	1	1975-1993
Whetten-Goldstein, 2000	Price	A-R driver MV fatality	12	50	1984-1995
Young, 2000	Tax	A-R driver MV fatality	9	48	1982-1990
Young, 2006a	Price	Total MV fatality	19	48	1982-2000

Note: All but Saffer, 1989 are longitudinal studies conducted at the state/province level.

Results

Study name	Correlation	Lower limit	Upper limit	Z-Value	p-Value
Sattler, 1989	-0.20	-0.31	-0.09	-3.51	0.00
Adrian, 2001	-0.65	-0.85	-0.28	-3.10	0.00
Chaloupka, 1993	-0.26	-0.35	-0.16	-4.85	0.00
Dea, 1999	-0.09	-0.16	-0.02	-2.50	0.01
Evans, 1991	-0.11	-0.19	-0.03	-2.80	0.01
Mast, 1999	-0.01	-0.10	0.09	-0.19	0.85
Ruhm, 1995	-0.21	-0.28	-0.13	-5.31	0.00
Ruhm, 1996	-0.14	-0.24	-0.03	-2.51	0.01
Sattler, 1987a	-0.21	-0.31	-0.11	-3.91	0.00
Sattler, 1987b	-0.24	-0.34	-0.13	-4.43	0.00
Sattler, 1997	-0.03	-0.09	0.02	-1.15	0.25
Sloan, 1994	-0.44	-0.67	-0.11	-2.60	0.01
Smart, 1998	-0.37	-0.71	0.10	-1.57	0.12
Whatley-Goldstein, 2000	-0.01	-0.09	0.07	-0.27	0.79
Young, 2000	-0.02	-0.12	0.08	-0.37	0.72
Young, 2005a	-0.05	-0.11	0.02	-1.40	0.16
Summary	-0.13	-0.18	-0.08	-5.05	0.00



Conclusions—Traffic Crashes

- Beverage alcohol taxes are significantly related to crash involvement
  r = .13
- A one standard deviation increase in tax is related to a 0.13 standard deviation decrease in alcohol-related fatal traffic crashes
- Beer tax increase of 14 cents per liter (a 24% increase) related to decline in fatal a-r crashes of 3.3 per year per state (a 3% decline)
- Elasticity: 10% increase in tax related to 1.3% decline in a-r crashes
- Policies that raise taxes on alcoholic beverages reduce the burden of alcohol-related automobile crashes, injuries and deaths.

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Effects of Alcohol Tax Increases on Alcohol-Related Disease Mortality in Alaska: Time-Series Analyses from 1976 to 2004

American Journal of Public Health, 2009

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Institute for Child Health Policy

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Research Design

Experimental (Alaska)	O_{t1}	O_{t2}	. . .	O_{tm}	X_1	O_{tm+1}	. . .	O_{tm+n}	X_2	O_{tm+n+1}	. . .	O_{t116}
Comparison (other states)	O_{t1}	O_{t2}	O_{t3}	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	O_{t116}

O_t : Observation at given time t, with each t being one quarter of a calendar year

X_1 : Increase in alcohol tax in August 1983

X_2 : Increase in alcohol tax in October 2002

m : Number of quarterly observations before first tax increase (m=30)

n : Number of quarterly observations after first tax increase and before the second tax increase (n=77)

Measurement

Alaska Alcohol Excise Tax Changes

August, 1983:

- **Beer ↑ from $0.25 to $0.35 per gallon**
- **Wine ↑ from $0.25 to $0.35 per gallon**
- **Spirits ↑ from $4.00 to $5.50 per gallon**

October, 2002:

- **Beer ↑ to $1.07 per gallon**
- **Wine ↑ to $2.50 per gallon**
- **Spirits ↑ to $12.80 per gallon**

Measurement

- **Alcohol-related Mortality Outcomes**
  - **Alcohol-caused mortality (AAF = 1.0)**
  - **Alcohol-related mortality (0.35 < AAF < 1.0)**

