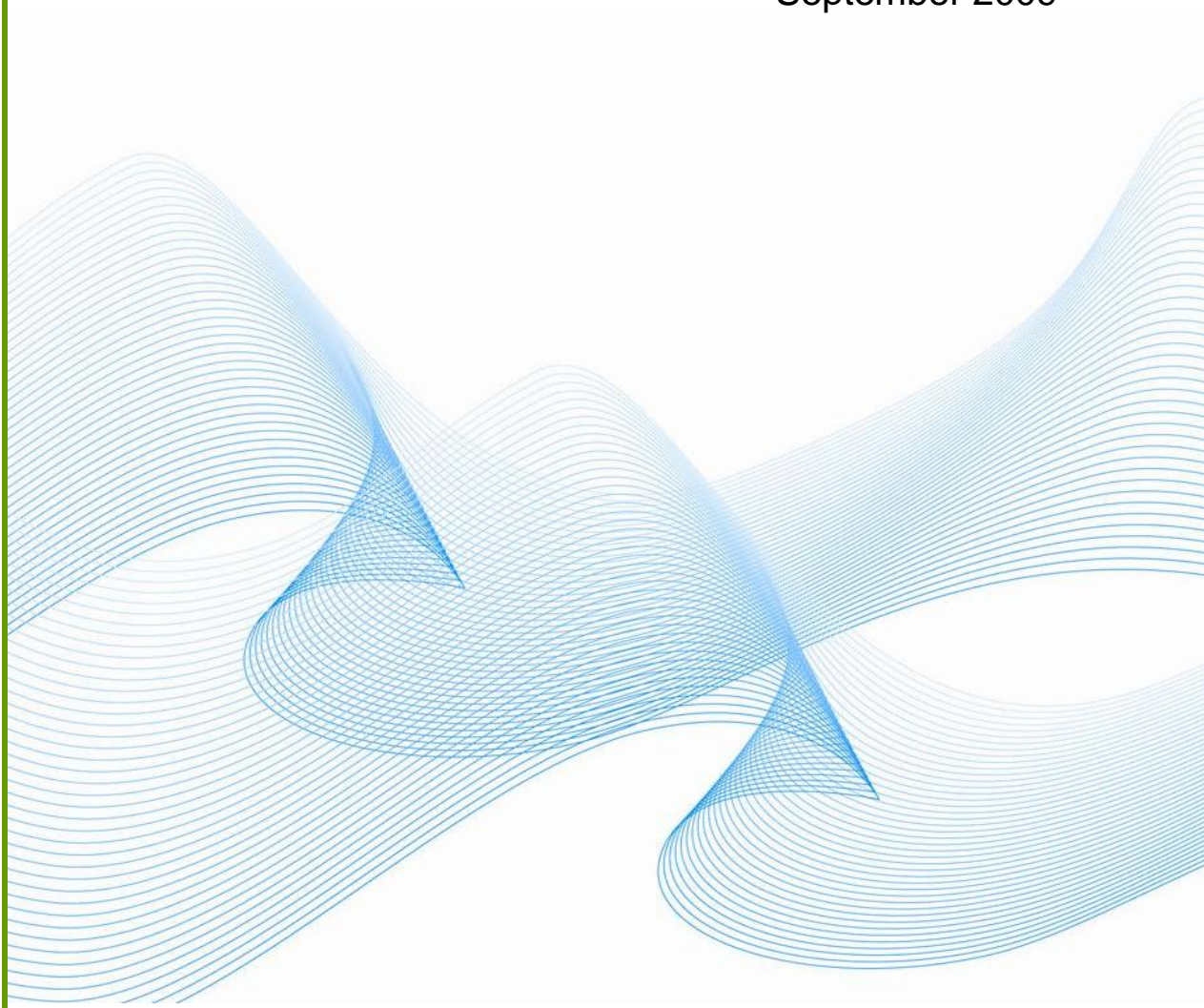




# Water and Sewerage Service Price Control 2010-13

Draft Determination Main Report – Annex C2  
Operational Efficiencies: A Methodological Note

September 2009



# Water and Sewerage Revenue and Charges Price Control 2010-2013

Draft Determination Main Report

Annex C2 – Operational Efficiencies: A Methodological Note

## Content Note

The operational efficiency methodological note has been previously communicated to NI Water in a letter and report sent on the 24<sup>th</sup> April 2009. This annex reproduces the information produced in that initial report, so has not been reformatted to reflect the style and numbering of the main document.

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# **Operational Efficiencies: A methodological note**

## 1. Why a methodological note?

During early 2009 and in the interest of transparency and of facilitating representation(s) from NI Water (either in advance or post-Draft Determination), the Utility Regulator considered that it would be beneficial to set out our approach toward interpreting NI Water's Cost Base. This note extends that approach to also cover the main methodologies under consideration for setting operational expenditure efficiencies at PC10.

This note lays out, in a single document our intended range of applied econometric techniques and our consideration of available "top-down" evidence and regulatory precedent to inform such efficiency targets. Previously, we have stated the same at various workshops, presentations and meeting with company representatives.

The range of assumptions and options we face when undertaking our efficiency modelling of NI Water are extensive and, whilst dealt with in more detail under Section 10 onwards, they are summarised below with a brief indication of our likely approach:-

- **Re-specification of the water distribution model** - whether or not to seek an alternative water distribution model rather than use the new Ofwat version, since NI Water figures represent a significant outlier in terms of the explanatory variable;
- **Adjusted or unadjusted modelling** – we are minded to continue efficiency modelling using an unadjusted COLS approach;
- **Special factors & atypical expenditure adjustment** – we have analysed NI Water's recent re-submission in light of the new water distribution model published by Ofwat and our initial decisions are subject to separate reports;
- **Discounts and efficiency bands** – we intend to model using both Ofwat and Cubbin's discounts and triangulate around a central estimate of efficiency as in previous years. We reserve judgement on whether to adopt an efficiency banding approach until determination stages;
- **Choice of benchmark** – we intend triangulating around the available options including taking NI Water to the industry frontier or the celtic fringe. We do so in recognition of early analysis which indicates that for NI Water a significant efficiency challenge remains;
- **Continuing efficiency or frontier shift** – we are minded to adopt the same considerations as Ofwat published recently, namely 0 per cent relative to the RPI for both water and sewerage services. Our view may alter if we decide to materially uplift NI Water's allowed operating expenditure across PC10 for likely cost pressures;

- **Controllable/uncontrollable costs** – once we have derived our efficiency targets we are minded to apply these to all of NI Water’s PC10 operating expenditure. There may be some scope for NI Water to argue the exclusion of BIP and VER costs from PC10 efficiencies on an exceptional basis;
- **Excluded models** – given continuing deferral of domestic charging we are minded to exclude both water and sewerage business activities models from our COLS efficiency modelling to ensure robust and “like for like” comparison of NI Water to the E&W industry;
- **Treatment of PPPs** – our analysis is predicated upon AIR08 data, pre-dating the Alpha and Omega contracts. We are minded to allow NI Water to use the widely anticipated savings from these PPPs to meet or even outperform new operational efficiency targets going forward; and,
- **Rate of catch-up** – we are minded to apply a high catch-up rate rather than at a level comparable to Ofwat’s.

