

Water Use Adaptation and the Role of Demand Side Management.

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A horizontal banner with a dark blue background. On the left, there is a small image of a green leaf with water droplets. The text "Environmental Economics Research Hub" is centered in white.

Environmental Economics Research Hub

Prices vs. Restriction Revisited

- Urban water management ongoing issues in Australia.
- Policy response has been combination of price, restrictions and awareness campaigns.
- Economics literature in consensus in favor of prices
- We do an empirical analysis in combination with presenting psychological insight

Canberra residents urged to conserve water

*Posted Sun Mar 1, 2009 2:00pm AEDT
Updated Sun Mar 1, 2009 2:14pm AEDT*

A new target has been set for Canberra residents' daily average water consumption.

From today, the target for each person is to use less than 112 litres per day.

The average consumption across last week was 163 litres per day.

Chris Hare from ACTEW says the target has been lowered because less water is used during the cooler months

"It's very important that we try and meet our target water usage. When we're in quite serious restrictions like we are at the moment, those targets are crucial for ensuring we have a very long-term water supply," he said.



The average consumption across last week was 163 megalitres per day. (ABC News: Giulio Saggin, file photo)

Research Question

- How well do today's different demand side management tools work?
 - The role of prices.
 - Can we estimate the relevant price elasticity?
 - What are the effects of non-market management tools?
 - Introduction of roadside LED signs and other awareness campaigns
 - Water usage targets
 - Water restrictions

Literature

Prices v. Restrictions

- Grafton & Ward (2008)
 - General consensus in the economics literature about the superiority of price for long-term demand management
 - Estimated price elasticity may be optimistic

Other demand management tools

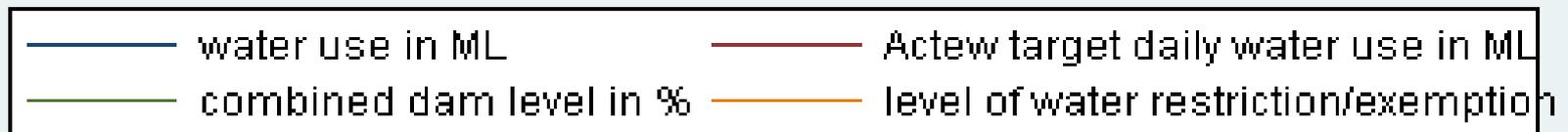
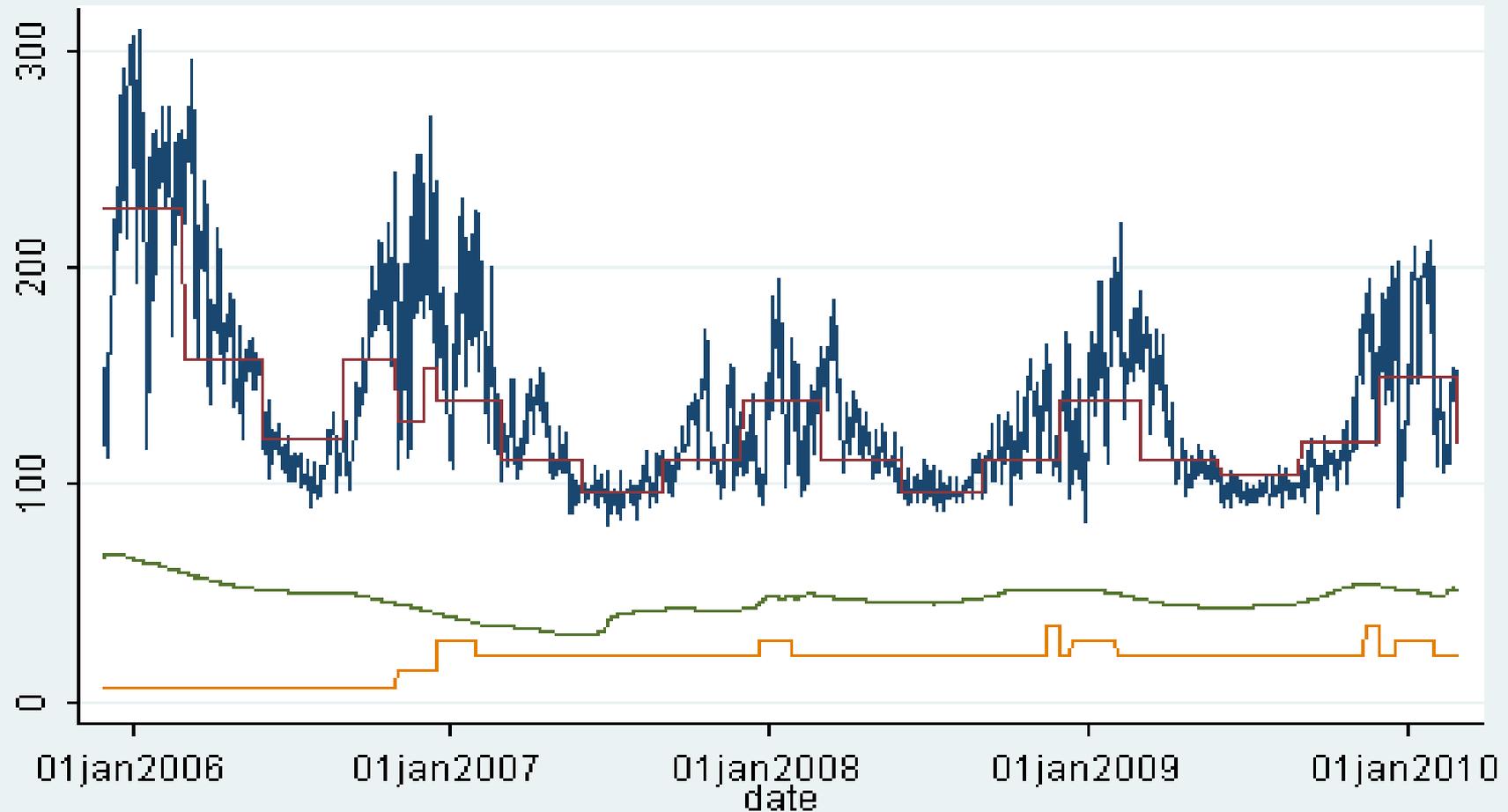
- Yardley (2009) finds road users in ACT observed and respond to roadside water signs

