Methodology Information Paper 23: Ofwat's capital maintenance econometric models

Introduction

This information paper sets out Ofwat's econometric models for assessing capital maintenance expenditure efficiency.

Outline of the econometric models

Information Paper 21 sets out Ofwat's overall approach to capital maintenance expenditure assessments. Part C of that assessment is an assessment of the scope for future efficiency in capital maintenance expenditure.

Ofwat's relative efficiency assumptions for capital maintenance are based on a 50/50 split of its targets from its cost-base[1] approach and its econometric assessment of efficiency.

Summary of the econometric models

Ofwat published a consultation on its econometric models in May 2007[2]. There are nine models for capital maintenance expenditure:

- water resources and treatment;
- water distribution infrastructure;
- water distribution non-infrastructure;
- water management and general;
- sewerage infrastructure;
- sewerage non-infrastructure;
- sewage treatment;
- sludge treatment and disposal; and
- sewerage management and general.

The purpose of each model is to establish a relationship between the costs reported by the companies and external cost drivers. These cost drivers have a significant impact on costs but are outside the control of the management of the company. By controlling the principal external cost drivers in the models, we can determine the amount of capital maintenance that should be allowed for with some accuracy.

[1] The cost base method is a series of standard costs for completing units of work used for benchmarking companies' relative procurement efficiency. We explain this further in Information Paper 25.

[2] 'Capital Maintenance Relative Efficiency Modelling for the 2009 Periodic Review', Ofwat May 2007.

The cost drivers that are included within the econometric models are known as 'explanatory factors'. The models themselves take different forms. These are summarised in Table 1.

Table 1: Summary of econometric models and explanatory factors

Model	Model type	Explanatory factors
Water resources and treatment	Unit cost	Total connected properties
Water distribution infrastructure	Log linear	Length of main; total connected properties
Water distribution non-infrastructure	Log linear	Pumping station capacity; water service reservoir and storage tower capacity
Water management and general	Log linear	Billed properties; proportion of billed properties that are non-household
Sewerage infrastructure	Log linear	Length of sewer and number of combined sewer overflows
Sewerage non-infrastructure	Unit cost	Number of pumping stations
Sewage treatment	Log linear	Total load; total number of works
Sludge treatment and disposal	Unit cost	Total weight of dry solids
Sewerage management and general	Unit cost	Billed properties

We now explain each of the models in detail[3].

Water resources and treatment

This model estimates the costs of maintaining those assets from which water is sourced (eg reservoirs, dams and aqueducts) and where water is treated (eg water treatment works and associated pumping stations). The model is based on the premise that capital maintenance expenditure increases uniformly with company size; that is, there are constant returns to scale. In the model, the number of connected properties is used as a surrogate for company size.

The model shown in Table 2 was published in May 2007 and was developed from 1997-98 explanatory variables and six-year average expenditure (2000-01 to 2005-06) for the water companies in England and Wales.

[3] All monetary values are in 2005-06 prices.

Table 2: Ofwat's model for water resources and treatment capital maintenance expenditure

Water resources and treatment	
This is a unit cost model. Each company's average annual water resources and treatment capital maintenance expenditure is divided by the total connected properties. This is then compared with the weighted average industry cost.	
£ per connected property	Weighted average industry cost = 8.973
Number of observations: 22	

Water distribution infrastructure

This model estimates the costs of maintaining the network of water mains. The main cost driver in this model is the logarithm of connected properties per length of main.

The model shown in Table 3 was published in May 2007 and was developed from 1997-98 explanatory variables and six-year average expenditure (2000-01 to 2005-06) for the water companies in England and Wales.

Table 3: Ofwat's model for water distribution infrastructure capital maintenance expenditure

Water distribution infrastructure		
Modelled cost	Log to base e of (annual average water distribution infrastructure functional expenditure (£m), divided by length of main (km))	
Explanatory variables	Coefficient	Standard error
Constant	-5.103	0.661
Log to the base e of (total number of connected properties (000s) divided by total length of main (km))	0.739	0.244
Form of model	Log to base e of (annual average water distribution infrastructure functional expenditure (£m), divided by length of main (km)) = -5.103 + Log to the base e of (total number of connected properties (000s) divided by total length of main (km)) x 0.739	
Statistical indicators	Number of observations: 22	R^2: 0.314

Water distribution non-infrastructure

This model estimates the costs of maintaining the non-infrastructure assets related to water distribution such as service reservoirs, pumping stations and meters. The model recognises that capital maintenance expenditure increases with pumping station capacity and water storage capacity.

The model shown in Table 4 was published in May 2007 and was developed from 1997-98 explanatory variables and six-year average expenditure (2000-01 to 2005-06) for the water companies in England and Wales.

Table 4: Ofwat's model for water distribution non-infrastructure capital maintenance expenditure

Water distribution non-infrastructure		
Modelled cost	Log to base e of (annual average water distribution non-infrastructure functional expenditure (£m), divided by pumping station capacity (kW))	
Explanatory variables	Coefficient	Standard error
Constant	-5.739	0.530
Log to the base e of (water service reservoir and water tower storage capacity (Ml/d) /pumping station capacity (kW))	0.941	0.206
Form of model	Log to base e of (annual average water distribution non-infrastructure functional expenditure (£m), divided by pumping station capacity (kW)) = -5.739 + ln (water service reservoir and water tower storage capacity (Ml/d)/pumping station capacity (kW)) x 0.941	
Statistical indicators	Number of observations: 22	R^2: 0.510

Water management and general

This model estimates the costs of maintaining those assets used in the management function of the water business such as IT equipment, buildings and vehicles. The model relates costs to the size of the company (using the number of billed properties as a surrogate for company size). It recognises that costs increase with a greater proportion of business customers.