## 2. Introduction

In the absence of competition in the provision of water and sewerage services in Northern Ireland, our objective when setting efficiency targets is to mimic those that would be faced by an efficient competitor. Relative efficiency analysis is used to identify a benchmark company and the efficiency gap between that benchmark and other comparator companies. Such analysis produces an efficiency gap or “catch up” efficiency for each individual company.

When this “catch up” is allied to a “continuing efficiency” forecast, or the expected efficiency shift of the entire industry, it is possible to set an efficiency target appropriate to a company’s individual circumstances and its ability or otherwise to deliver additional efficiencies in the shorter term.

Our intention is to set tough but realistic targets for the PC10 period (2010/11 to 2012/13) and to serve notice of indicative targets extending beyond 2013; this is important for deliverability as PC10 covers a shorter regulatory period than would normally be the case.

The result of this is that, once the regulatory contract is agreed there will likely be slightly less than three years available for delivery, once any prior planning has taken place post Final Determination. And the efficiencies we wish to see delivered for customers benefit are those that reduce costs whilst maintaining or improving levels of service; cost cutting *per se* is not efficiency. The long term challenge for NI Water is to provide an equivalent level of service at an efficient level of operating expenditure taken from leaders within the industry.

### 3. Applied econometrics

The efficiency of a company can be defined as the extent to which it is able to minimise its costs for producing a given set and volume of outputs, taking into account the environment in which it operates (including demographic and geographical circumstances). A perfectly efficient company is one which has the lowest costs possible given the outputs that it produces and the environment in which it operates.

There are a variety of econometric approaches that can be used to assess the comparative efficiency of different companies. Such approaches use statistical techniques like regression analysis to estimate a model, based on past company data relating costs to different types of output (such as water delivered, sewage disposed, etc....) and environmental factors (network size, urbanisation, etc...).

Broadly, the techniques that we intend to examine at PC10 include the following:

- Ordinary least squares (OLS): OLS uses observations from a single point in time for a set of companies; the Ofwat technique that we favour is called Corrected Ordinary Least Squares (COLS) and is a variant of this.
- Panel data techniques: Unlike OLS, these utilise datasets which include repeated observations over time from the same set of companies. The key advantages of using panel data techniques are: that they allow more observations for the same set of companies to be incorporated in the analysis (which should improve the robustness of the results) and they take into account not only variation in the data between companies, but also within companies over time (therefore company specific effects that are persistent over time can be taken into account).
- Stochastic frontier analysis (SFA): This technique can be used on a single cross section or on a panel dataset. The SFA analysis undertaken so far uses a panel dataset only. The key characteristic of SFA is that it attempts to distinguish between random error and genuine inefficiency.

When considering these methods, some important caveats are worth bearing in mind. First, the use of any statistical model inherently implies the existence of random variation in the data. Since it is not possible to observe either variations in efficiency – over time or across companies – or random factors directly, the transition from statistical analysis to conclusions about company efficiency has to rest on assumptions about how variation in the data is divided between random factors and efficiency.

These assumptions may be explicit, as in the case of the COLS approach, or they may be embedded in the structure of the statistical model. In discussing the various statistical methods that have been used we will highlight these assumptions, since understanding them is essential to any assessment of the robustness of the results generated.



Second, when using any applied econometrics, assumptions regarding data are often required which give rise to their own particular sensitivities. For example, whether it is appropriate to include the Business Activities model from the full Ofwat suite when NI Water does not presently bill domestic customers will lead to an artificially favourable analysis of relative efficiency for the company. In such cases, and as discussed later, we are minded to exclude such a model in its entirety from our supporting analysis.

### *Conclusion*

We do not consider any one single approach to provide a single point estimate of relative efficiency for the setting of targets. Rather we prefer to examine a number of ranges based upon application of different applied econometric approaches set against “top-down” analysis of precedent. We term this “triangulation” and endeavour to satisfy ourselves that our determined efficiency target is supported by a number of different approaches at once.

We intend conducting our analysis of relative operational efficiency primarily through use of COLS, whilst recognising the potential to include further additional analysis using both panel data and SFA as alternative approaches.

## **4. Unit Cost Comparison and International Benchmarking**

An alternative approach to applied econometrics is the use of unit cost comparison. This provides a very simple indicator of relative cost performance between companies. We intend expressing NI Water costs on the basis of cost per property and cost per cubic metre of water delivered and sewage collected. Overall unit costs can then be broken down into:-

- cost of operations (separated into functional areas of expenditure);
- maintenance; and,
- servicing capital (the residual of Total Costs minus Cost of operations minus Maintenance).

NI Water’s unit costs for water and sewerage have been compared with those of international counterparts and are laid out in the tables below. High and low costs do not always directly reflect relative efficiency because factors relating to the operating environment may increase or reduce unit costs relative to other businesses.

Nor do unit costs allow for any more sophisticated understanding of relative costs and cost drivers, other than to highlight which companies have high, low or mid range costs. This is especially so when undertaken on an international basis; accounting and PPP treatment of costs vary by country and within industry, despite all companies within the E&W industry being subject to a standard set of Regulatory Accounting Guidelines. Also, one reason for the different rankings of companies between these two measures is the impact of significantly large

users who only receive one bill, and receive a large volume of water. This highlights the importance of not relying too heavily on unit cost comparisons.

We are cautious in adopting such unit cost analysis to set operational efficiency targets, preferring instead our “triangulation” approach detailed at Section 3.