Data

- Daily water usage, dam level, prices, restrictions from ACTEW
- Weather data from the Bureau of Meteorology
 - Includes: precipitation, evaporation, max & min temperatures, sunshine hours, wind, humidity

 merged data set with 4 ½ years of daily data from December 2005 through March 2010

ACT water usage, dam levels, water restrictions and targets.



Summary statistics

| | | 2006 | 2007 | 2008 | 2009 |
|------------------------|------|-------|-------|-------|-------|
| Usage (ML) | mean | 169 | 121 | 120 | 126 |
| | min | 89.5 | 82.1 | 88.1 | 87.1 |
| | max | 309.4 | 231.9 | 195.3 | 220.4 |
| Dam level (%) | mean | 51.8 | 38.2 | 48.3 | 47 |
| | min | 39.1 | 30.8 | 45.3 | 43 |
| | max | 66.1 | 48.2 | 52.1 | 54 |
| Total rain (mm) | | 361.2 | 568.4 | 482 | 440 |
| Total rain days | | 71 | 109 | 90 | 101 |
| Marginal Cost in \$/KL | | 1.75 | 2.19 | 3.06 | 3.83 |

Empirical Specification

$$\ln(y_t) = \alpha_1 \ln(\text{price}_t) + \alpha_2 \text{damlevel}_t + \alpha_3 \text{signs}_t + X_t \delta + \varepsilon_t$$