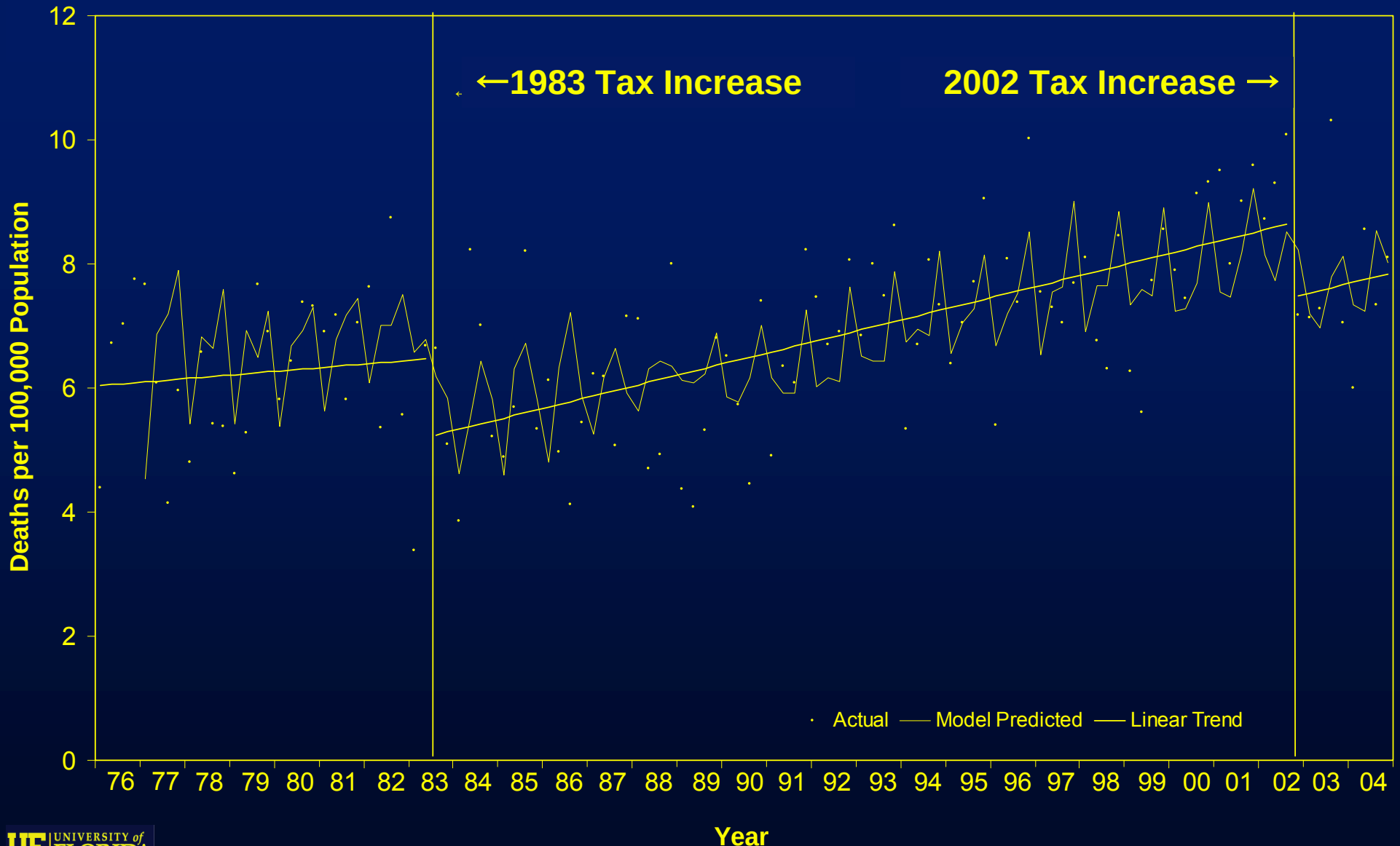
Source: National Vital Statistics System

ARIMA plus Structural Model

$$(1 - B^4)Y_{it} = \alpha + \omega_1 I_{1t} + \omega_2 I_{2t} + \psi_i X_i + \beta Z_t + (1 - \Theta B^4)u_t$$

- $Y_{i=1}$ to $Y_{i=3}$ three outcomes
- t_1 to t_{116} quarter (1976 – 2004)
- ω_1 effect of 1983 tax increase
- I_{1t} 1983 tax increase step function
- ω_2 effect of 2002 tax increase
- I_{2t} 2002 tax increase step function
- ψ_i effects of outliers
- X_i outliers
- β effect of Z_t
- Z_t frequency (or rate) of alcohol-related disease in comparison states
- θ first-order moving average
- Θ first-order seasonal moving average
- u_t random (white noise) error
- B backshift operator such that $B(y_t)$ equals y_{t-4}

Rate of Quarterly Alcohol-related Disease Mortality per 100000 Population Aged 15 Years and Older



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Press Coverage

- ABC Broadcast News “Medical Minute”
- Bloomberg News
- Chicago Tribune
- CNN, CNN Radio, CNN International
- Denver Post
- Detroit Free Press
- Los Angeles Times
- Medical News Today
- NewScientist
- Science Daily
- U.S. News & World Report
- Washington Post

"Expensive Booze Could Lower Alcohol-linked Deaths"

"Raising Alcohol Taxes Shown to Reduce Deaths"

"Alcohol Disease Mortality Decreases After Tax Increases"

"When Alcohol Taxes Go Up, Deaths Go Down"

"Study Correlates Death by Drinking, Price of Alcohol"

"Study Suggests Alcohol Taxes Affect Death Rate"

"Cheap Booze Can Lead to More deaths"

"Study: Paying More for Alcohol Saves Lives"

"Where Booze Costs the Most, Fewer People Die"

"Higher Alcohol Taxes Reduce Alcohol-related Mortality"

"Raising the Tax on Alcohol May Actually Save Lives"

"Why Charging More for Alcohol Could Save Lives"

"High Taxes Better Way to Lower Risk of Alcohol-related Death"

Some of the States with Alcohol Tax Bills

- AR: SB 90
- HI: SB 42
- ID: HB 12
- IN: HB 129 & HB 1613
- KS: HB 2062
- NE: LB 59
- NY: HB 2454
- SD: HB 1038
- TX: SB 462

CA: Governor proposed
NM: Debates underway
FL: Media discussions

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