**Table 1: Water Delivered Unit costs (£/property)<sup>1</sup>**

	Cost of operations	Resources & treatment	Distribution	Business activity	Cost of capital maintenance	Return on capital	Total cost
Northern Ireland	115 – 123	35-38	58	21-22	74	11	199
E&W average	75	24	28	25	53	53	182
E&W range	59-106	46-49	18-60	15-37	26-80	22-77	106-216
Scotland average	57	18	18	21	47	58	163
Australia average	105	-	-	-	72	25	202
Australia range	84-133	-	-	-	21-186	-13-95	125-265
Canada average	137	51	87	-	-	-	-
Canada range	42-163	34-101	42-86	-	-	-	-
Netherlands average	87	-	-	-	28	31	145
Netherlands range	63-106	-	-	-	15-49	8-63	121-178
USA average (median)	179	-	-	-	-	-	-

**Table 2: Water Delivered Unit costs (p/m<sup>3</sup>)**

	Cost of operations	Resources & treatment	Distribution	Business activity	Cost of capital maintenance	Return on capital	Total cost
Northern Ireland	47 – 50	14 – 15	24 – 25	8 – 9	30	4	80 – 82
E&W average	39	12	14	12	28	28	94
E&W range	28 – 61	8.4 – 25.9	8.3 – 27	7 – 22.6	13 – 42.5	11 – 53.9	54 – 151
Scotland average	27	8	9	10	22	28	77
Australia average	41		-	-	28	10	78
Australia range	30 – 58	-	-	-	10 – 71	-6 – 32	0 – 120
Canada average		7	13	-	-	-	20
Canada range	4 – 35	5 – 22	4 – 21	-	-	-	
Netherlands average	58	-	-	-	19	20	97
Netherlands range	36 – 73	-	-	-	9 – 33	5 – 36	77 – 125
USA average (median)	26	7	-	-	-	-	-

**Table 3: Sewage collected (£/property)**

	Cost of operations	Sewerage	Sewage treatment	Sludge treatment & disposal	Business activity	Cost of capital maintenance	Return on capital	Total cost
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<sup>1</sup> We have expressed NI Water’s unit costs in a range rather than an exact figure to reflect ongoing work to assess



Northern Ireland	116 - 131	41 - 46	35 - 39	17 - 19	23 - 26	59	33	208 - 223
E&W average	66	12	22	13	19	62	69	196
E&W range	52-103	10-14	16-46	11-19	13-35	45-103	31-118	128-324
Scotland average	48	14	15	4	15	47	101	196
Australia average	89	-	-	-	-	90	65	245
Australia range	68-103	-	-	-	-	22-256	45-178	151-354
Canada average	58	23	57	15	-	-	-	-
Canada range	13-107	13-37	54-65	9-16	-	-	-	-
Netherlands average	-	-	-	-	-	-	-	-
Netherlands range	-	-	-	-	-	-	-	-
USA average (median)	178	-	-	-	-	-	-	-

**Table 4: Sewage collected (p/m3)**

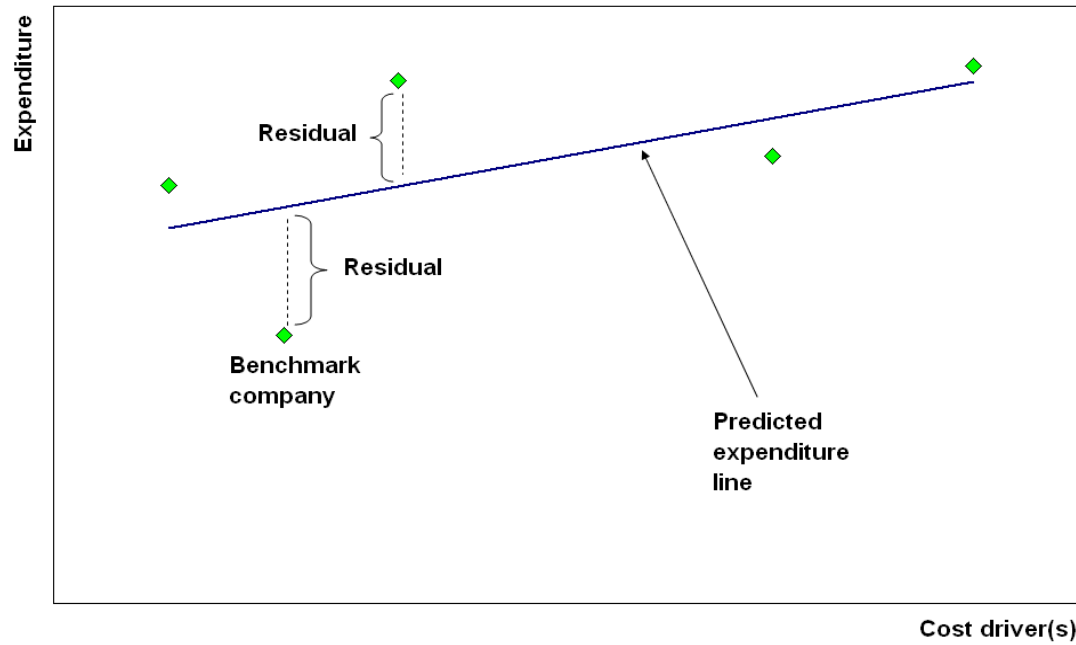
	Cost of operations	Sewerage	Sewage treatment	Sludge treatment & disposal	Business activity	Cost of capital maintenance	Return on capital	Total cost
Northern Ireland	52 - 59	18-21	16 - 18	8 - 9	11 - 12	27	15	95-102
E&W average	40	7	13	8	12	38	42	119
E&W range	27-76	5-9	8-34	6-14	7-22	23-76	16-87	66-239
Scotland average	32	9	10	3	10	31	67	130
Australia average	39	-	-	-	-	39	29	107
Australia range	30-57	-	-	-	-	12-109	19-95	75-184
Canada average	9	3	6	1	-	-	-	-
Canada range	2-22	2-8	6-12	2-3	-	-	-	-
Netherlands average	-	-	-	-	-	-	-	-
Netherlands range	-	-	-	-	-	-	-	-
USA average (median)	32	-	16	-	-	-	-	-

## 5. COLS Regression Analysis

Ordinary Least Squares analysis is one of a variety of techniques which fall under the heading of regression analysis. It involves the identification of the statistical relationship between different variables. In the case of this study therefore, the objective is to derive the relationship

between total cost and a variety of exogenous cost drivers. OLS regression analysis can be best understood through the use of a simple illustration.

**Figure 5.1**



If the cost of building and operating a network ( $C$ ) depended on a single cost driver, network length ( $L$ ), then each operator's level of costs and network length could be plotted on a graph, as in Figure 5.1, where each point represents a different operator.