y_t – Water usage in ML at date t in the ACT

price_t – Marginal price of KL of water in 2009 \$AU

damlevel_t – Dam level in decimal percentiles

signs_t – Introduction of roadside LED signs

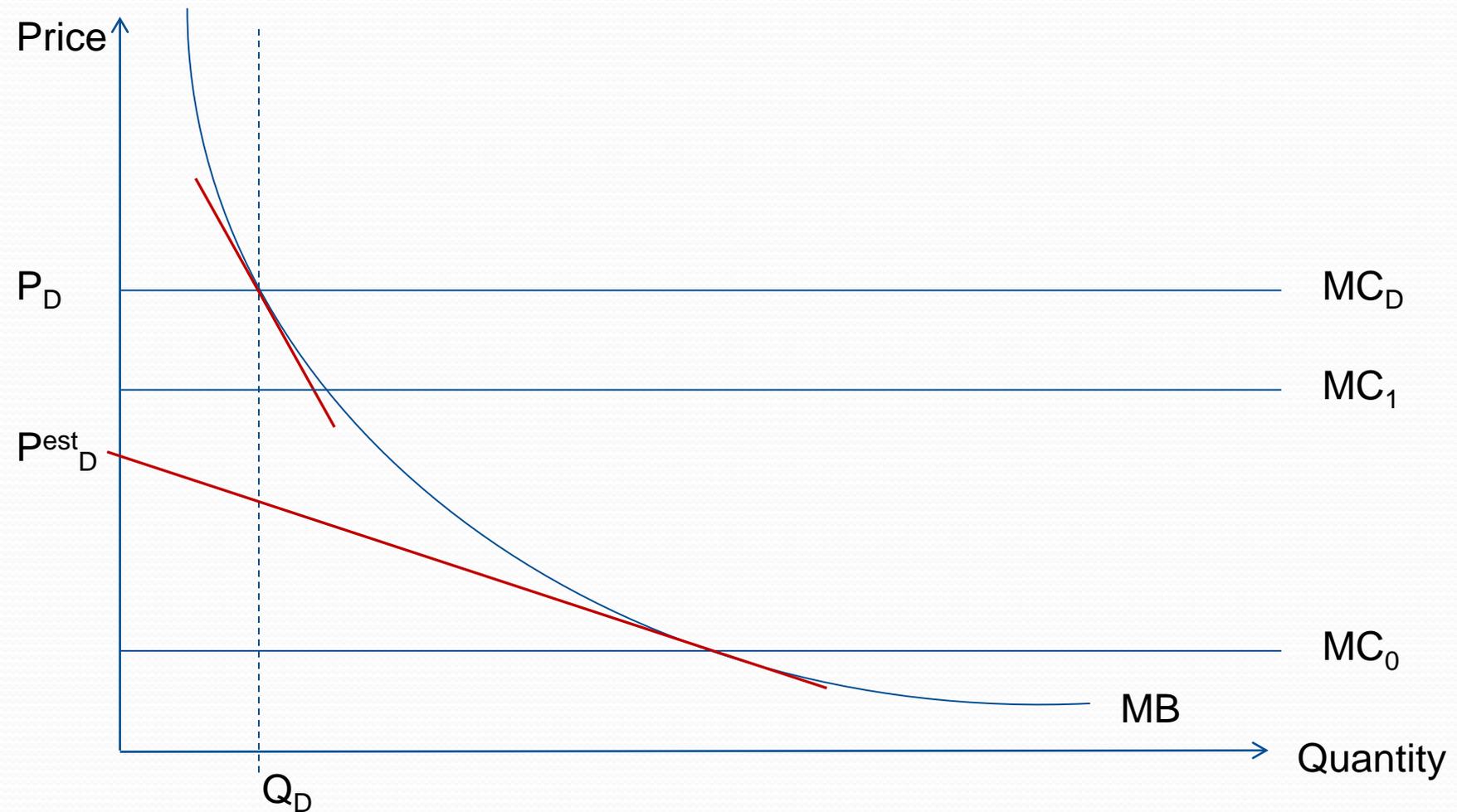
X_t – Weather controls: rainfall (incl. 5 lags & ma); sun hours; evaporation (incl. 3 lags & ma); max temp (1 lag); weekdays; month; and restriction levels

