Deloitte.

Measuring ‘bounceback’ in water usage

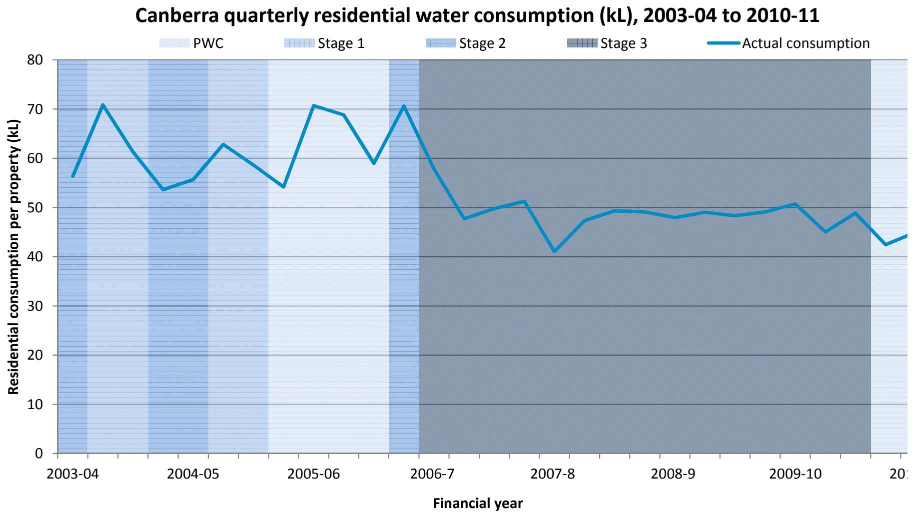
Presentation to the ESC Demand Forecasting Workshop

30 March 2012

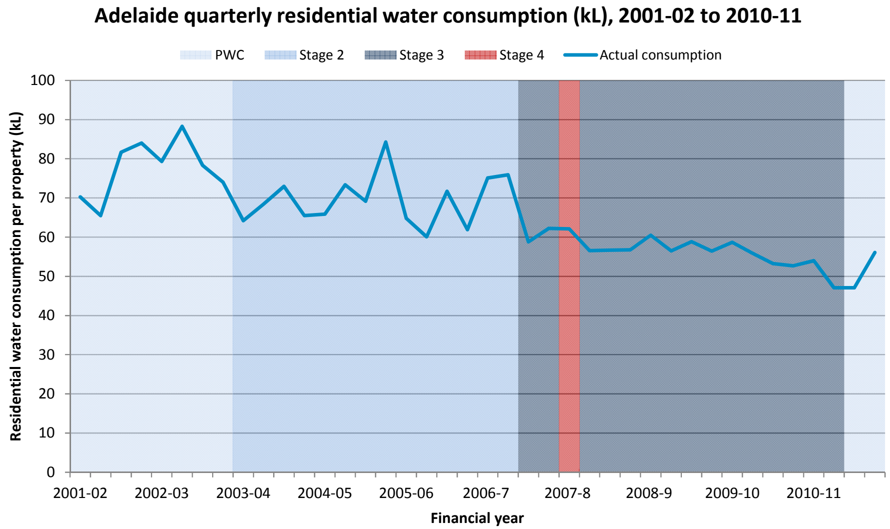
Background and approach

- We were asked by the Melbourne retailers to investigate the level of ‘bounceback’ in other jurisdictions in water sales following the lifting of restrictions
- Spoke to Sydney Water about their approach to demand forecasting and measuring bounceback
- We collected data from a number of Australian water utilities, with a focus on those with
  - similar demand/supply characteristics to Melbourne
  - the longest period of post-restriction data
- Used regression techniques to estimate bounceback