Ordinary least squares regression analysis fits a "line of best fit" to these points, such that the line minimises the sum of the squared vertical distances or residuals of the observed company's costs (represented by diamonds) from the line.

The line of best fit can be written in equation form as:

$$C_i = a + bL_i + u_i$$

where  $i$  represents the observations for the different operators,  $a$  is the fixed cost involved in providing a network regardless of the network length,  $b$  is the cost of providing each additional unit of network length (the marginal cost), and  $u$  is the regression residual (the difference between actual costs and those predicted by the "line of best fit").

If there are many companies in the sample, it is very unlikely that they would all lie on the best-fit line, but rather some would be above and others below. The best-fit line therefore represents the costs that a company of 'average' efficiency would be expected to incur at a given network length. Those companies with an observation above the line have costs above those of a

company of average efficiency with the same network. Such companies are, in this relative sense, inefficient. Conversely, those companies that lie below the regression line may be viewed as being relatively efficient (above average efficiency).

In practice, rather than plotting all the companies' observations on a graph, a computer program is used to estimate the regression coefficients ( $a$  and  $b$ ) using the data on all the companies in the sample. Individual companies are then judged by substituting their actual output numbers into the equation to give a predicted level of costs,  $Z$ , as if the company were of average efficiency. If the company's actual cost level were larger than  $Z$ , then it would lie above the regression line and, therefore would be deemed inefficient (compared to "average performance"). Likewise, if its predicted costs were to exceed its actual costs, it would be judged to be efficient compared to "average performance".

The difference between a company's actual costs and its predicted costs is termed the residual. A positive residual therefore indicates inefficiency relative to the sample "average", and a negative residual indicates efficiency relative to the sample "average".

Most cost functions are likely to have more than one cost driver. OLS regression analysis deals with this through the use of multivariate regressions, which take the general form:

$$C_i = a + b_1L_i + b_2P_i + b_3Q_i + \dots + u_i$$

As before,  $a$  represents the level of fixed costs,  $b_1$  measures the marginal cost of explanatory factor  $L$ , and  $u$  is the regression residual. However, in addition,  $b_2$  and  $b_3$  now measure the marginal cost of the new explanatory factors  $P$  and  $Q$  respectively (assuming in each case that the other two explanatory factors are held constant). Also, " $\dots$ " indicates the other variables that may have been included in the model.

We use a version of OLS in our relative efficiency analysis known as Corrected Ordinary Least Squares (COLS). As discussed above, OLS estimates the impact of cost drivers on costs at the average or mean to be statistically precise, not at the efficient frontier. However, we require comparison to the efficient frontier, to enable the setting of an efficiency target for cost reductions to enable "catch-up" to the frontier by NI Water over time.

To this end, we intend to compare the relative efficiency of NI Water (the ratio of actual costs to the costs predicted for it by the OLS regression line) to the relative efficiency of a selected benchmark company. Ofwat presently choose their benchmark company on the basis that it is highly efficient relative to the average, and meets certain additional criteria (such as comprising more than three percent of industry turnover by service). This generally results in a benchmark company which, while not necessarily having the lowest costs, is judged to be the most efficient company operating under typical industry conditions.

More generally, efficiency analyses that rely upon OLS regression often assume that some proportion – say  $r\%$  - of the deviations from the regression line are caused by random variation and the remainder by efficiency differences across companies. It would be unlikely for all of the residual differences to be attributable to inefficiency alone. Thus, the efficiency difference between the benchmark firm with error  $u_b$  and firm  $i$  is  $[1-(r/100)]*(u_i - u_b) / (C_i - u_i + u_b)$ .

The value of  $r$  is clearly important, but it is also arbitrary unless there is independent evidence on the magnitude of efficiency differences relative to random errors. We present some analysis in later sections which attempts to place a number on the  $r\%$  and we shall encompass such within our general “triangulated” approach.

A more worrying consequence of this formulation is that the random error is perfectly correlated with the efficiency error, which seems highly improbable. This aspect of COLS is partially offset within SFA.

Again, this shows the advantage and prudence of relying not on a single technique, but triangulating one’s approach.

## 6. Multi-year least squares regression analysis

The analysis described above uses data for a single year to assess how efficient one firm is compared to others. However, depending upon the number of firms for which data are available, such analysis has limitations with regards to accuracy and robustness. If, for example, a number of firms have low costs for spurious reasons (such as misreporting of accounting data in a particular year) this could skew the model significantly, making other firms look less efficient than they actually are. Also, the number of observations is limited to the number of companies for whom the required data are available.

Where a number of years of data are available, it is possible to create a data panel (or “pool”), which includes data for different companies over a number of years. This helps overcome problems associated with a limited number of observations, and reduces or eliminates the impact of peculiarities in the data, as these tend to “average out” over time. The use of a panel dataset should therefore lead to a more robust and stable model. Furthermore, the availability of repeated data observations for the same company over time allows persistent unobserved effects on company costs to be taken into account in the analysis.

However, including more than one year’s worth of data from any firm can lead to problems due to the existence of heterogeneity both within observations across time and between the different observations in the panel. This can lead to difficulties in obtaining efficient and unbiased estimates of the regression coefficients. In addition, panel data can also lead to problems of autocorrelation, if the within-observation heterogeneity is low (if the figures for each year for an observation do not differ by a large amount).

OLS analysis is neither able to control for the heterogeneity both within and between observations, nor for the autocorrelation problems that can arise with panel data, and hence it is not an appropriate technique to use with this type of data. In its place a two-step Generalised Least Squares (GLS) approach can be used, which takes account of the repeat observations for each firm.

A possible GLS model using data for a number of years might be similar to that used in single-year analysis, but has an additional term measuring the time trend. This variable, which effectively allows the constant term to change over time, takes account of technological progress, inflation, or other such items that cause changes in the costs of all companies over time. The regression equation in this case is:

$$C_{i,t} = a + b_1 L_{i,t} + b_2 P_{i,t} + b_3 Q_{i,t} + \dots + T + u_{i,t}$$

where  $T$  is the time trend, and  $L_{i,t}$  is the value of variable  $L$  for company  $i$  in time period  $t$ , and so on. Finally,  $u_{i,t}$  is the regression residual which indicates the gap between actual and predicted (average) efficiency for each company in each time period.

It is possible to run panel data analysis with an “unbalanced panel”; that is a dataset that does not contain an observation for each company in every year in the panel. If, for example, the panel covers eight years, it is possible to include firms in the panel, which are missing data for some of those years (for example a firm which has data for only 5 of the 8 years), without the model being adversely affected.