Regression Results

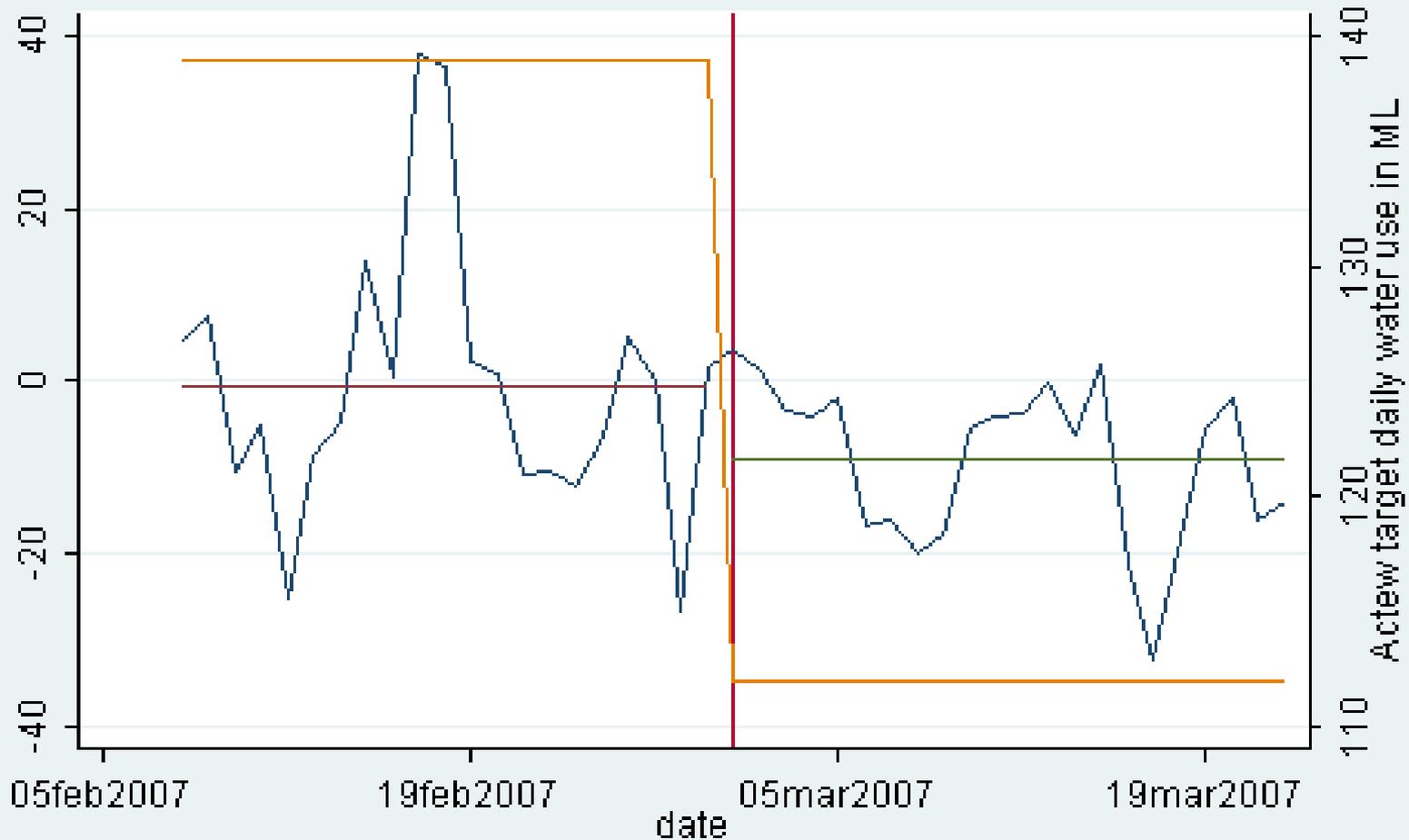
| | (1) | (2) | (3) | (4) |
|----------------------|----------------------|---------------------|---------------------|-----------------------|
| | water use in | water use in | water use in | water use in |
| | ML (ln) | ML (ln) | ML (ln) | ML (ln) |
| Marginal cost (ln) | -0.252*** (-8.72) | 0.00182 (0.07) | -0.0144 (-0.33) | -0.000834 (-0.02) |
| Roadside signs | | | 0.0108 (0.45) | -0.0723*** (-2.64) |
| Dam level in % | | | | 0.00774*** (5.16) |
| Stage 1 restrictions | | 0.262*** (13.59) | 0.260*** (13.25) | 0.132*** (4.29) |
| Stage 2 restrictions | | 0.121*** (3.43) | 0.121*** (3.42) | 0.122*** (3.69) |
| summer exemption | | -0.0359 (-1.64) | -0.0359 (-1.64) | -0.0181 (-0.85) |
| spring clean | | -0.0416 (-1.18) | -0.0428 (-1.21) | -0.0396 (-1.17) |
| Observations | 1539 | 1539 | 1539 | 1539 |
| R^2 | 0.684 | 0.758 | 0.758 | 0.771 |

t statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

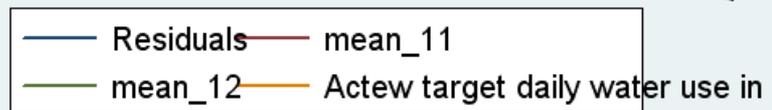
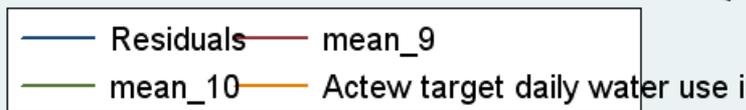
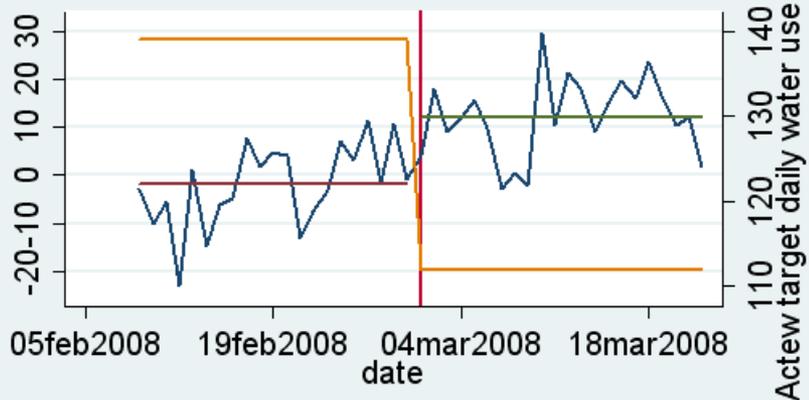
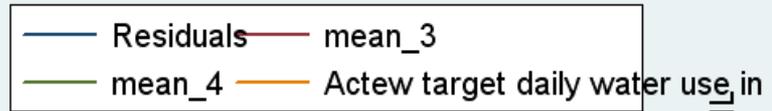
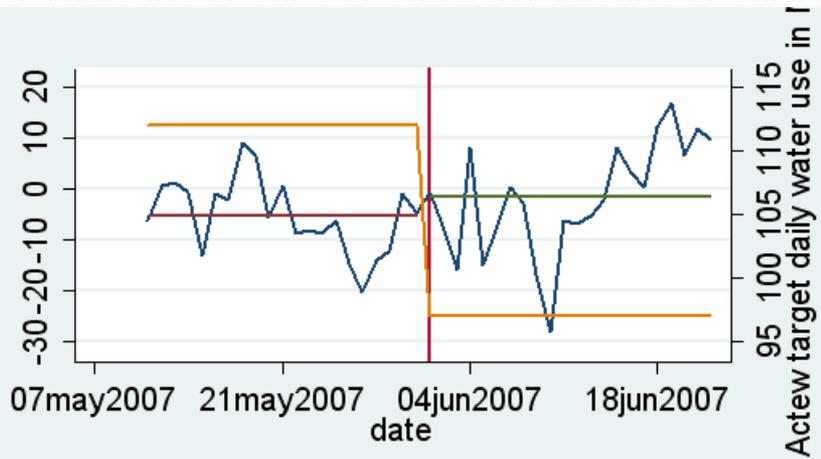
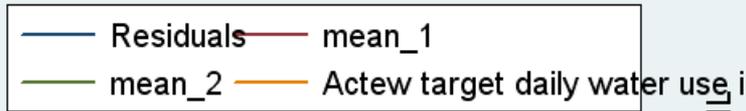
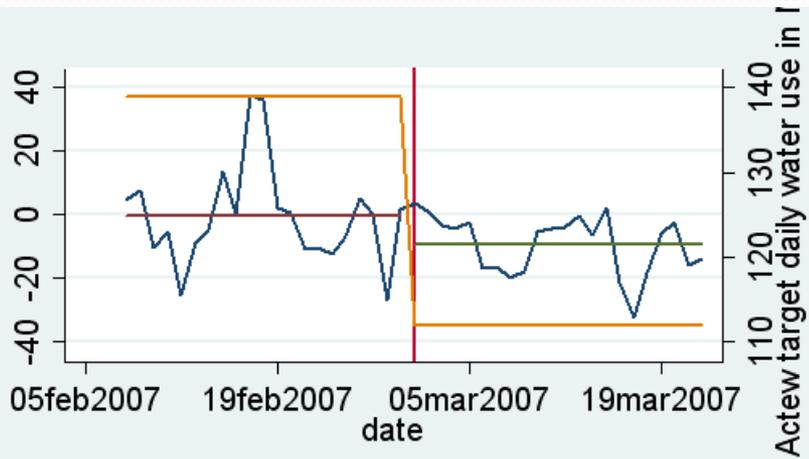
Can we estimate the relevant price elasticity?