The model shown in Table 5 was published in May 2007 and was developed from 1997-98 explanatory variables and six-year average expenditure (2000-01 to 2005-06) for the water companies in England and Wales.

Table 5: Ofwat's model for water management and general capital maintenance expenditure

Water management and general		
Modelled cost	Log to base e of (annual average water management and general expenditure (£m), divided by billed properties (000s))	
Explanatory variables	Coefficient	Standard error
Constant	-5.543	0.255
Proportion of billed properties that are non-household	9.165	3.324
Form of model	Log to base e of (annual average water management and general expenditure (£m), divided by billed properties (000s)) = -5.543 + proportion of properties that are non-household x 9,165	
Statistical indicators	Number of observations: 22	R^2: 0.286

Sewerage infrastructure

This model estimates the costs of maintaining the sewer network. The model recognises that capital maintenance expenditure on sewerage infrastructure increases with company size and uses sewer length as a surrogate for company size. Combined sewers are recognised as having higher maintenance costs than foul sewers; the number of combined sewer overflows is used in the model as a proxy for the length of combined sewers.

The model shown in Table 6 was published in May 2007 and was developed from 1997-98 explanatory variables and six-year average expenditure (2000-01 to 2005-06) for the water companies in England and Wales.

Table 6: Ofwat's model for sewerage infrastructure capital maintenance expenditure

Sewerage infrastructure		
Modelled cost	Log to base e of (annual average sewerage infrastructure expenditure (£m), divided by the total length of sewer (km))	
Explanatory variables	Coefficient	Standard error
Constant	-6.141	0.211
Log to the base e of (the number of combined sewer overflows divided by the total length of sewer (km))	0.385	0.060
Form of model	Log to base e of (annual average sewerage infrastructure expenditure (£m), divided by the total length of sewer (km)) = -5.606 + log to the base e of (the number of combined sewer overflows divided by the total length of sewer (km)) x 0.379	
Statistical indicators	Number of observations: 63	R^2: 0.399

Sewerage non-infrastructure

This model estimates the costs of maintaining the non-infrastructure assets of the sewerage service, largely sewage pumping stations. The model is based on the premise that capital maintenance expenditure increases uniformly with the number of pumping stations.

The model shown in Table 7 was published in May 2007 and was developed from 1997-98 explanatory variables and six-year average expenditure (2000-01 to 2005-06) for the water companies in England and Wales.

Table 7: Ofwat's model for sewerage non-infrastructure capital maintenance expenditure

Sewerage non-infrastructure	
This is a unit cost model. Each company's average annual sewerage non-infrastructure capital maintenance expenditure is divided by the total number of pumping stations. This is then compared with the weighted average industry cost.	
£m/number of pumping stations (000s)	Weighted average industry cost = 3.304

Number of observations: 10

Sewage treatment

This model estimates the costs of maintaining sewage treatment works. The model recognises that maintenance costs increase with the volume of sewage that is treated. In addition, the model takes into account the economies of scale of maintaining a few large works relative to maintaining a large number of smaller works.

The model shown in Table 8 was published in May 2007 and was developed from 1997-98 explanatory variables and five-year average expenditure (2000-01 to 2005-06) for the water companies in England and Wales.

Table 8: Ofwat's model for sewage treatment capital maintenance expenditure

Sewage treatment		
Modelled cost	Log to base e of (annual average sewage treatment functional expenditure (£m), divided by the total load received at sewage treatment works (kg BOD_5/day)	
Explanatory variables	Coefficient	Standard error
Constant	-7.849	0.300
Log to the base e of (the total number of works divided by total load received at sewage treatment works (kg BOD_5/day))	0.204	0.044
Form of model	Log to base e of (annual average sewage treatment functional expenditure (£m), divided by the total load received at sewage treatment works) = -7.849 + log to the base e of (the total number of works divided by total load received at sewage treatment works) x 0.204	
Statistical indicators	Number of observations: 60	R^2: 0.270

Sludge treatment and disposal

This model estimates the costs of maintaining the assets used for sludge treatment and disposal. The model is based on the premise that capital maintenance expenditure increases uniformly with the total weight of dry solids disposed of.

The model shown in Table 9 was published in May 2007 and was developed from 1997-98 explanatory variables and six-year average expenditure (2000-01 to 2005-06) for the water companies in England and Wales.

Table 9: Ofwat's model for sludge treatment and disposal capital maintenance expenditure

Sludge treatment and disposal	
This is a unit cost model. Each company's average annual sludge treatment and disposal capital maintenance expenditure is divided by the total weight of dry solids disposed of. This is then compared with the weighted average industry cost.	
£000/weight of dry solids (ttds)	Weighted average industry cost = 70.566
Number of observations: 10	

Sewerage management and general

This model estimates the costs of maintaining the assets that are used in the management function of the sewerage business, such as IT equipment, buildings and vehicles. The model relates costs to the size of the company and uses the number of billed properties as a surrogate for company size.

The model shown in Table 10 was published in May 2007 and was developed from 1997-98 explanatory variables and five-year average expenditure (2000-01 to 2005-06) for the water companies in England and Wales.

Table 10: Ofwat's model for sewerage management and general capital maintenance expenditure

Sewerage management and general	
This is a unit cost model. Each company's average annual sewerage management and general capital maintenance expenditure per billed property is calculated. This is then compared with the weighted average industry cost.	
£ per billed property	Weighted average industry cost = 6.768
Number of observations: 10	