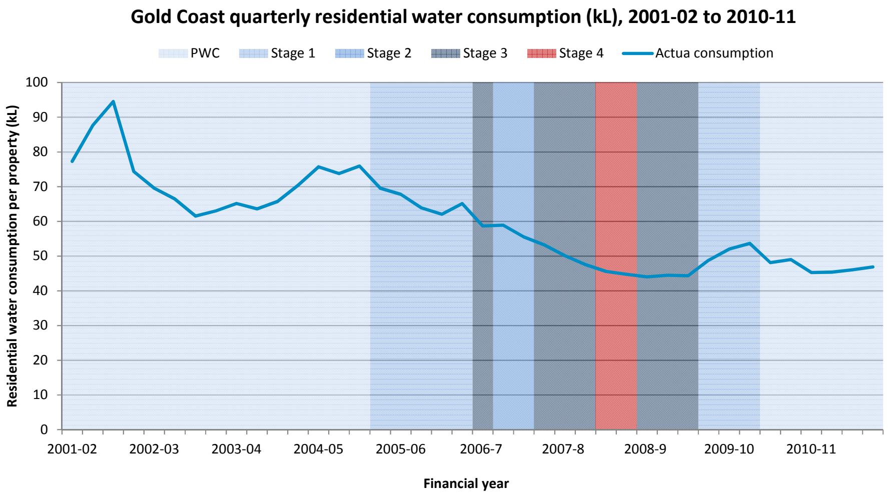
Bounceback



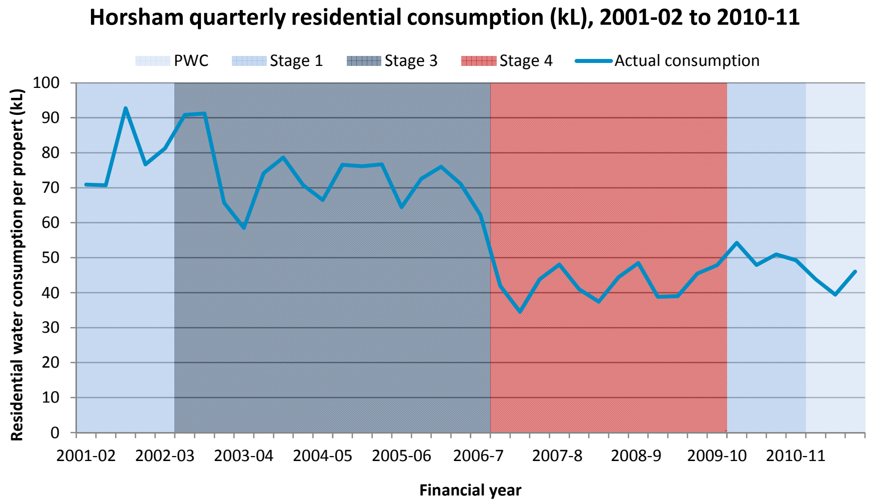
Canberra quarterly residential water consumption (kL), 2003-04 to 2010-11
PWC
Stage 1
Stage 2
Stage 3
Actual consumption
Residential consumption per property (kL)
0
10
20
30
40
50
60
70
80
2003-04
2004-05
2005-06
2006-7
2007-8
2008-9
2009-10
Financial year



Adelaide quarterly residential water consumption (kL), 2001-02 to 2010-11
PWC
Stage 2
Stage 3
Stage 4
Actual consumption
Residential water consumption per property (kL)
0
10
20
30
40
50
60
70
80
90
100
2001-02
2002-03
2003-04
2004-05
2005-06
2006-7
2007-8
2008-9
2009-10
2010-11
Financial year



Gold Coast quarterly residential water consumption (kL), 2001-02 to 2010-11
PWC
Stage 1
Stage 2
Stage 3
Stage 4
Actua consumption
Residential water consumption per property (kL)
0
10
20
30
40
50
60
70
80
90
100
2001-02
2002-03
2003-04
2004-05
2005-06
2006-7
2007-8
2008-9
2009-10
2010-11
Financial year



Horsham quarterly residential consumption (kL), 2001-02 to 2010-11
PWC
Stage 1
Stage 3
Stage 4
Actual consumption
Residential water consumption per propert (kL)
0
10
20
30
40
50
60
70
80
90
100
2001-02
2002-03
2003-04
2004-05
2005-06
2006-7
2007-8
2008-9
2009-10
2010-11
Financial year

Approaches used to estimate bounceback

- **We used two alternative approaches to estimating bounceback in consumption following the removal of restrictions:**
  - **Approach 1:** Estimated change in consumption when restrictions are removed, controlling for rainfall, evaporation and price on an individual utility basis
    - Key strength is simplicity
    - The bounceback observed in other jurisdictions can then be used to estimate possible bounceback in other areas, based on a qualitative comparison of characteristics between jurisdictions
  - **Approach 2:** Panel data approach using cross-sectional (across utilities), time series (across time) data to establish the relationship between consumption and key variables (price, rainfall, evaporation and restrictions)
    - Controls for unobserved, time constant attributes which may also be effecting consumption but are not included in the specification of the model (e.g. income)
    - Key strength is use a greater number of data points to identify relationships between the dependent variable (consumption) and independent variables (price, rainfall, evaporation and restrictions)
    - Applicability of the results to an individual utility depends upon whether the sample is a representative sample, and how closely the characteristics of the comparator utilities match those of the utility in question

Results - Approach 1
Individual utility

Approach 1 – Methodology

Deseasonalising and normalising consumption

In order to isolate and remove the effects of seasonal factors on the consumption series used in the analysis, the following equation was estimated:

$$C_{i(q,y)} = C^*_{i(q,y)} \times s_{iq}$$

Where $C_{i(q,y)}$ is consumption per household (in kL) by utility *i* in quarter *q =1 to 4* in year *y,*

s_{iq} is a quarterly seasonal factor (for each utility).