The availability of multiple observations for the same firm in different periods permits the estimation of a specification that distinguishes the efficiency error from the random error. If the efficiency error is constant over time, the error  $u_{i,t}$  can be rewritten as the sum of a company-specific efficiency error  $w_i$  and a separate, independent random error  $v_{i,t}$  that is normally distributed. This is known as the panel fixed effects model and can be estimated using dummy variables for each company, whose coefficients capture the efficiency of the companies. An alternative specification assumes that the efficiency errors  $w_i$  are not fixed but are random variables drawn from (perhaps) heteroskedastic distributions – known as the random effects model. Thus, the relative importance of the efficiency and random errors depends upon the data and the model specification rather than being imposed by the analyst.

Even so, one must bear in mind that the efficiency fixed effects capture not only differences in efficiency but also systematic differences between companies caused by explanatory factors that are not included in the model. This applies to the OLS and other specifications but the omission of relevant explanatory factors may be problematic with panel data.

## 7. Stochastic Frontier Analysis (SFA)

A significant drawback of both OLS and GLS regression analysis is that they both implicitly assume that the whole of the residual that is obtained for any company in any period of time can be attributed to relative inefficiency (or efficiency). However, it is possible, if not probable, that the residuals from such an analysis will include unexplained cost differences that are the result of data errors and other factors affecting costs that have not been picked up in the regression equation. Stochastic Frontier Analysis (SFA) builds on the methodologies outlined above and aims to address this shortcoming.

There is an extensive academic literature on efficiency measurement using SFA, and this technique is increasingly being used by utility regulators to measure efficiency. It is based on regression analysis, but has two distinctive features:

- In contrast to OLS and GLS regression analysis, SFA models incorporate the possibility that some of the model residual may result from errors in measurement of costs or the omission of explanatory variables, as opposed to the existence of genuine inefficiencies. This decomposition of residuals between 'error' and 'genuine inefficiency', which is based on assumptions made about the distributions of the 'error' and 'genuine inefficiency' terms, is intended to provide a more accurate reflection of the true level of inefficiency.
- Secondly, the regression for SFA looks not at the average firm, but at the theoretically most efficient one.

In the case of data for just one year SFA estimates the equation:

$$C_i = a + b_1 L_i + \dots + v_i + u_i$$

where '...' indicates the other variables included in the model.

The residual in a stochastic frontier model is assumed to have two components: the  $u_i$  component, which represents the genuine inefficiency; and the  $v_i$  component, which represents the genuine error. In econometrics literature,  $u_i$  is often referred to as the inefficiency term and  $v_i$  is often referred to as the random error.

In order to be able to decompose the residual into inefficiency and random error it is necessary to make assumptions about the distributions of its two components. For single year SFA models, the inefficiency term is assumed to follow a non-negative distribution (such as the half-normal or truncated normal distributions), whilst the genuine error term is assumed to follow a symmetric distribution. By making these assumptions the technique is able to decompose the residual by fitting the assumed non-negative distribution to the residuals to identify the proportion of the residuals that can be explained by this distribution.

Having to make such assumptions is a key disadvantage of single year SFA, as the appropriateness of these assumptions cannot accurately be measured.



## 8. Multi-year stochastic frontier analysis

SFA can also be applied to panel data. This involves estimating a regression equation of the following form:

$$C_{i,t} = a + b_1 L_{i,t} + b_2 P_{i,t} + b_3 Q_{i,t} + \dots + T + v_{i,t} + u_{i,t}$$

where  $T$  is a time trend variable that identifies the change over time in the regression constant,  $i$  represents an individual company observation and  $t$  represents the time period. With this specification, residuals can be different for each firm and for each year. Once again, in a multi-year setting, SFA decomposes the residual between inefficiency and error by making assumptions about the statistical distributions of these two components of the residual.

The advantages of using panel data over simple cross-sectional data (single year data) is that with cross-sectional data in SFA analysis, strong assumptions are required about the statistical distribution of the inefficiency component of the regression residuals and, in many practical cases when cross-sectional data are used, insufficient data are available to support these assumptions. There is often little evidence to suggest which statistical distribution is appropriate in constructing a model, and in many cases, more than one distribution may be deemed to 'fit' the data. The use of panel data in contrast, allows for these distributional assumptions to be relaxed. By observing each firm more than once, inefficiency can be estimated more precisely as firm data is embedded in a larger sample of observations.

Specifically, with panel data, it is possible to construct consistent estimates of the efficiency level of each firm, as the number of time-series observations per firm ( $t$ ) increases.

In early SFA panel data studies, however, the benefits described above came at the expense of another strong assumption, namely that relative firm efficiency does not vary over time (that is,  $u_{i,t} = u_i$ ). This may not be a realistic assumption, especially in long panels. Recent studies on this issue, however, have shown that this assumption of time-invariance can be tested, and can also be relaxed, without losing the other advantages of panel data.

Reflecting these points, NERA has applied two different possible parameterisations of the inefficiency term  $u$  to the SFA panel.

- A time-invariant model where the inefficiency term is assumed to be constant over time within the panel; and
- A parameterisation of time effects (time-varying decay model) where the inefficiency term is modelled as a random variable multiplied by a specific function of time:

$$u_{i,t} = \varepsilon_i \cdot e^{\eta(t-T)}$$

where  $T$  corresponds to the last time period in each panel and  $\eta$  is the decay parameter to be estimated.

Again, it is the specification that provides the basis for separation of efficiency and random errors. The equation above has the same error component structure as for the panel GLS model but it goes further; (a) by assuming that the efficiency error can only take positive values, and (b) in the time-varying model by allowing the errors to follow some trend over time.

## 9. Assessing the Regression Model

Before drawing conclusions about relative efficiency, it is essential to verify that the regression equation is theoretically and statistically valid and that it represents the best possible model, if there is more than one possibility. The types of questions likely to be raised in this context are:

- How well does the cost model fit the observations? Is there a large proportion of cost variation that is left unexplained by the variation in the chosen explanatory factors? Under Ordinary Least Squares analysis this is measured by the coefficient of determination  $R^2$  (or a variation on it);
- Are the coefficients sensible? For example, does the model predict that costs will rise (rather than fall) as population increases, as intuition and experience would suggest? Care must be taken here to consider the possible impact of multicollinearity, which may make some coefficients appear unintuitive when they in fact are closely related to other variables; and,
- Are the coefficients statistically significant? In other words, can we be confident that the relationship described is a statistically valid one?