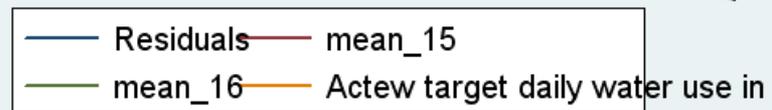
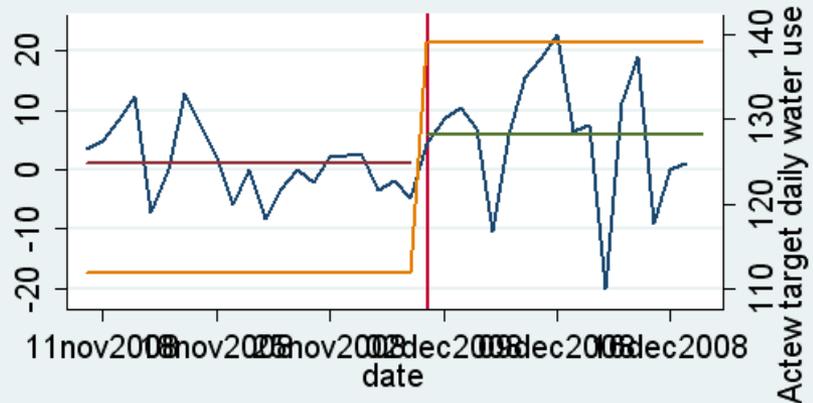
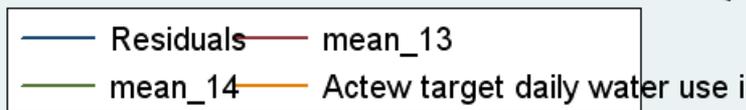
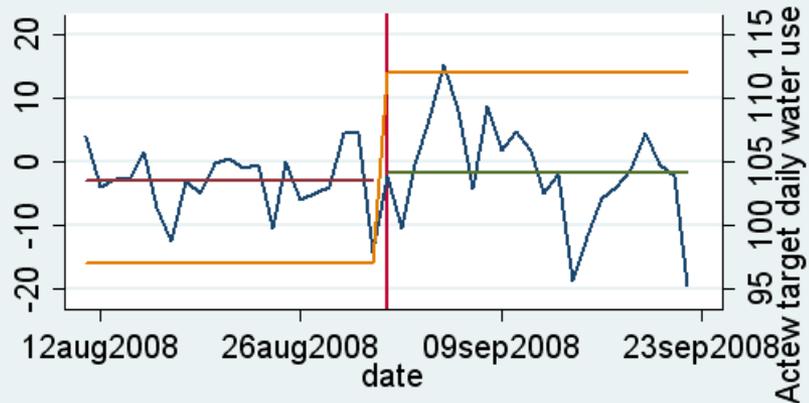
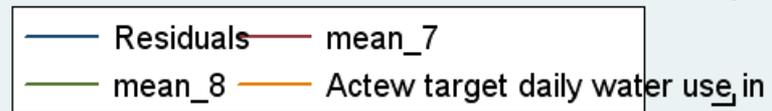
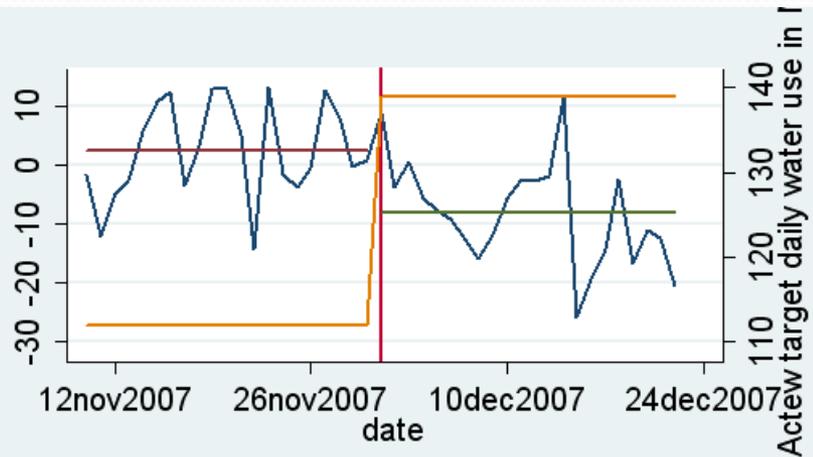
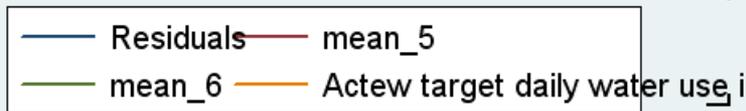
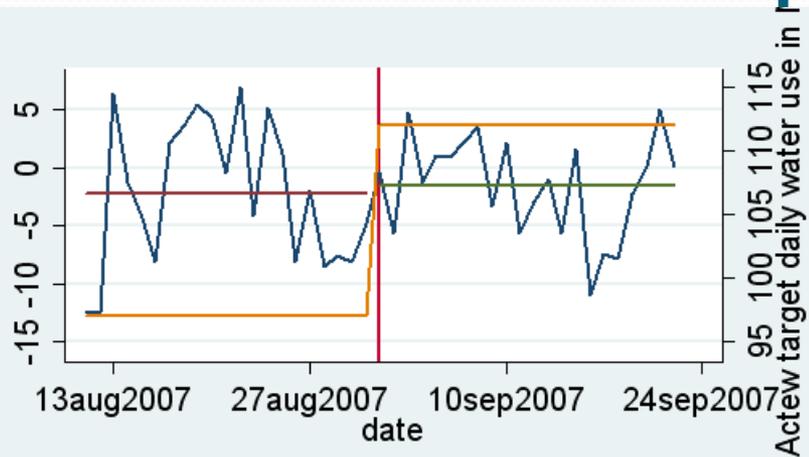
Event Study – Target Changes



Events with downward shift



Events with upward shift



Psychological Insights

- Behavioral phenomena that might hamper price
 - Average as proxy for marginal cost (Ito 2010)
 - Water bills every three months give infrequent feedback; slow response to price changes
 - Adaptation to prices
- Phenomena that help restrictions
 - Daily reminders on road signs and in the news rehearses memories – raises perceived importance
 - Evidence of altruistic water savings
 - Community enforcement of restrictions
 - Manual watering costs are amplified by present-bias preferences

Conclusion

- Water usage restrictions from stage 1 to stage 3 led to reductions of 13-26%, or 50-80% of total savings since 2006
- Extremely low estimated price elasticity suggests restrictions were binding consumption throughout sample period → significant price increases may be necessary to replace restrictions
- Public awareness campaigns appear to be effective at improving water conservation
- Event study suggests that target *levels* have no effect.



Thank you.