Rearranging this equation gives deseasonalised consumption (or "actual consumption", as defined in the results that follow):

$$C^*_{i(q,y)} = \frac{C_{i(q,y)}}{s_{iq}}$$

The resulting actual consumption series was then used in the following equations to determine the effects of rainfall and evaporation on consumption:

$$C^*_{i(q,y)} = \alpha_i + \beta_{1i}\Delta R_{i(q,y)} + \beta_{2i}\Delta E_{i(q,y)} + \delta_{1i}t_{(q,y)} + \varepsilon_i$$

Where:

$C^*_{i(q,y)}$ is deseasonalised quarterly consumption

α_i is a constant,

$\Delta R_{i(q,y)}$ is deviation in rainfall from the long-run average,

$\Delta E_{i(q,y)}$ is deviation in evaporation from the long-run average,

$t_{(q,y)}$ is an autoregressive process

ε_i is the error term.

Approach 1 – Summary of results

- Using normalised consumption, bounceback is measured as the difference in consumption (in percentage change) when under restrictions and when restrictions are removed.

Stages	Lower Murray Water	South Australia Water	ActewAGL	Allconnex (Gold Coast)	GWM Water
Stage 4 to PWC/no restrictions	-	-	-	-	42%
Stage 3 to PWC/no restrictions	42%	35%	11%	6%	-
Stage 2 to PWC/no restrictions	-	-	-	-	-
Stage 1 to PWC/no restrictions	14%	-	-	8%	1%

- The percentage change is based on the same quarter under both restrictions and no restrictions – that is, if the data point is quarter two under restrictions, the comparison point under no restrictions/PWC measures will also be quarter two. When there is more than one quarter two under restrictions the last data point is used.
- This can potentially lead to unusual results in the event that the quarterly data point used for the comparison is an outlier. To reduce the effect of outliers on the results, the analysis was also performed on the four-quarter moving average of consumption.

Stages	Lower Murray Water	South Australia Water	ActewAGL	Allconnex (Gold Coast)	GWM Water
Stage 4 to PWC/no restrictions	-	-	-	-	25%
Stage 3 to PWC/no restrictions	40%	13%	8%	6%	-
Stage 2 to PWC/no restrictions	-	-	-	-	-
Stage 1 to PWC/no restrictions	12%	-	-	12%	1%

Results - Approach 2: Panel data

Approach 2 – Methodology

- **Econometric equation**
  - The econometric equation is based on a fixed effects model; this allows the model to control for unobserved effects across utilities (for simplification, utility and time period subscripts have been dropped from the equation):

$$\ln C = \alpha + \beta_1 (Rain - Evaporation) + \beta_2 \ln Price + \delta_1 Stage1 + \delta_2 Stage2 \\ + \delta_3 Stage3 + \delta_4 Stage4 + \delta_5 PostR + \gamma_1 Season1 + \gamma_2 Season2 + \gamma_3 Season3 + u$$

- **Where:**
  - *C* is consumption per household in kL (across utilities, across time);
  - *α* is the individual (or utility) effect (across utilities);
  - *(Rain – Evaporation)* is rainfall minus evaporation in mm (across utilities, across time);
  - *Price* is average volumetric (residential price) in $/kL (across utilities, across time);
  - *Stage 1, 2, 3 and 4* are dummy variables representing the stages of water restrictions (across utilities, across time).
  - *PostR* is a dummy variable representing PWC periods after the removal of water restrictions. Note, the base is no restrictions prior to the introduction of restrictions, and the model does not distinguish between periods with no restrictions and PWC measures;
  - *Season 1, 2 and 3* are dummy variables representing the seasonal variations in consumption (across time). Note, season 4 represents the base case in this model;
  - *u* is the idiosyncratic errors (across utilities, across time).

Approach 2 – results

- The equation specified above was estimated in Eviews 6 as an unbalanced panel as not all utilities had the full dataset. The final model was estimated on 217 observations from 7 utilities (excluding GWMWater due to a lack of evaporation data) over 38 time periods.
- All coefficients measure the change from a 'base case' situation, i.e. zero deficit between rainfall and evaporation, average volumetric price, and pre-restrictions PWC measures.