Even if the model appears to be satisfactory, there are several potential sources of inaccuracy; namely:

- Inaccuracies of functional form; it is unlikely that in practice the model's functional form is known exactly in advance. For example, are costs linearly related to the network length or is the functional form more complex? Does logarithmic transformation of explanatory factors give a better or worse fit?
- The omission of relevant variables. The accuracy of regression analysis in measuring relative efficiency depends to a large extent on the degree to which all relevant explanatory factors have been included. If, for example, hilly countryside had a significant adverse effect on costs but was ignored in the regression study, then those companies serving hilly terrain might appear to have unduly high costs simply because of their location rather than because of inefficiency;
- Conversely the "law of parsimony" applies such that better equations tend to have fewer explanatory variables than those which seek to encompass every single potential explanatory variable as a cost driver. Whilst  $R^2$  will undoubtedly improve as extra variables are included it is worth noting that such an approach based wholly on improving "goodness of fit" can easily lead to spurious regression. A famous example in

the literature is that it is easily proven statistically that sunspot activity is a precursor to economic booms and vice versa; and,

- A lack of independence among the cost drivers. For meaningful results, there need to be many more independent observations than the number of cost-driver coefficients being estimated (in econometric terms, there need to be many degrees of freedom).

## **10. COLS based efficiency analysis; our approach & options**

In this section we outline our primary approach to setting operational efficiency targets for NI Water and the full suite of Ofwat operating expenditure models we use when applying the COLS approach to NI Water.

### **10.1. Ofwat COLS models**

The following is a re-statement of the latest Ofwat suite of COLS models and can be found on their web-site [relative efficiency analysis 2007-08](#).

*We assess relative efficiency separately for the water and sewerage services. We assess operating expenditure relative efficiency for the water service using four econometric models:*

- *water distribution;*
- *water resources and treatment;*
- *water power; and*
- *water business activities.*

*We assess operating expenditure relative efficiency for the sewerage service using two econometric models and three unit cost models. The econometric models are for:*

- *large sewage treatment works; and*
- *sewerage network including power.*

*The three operating expenditure sewerage service unit cost models are for:*

- *small sewage treatment works;*
- *sludge treatment and disposal; and*
- *sewerage business activities.*

### **Water Operating Expenditure Models**

#### *Water distribution*

*We have used a new form of this model for 2007-08. The new model is a log model expressed in unit cost form with the number of connected properties at year end as the scale variable. A density variable (length of mains/number of connected properties) is used as the cost driver in this model. We previously used the proportion of large mains to small mains as the cost driver in this model. This was used as a proxy for urbanisation.*

#### *Water resources and treatment*

*This is a linear model expressed in unit cost form with resident winter population as the scale variable. The model uses the proportion of supplies from boreholes as an explanatory variable. We also take into account the explanatory variables of number of sources and distribution input. These variables ensure that we take into account economies of scale at source level (costs will be lower if fewer sources are used) and the difficulty of treatment (borehole supplies will generally be cheaper to treat).*

#### *Water power*

*This is a log linear model. For most companies, power expenditure is almost entirely for pumping, although there are some water treatment processes that use a lot of energy. The model considers the effects of terrain (companies in hilly areas will require more power to move water around) and the significant economies of scale associated with high power consumption. The cost drivers in this model are average pumping head and distribution input.*

#### *Water business activities*

*This is a log linear model. Business activities include customer services and scientific services, and the charge for doubtful debts. The cost driver is the number of billed properties. The model takes into account the economies of scale associated with high volume billing and customer service activities.*

### **Sewerage Operating Expenditure Models**

*Three of the operating expenditure models for the sewerage service are unit cost models for:*

- small sewage treatment works (and sea outfalls);*
- sludge treatment and disposal; and*
- business activities.*

*The remaining two operating expenditure econometric models for the sewerage service are set out below.*

#### *Network including power*

*This is a log linear model expressed in unit cost form with the total length of sewer as the scale variable. The explanatory variables used in the network model are:*

- sewer length;*
- area of sewer district;*
- resident population; and*
- holiday population.*

*In simple terms, the model takes account of the density of the sewerage network and the population it serves, and the higher costs associated with the sewer capacity required to serve additional summer populations.*

#### *Large sewage treatment works*

*This is a log linear model. It uses a number of explanatory variables that take account of the total load, the type of treatment used, and the nature of effluent consents. These explanatory variables affect costs (it is more expensive to meet tight effluent consents, for example).*

All but one of Ofwat's regression models are estimated in natural logarithms (ln). The main reason for this is to enable equal weighting across companies within the E&W industry regardless of size. Also, it simplifies the interpretation of estimates co-efficients, as they indicate the relative change in expenditure when the value of the cost driver changes by 1% (only when both are in natural logarithms).

For example, the coefficient on the Water Distribution Expenditure model, which accounts for just over half of NI Water's modelled operating expenditure, equals 0.713 indicating that if length mains (km) per connected properties at year end increases by 1% then distribution expenditure will rise by 0.713%. In other words, there are economies of scale.

#### **10.2. AIR08 (NI Water only) & JR08 confidence grading**

On comparing the explanatory variables required to enable a COLS approach to NI Water's AIR08 return to those evidenced within the E&W industry, the majority of NI Water data exhibits a good degree of confidence. Most NI Water data is at least as good as that used by Ofwat, if not better as identified by our traffic lighting.

Given the continued absence of domestic billing, "household billed properties" displays the worst confidence grading. We discuss later an approach which avoids the use of such poor data altogether. Whilst the grading for "load received" is worrying at C3 the inclusion of two other variables with B3 and C3 gradings has to be viewed in the light of a further x31 B3 or worse gradings across the entire suite of E&W industry gradings numbering some x160 (= x10 water & sewerage companies by x16 explanatory variables). Just under 20% or 1:5 of all E&W industry explanatory variables is poorer in comparison to NI Water data.