Variable	Coefficient	p-value
Constant	-0.000	0.5384
(Rainfall – Evaporation)	-0.001	0.0000**
Price	-0.120	0.0069**
Stage 1	-0.147	0.0001**
Stage 2	-0.280	0.0000**
Stage 3	-0.348	0.0000**
Stage 4	-0.503	0.0000**
PWC post restrictions	-0.318	0.0001**
Season 1	-0.147	0.0000**
Season 2	-0.072	0.0463*
Season 3	0.061	0.1057
R-squared	0.8317	
Adjusted R-squared	0.8182	
F-statistic	61.77**	

Note: * denotes statistical significance at the 10% level of confidence; ** denotes statistical significance at the 5% level of confidence

Approach 2 – interpretation of results

Variable	Modelled results
(Rainfall – Evaporation) *0.001*	A 1mm deviation in (rainfall less evaporation) per quarter will change consumption per household by 0.1%. Given deviations from the mean of typically around 100-200mm, changes in consumption due to climate (all else remaining equal) are typically around 10-20%.
Price (elasticity) *-0.120*	Price elasticity of demand = -0.12%. That is, all else equal, a 1% increase in price will reduce consumption per household by 0.12%
Restrictions (compared to base case) *Stage 1 = -0.147* *Stage 2 = -0.280* *Stage 3 = -0.348* *Stage 4 = -0.503* *PWC post restrictions =-0.318*	Consumption under Stage 3 restrictions is 34.8% less than the base case prior to restrictions being applied. 'Bounceback' from stage 3 to PWC is 3% (-0.0318-0.348) 'Bounceback' from stage 2 to PWC is -3%

Key issues and challenges

- Raw data on consumption, including the number of observations/data points
- Defining the form of the parameters – e.g. rainfall
- By not controlling for all factors likely to have changed behavioural responses (when consuming water), the difference between estimated and actual consumption may contain ‘noise’. (Approach 1)
- Results are particularly sensitive to the consumption patterns in the quarters chosen for making the comparison for bounceback (Approach 1)
- Assessment of bounceback is reliant on the accuracy of the approach taken to de-seasonalise (remove seasonal factors) and normalise (control for price, rainfall and evaporation) consumption (Approach 1)
- Standardising restriction levels across utilities (Approach 2),
- Possible correlation between dependent and independent variables leading to endogeneity - there is a connection between average volumetric price and consumption (i.e. under a two-part or inclining block tariff, the level of consumption determines the marginal price)
- Each utility is given the same ‘weight’ with respect to results (Approach 2)
- Nevertheless, the model outputs for Approach 2 shown above suggest that the model is well-specified, with key results being the high R-squared and high and statistically significant F-statistic:
    - The R-squared provides a measure of how closely the results from the estimation of the model match the actual data.
    - The F-statistic provides an indication of the extent to which the variation seen in the dependent variable (average household consumption) is explained by the independent variables specified in the model.
- Over the course of refining the specification of the model, it was also noted that the coefficients were relatively robust to changes in the model, such as altering the form of the independent variables

General information only

This presentation contains general information only, and none of Deloitte Touche Tohmatsu Limited, its member firms, or their related entities (collectively the "Deloitte Network") is, by means of this presentation , rendering professional advice or services.
Before making any decision or taking any action that may affect your finances or your business, you should consult a qualified professional adviser. No entity in the Deloitte Network shall be responsible for any loss whatsoever sustained by any person who relies on this presentation.

About Deloitte

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited, a UK private company limited by guarantee, and its network of member firms, each of which is a legally separate and independent entity. Please see www.deloitte.com/au/about for a detailed description of the legal structure of Deloitte Touche Tohmatsu Limited and its member firms.

Deloitte provides audit, tax, consulting, and financial advisory services to public and private clients spanning multiple industries. With a globally connected network of member firms in more than 150 countries, Deloitte brings world-class capabilities and deep local expertise to help clients succeed wherever they operate. Deloitte's approximately 170,000 professionals are committed to becoming the standard of excellence.

About Deloitte Australia

In Australia, the member firm is the Australian partnership of Deloitte Touche Tohmatsu. As one of Australia's leading professional services firms. Deloitte Touche Tohmatsu and its affiliates provide audit, tax, consulting, and financial advisory services through approximately 5,400 people across the country. Focused on the creation of value and growth, and known as an employer of choice for innovative human resources programs, we are dedicated to helping our clients and our people excel. For more information, please visit our web site at www.deloitte.com.au.