**Table 5: Best and Worst Confidence Grades – Water Models**

Explanatory variable	E&W “best” CG	E&W “worst” CG	NI Water CG
Connected properties (000)	A1	B2	A2
Length of main (km)	A1	B2	B3
Winter population (000)	N/A	N/A	B2
Distribution Input (DI)	A2	B3	B2
% DI from boreholes (%)	A1	B2	B2
Average pumping head (m.hD)	B2	C4	B3
Billed properties (000)	N/A	N/A	N/A

**Table 6: Best and Worst Confidence Grades – Sewerage Models**

Explanatory variable	E&W “best” CG	E&W “worst” CG	NI Water CG
Area of sewer district (km <sup>2</sup> )	A2	B3	B2
Resident connected population (000)	A2	B3	A3
Holiday population (000)	A2	C4	B2
Length of sewer (km)	A2	B3	B3
Population equivalent (pe)	A1	B3	N/A
Load received (kg of BOD/day)	A2	B4	C3
Sludge load (ttds)	A2	B3	B2
Household billed properties (000)	A1	B2	C4
Non-household billed properties (000)	A1	B3	B2

On the above basis we see no reason not to include NI Water data to inform our COLS analysis of their relative efficiency to the E&W industry.



### **10.3. Model specifications**

Whilst we intend using the full suite of Ofwat COLS models to enable our own relative efficiency analysis of NI Water we have some concerns about the new Water Distribution Model. This is due to the fact that NI Water is a significant outlier in terms of the explanatory variable, which has the potential to skew the results. We shall examine alternative specifications with respect to this model by virtue of the outlier status of the Company.

If we decide to adopt an alternative model specification for water distribution we shall include this as an additional sensitivity within our triangulated approach.

### **10.4. Adjusted v unadjusted modelling**

Previously we advised the Minister for Regional Development on his setting efficiency targets for NI Water for 2008/09 and 2009/10; the two remaining financial years of the company's 3-year transition into a fully regulated company subject to our first price control covering 2010/11 to 2012/12, otherwise referred to as PC10.

In both cases we adopted an unadjusted modelling approach. Simply explained, our approach uses the Ofwat suite of OLS specifications (unit cost and regression models) and uses NI Water data to derive a set of residuals with which to examine NI Water's relative efficiency compared to the E&W industry.

An adjusted approach would allow for the re-estimation of the Ofwat models including NI Water data (and even Scottish Water data). The WICS has in the past examined re-modelling the Ofwat suite of models for inclusion of Scottish Water data but has likewise rejected such an option for comparative analysis.

The adjusted approach is not practicable or robust since we are often faced with a very large residual resulting in serious corrosion in the quality of the models. In some cases, the very low  $R^2$  values that attended the Ofwat models were destroyed altogether such that by incorporating NI Water data we end up with no statistical relationship between cost drivers (E&W companies plus NI Water) and the dependent variable.

Whilst this is the case it does not follow that we cannot rely upon the Ofwat specifications when examining NI Water's relative efficiency. Rather it is a result of NI Water entering the statistical computations as an outlier, a company that has not been subject to the same degree of incentive based regulation for as long as its E&W counterparts and which faces a much larger degree of efficiency catch-up than most others.

The fact that we then observe NI Water's residuals as very large in comparison to the E&W companies is the result of either of three reasons:

- i. NI Water's data quality and/or comparability of data is poor;
- ii. Estimated relationship from E&W data does not apply locally; or,

- iii. Estimated relationship does apply, but relative efficiency is very different to that experienced in E&W ie NI Water is very inefficient.

As regards the first, and as examined at Section 10.2 there is no reason to doubt the company's audited and Reported AIR08, whose modelling input data have confidence grades equally as good as the E&W industry.

As regards the second reason, whilst the company has not been subject to incentive based regulation for as long as the E&W industry it was administered by the Department for Regional Development as a government agency and subject to a great number of KPIs and targets similar to or the same as those it now finds itself called to account on by the Regulator. The company delivered both water and sewerage services across the province and was subject to virtually the same quality regulation from EHS (now NIEA) and the DWI for many years previous. This was no different to that expected of any water & sewerage company within the E&W or Scottish context.

Indeed, NIWS previously would have employed similar technologies and attempted to mimic procurement practices within the E&W industry as appropriate.

We can find no reason to cast serious doubt upon the applicability of E&W cost relationships to our local context, apart from the applicability of the Business Activities models in the continuing absence of domestic charging.

The third reason remains such that any large residuals remaining ought to indicate inefficiency in the company. We are therefore minded to remain with our previous approach to modelling COLS relative efficiency for NI Water by using unadjusted Ofwat specifications in preference to a crude re-estimation for inclusion of NI Water data.

#### **10.5. Special factors and Atypical costs**

We wrote to NI Water under cover of one of our earliest Water Regulation Letters (equivalent to an RD or MD letter from Ofwat) informing the company of both the requirements around any submission on special and atypical factors as well as our timescale.

##### ***Special Factors Criteria***

We expected NI Water to include information about each claim based upon the four criteria:-

1. What is different about the circumstances that cause materially higher costs?
2. Why do these circumstances lead to materially higher costs?
3. What is the net impact of these costs on prices over and above that which would be incurred without these factors? What has been done to manage the additional costs arising from the different circumstances and to limit their impact?

4. Are there any other different circumstances that reduce the company's costs relative to the industry norms? If so, have these been quantified and offset against the upward cost pressures?

***Treatment of Atypical Operating Costs***

NI Water were also invited to declare "one-off" expenditure as "exceptional" within their accounts or alternatively flag specific cost items they considered atypical at AIR08 submission.

Some examples of such costs taken from Ofwat have included:-

- Extreme climatic events;
- Unusual compensation payments to customers; and,
- Abnormal changes in pension contributions.

For both special factors and atypical expenditure we consider making adjustments to exclude allowed claims from our modelling and benchmarking analysis.

The timeline as amended to include a revised company submission subsequent to a new Water Distribution model is detailed below:

- NIW submit AIR08 (including atypical expenditures as "exceptionals") August 2008
- NIW submit AIR08 related special factor claims September 2008
- Revised NIW claim submitted February 2009
- NIAUR determines allowed special factor and atypical claims April 2009
- NIAUR Draft Determination August 2009 and Final Determination December 2009

NI Water kept to both the timescale (and subsequent requirement for a revised special factors claim based on a revised Water Distribution model) and the broad thrust of our requirements in advance of accepting any such claims. This provides a firmer basis for taking forward our efficiency analysis to the eventual setting of targets.

Indeed, the company is to be commended for the openness with which they suggested we raise efficiency targets by an amount to reflect the fact that NI Water have nowhere near the same costs of metering as in E&W.

Whilst we are unlikely to require such a negative special factor if we remove the business activities models from our analysis, we remain convinced of the requirement to apply a negative special factor adjustment to account for the fact that NI Water's business costs, particularly local labour rates, are materially lower than in comparison to the E&W industry. We will take into account an acceptable amount of NI Water's special factors and atypical expenditure claim, subject to our applying our considered negative special factor claim.

## **10.6. Discounts and efficiency bands**

After we have derived our modelled residuals and the differences between the water and sewerage models' actual costs and the costs predicted by the models, we intend reducing them somewhat to account for any errors in the data and in the statistical process supporting Ofwat's final choice of models.

We are minded to apply a cautious approach and to that end we shall model using two different assumptions as regards the likely quantum of error and triangulate such results in our determination.

### **10.6.1. Ofwat's 10% and 20% Discounts**

Ofwat adjust their water residuals by 10% and the sewerage residuals by 20%; this is entirely in favour of companies since it reduces the potential scope for savings prior to setting any efficiency targets. To date we have been unable to locate any reasoned argument in favour of these very precise percentages, other than the fact that experience to date unequivocally supports the imposition of incentive based regulation upon the E&W water industry, albeit the companies concerned are profit maximising PLCs.

Had these percentage estimates been widely wrong and/or material to the analysis they may have resulted in the setting of inappropriate efficiency targets. The question, whilst appearing at first sight to be one at the margins of analysis, is material to protecting the consumer interest; poor efficiency analysis can have consequences both in the short and longer term. If targets are unduly stretching and based upon seeming arbitrary assumptions it may make any subsequent raising of additional loan finance and/or

subsidy only possible on the promise of higher returns. Conversely, lower prices now may only feed higher prices in the future.

With the above in mind, it was with the interests of the whole E&W industry that Professor Cubbin's advice was sought by WaterUK.

### **10.6.2. Cubbin's<sup>2</sup> Discounts**

The central question addressed by Professor Cubbin was to, "estimate the percentage of the residual from each (Ofwat) model which can be attributed to inefficiency as opposed to random noise, uncertainties and omitted explanatory factors".

The following sources of error in econometric models were examined:-

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<sup>2</sup> Assessing Ofwat's Efficiency Econometrics: a report for WaterUK (Mar-04) by Professor J. Cubbin, City University

- i. Sampling error – even with perfect data and models, econometric models provide estimates and are subject to statistical sampling error as long as there are limited observations
- ii. Measurement error (in the dependent variable) – there might be error in the measurement of the dependent variable
- iii. Omitted variables bias – certain explanatory variables might have been excluded from the analysis thereby to some degree biasing results
- iv. Poor proxies or errors in measurement – the explanatory variables used and chosen for any final specification may themselves be proxies for “real” cost drivers who are difficult or impossible to measure well enough. They will also be subject to their own degree of statistical sampling error
- v. Mathematical form – simply put, the wrong mathematical form may have been chosen to model the dependent variable against its cost drivers

Cubbin's findings, whilst largely based upon a subjective examination of each of the Ofwat models, were quantifiable at the functional expenditure level and summed on a weighted service basis to the following:

**Table 7: Cubbin's residuals (60% adding-back)**

Operating expenditure	Estimated proportion of residual attributable to efficiency (%)
<i>Water</i>	42
<i>Sewerage</i>	50

Cubbin stated that although the work would be subject to its own errors around such judgements, the calculations “are generally of the correct order of magnitude”. Indeed, one important adjustment to measurement errors was undertaken in deriving the above percentages. Whilst differences in cost allocation policies between companies would promote measurement errors, on average an overestimate of a company's efficiency on activity 1 would be compensated for by an under-estimate with respect to activity 2. Cubbin's response was to assume that 60% of measurement errors would be cancelled through an aggregation process; although the quantum of adjustment was not subject to any detailed analysis he suggested a 90% adding-back adjustment as a form of sensitivity. When applied at this level the resulting weighted adjustments are:

**Table 8: Cubbin's residual adjustment (90% adding-back)**

Operating expenditure	Estimated proportion of residual attributable to efficiency (%)
<i>Water</i>	45
<i>Sewerage</i>	53

We shall conduct sensitivity analysis around the use of Cubbin’s discounts to account for both the “adding-back” issue described above and with specific NI Water AIR08 based operating expenditure weights.

### 10.6.3. Efficiency banding

Another means by which Ofwat ameliorates its efficiency targets for any degree of inaccuracy in data and poor estimation is by setting efficiency targets at the mid-point of the range to which a particular company’s efficiency gap falls.

Although Ofwat does not report efficiencies for their companies it uses efficiency bands to group companies together (See Table 1) and reports ranks. This is done to protect companies’ confidentiality, but also linked to the reliability of data and/or model estimates since subsequent efficiency targets are set at the mid-point of each band. The highest implied efficiency target ever was 25.5% at band E after catch-up of 60% (equivalent to a 42.5% implied efficiency gap) and applied over their 5-year period in equal increments:

**Table 9: Ofwat efficiency bands**

Ofwat Band	Operating expenditure	Implied efficiency targets (60% catch-up)
A	Within 5% of benchmark	1.5%
B	Within 5 -15% of benchmark	6%
C	Within 15 - 25% of benchmark	12%
D	Within 25 - 35% of benchmark	18%
E	Greater than 35% or benchmark	25.5%

On the matter of whether we apply a similar approach to setting NI Water’s operational efficiency targets we reserve judgement until determination stages. Of note is the Scottish experience where the WICS chose not to apply efficiency targets within any theoretical maximum.

## 10.7. Choice of benchmark

We are not minded to follow Ofwat’s approach in our choice of benchmark. We may choose an alternative approach to Ofwat’s choice of benchmark where they use a modified least cost choice as a proxy for the efficiency frontier, using a set of criteria outlined below.

### 10.7.1. Ofwat’s criteria

Ofwat choose a separate benchmark company for both water and sewerage operating expenditure models, taken from the E&W industry. The benchmark is identified as the most efficient company, which:-



- has no special concerns in regard to the consistency of data with reporting requirements;
- has no special characteristics that are outside the control of management and which would significantly reduce costs relative to the industry norm; and,
- represents a reasonable proportion (>3%) of industry turnover.

In 2005, the aggregate of four small water only companies was used as the benchmark for water operating expenditure, in order to represent a reasonable proportion of the water industry.

#### **10.7.2. Celtic fringe**

The celtic fringe set of companies was first promoted by the previous N Ireland Water Service (NIWS) and includes South West Water, Welsh Water, Wessex Water and Scottish Water. NIWS contended that these companies represented many similar supply area geographic characteristics as locally. Whilst we presently have no standing arrangement for swapping data with the WICS we are able to model against a celtic fringe set including all the remaining companies.

Indeed, many previous commentators have argued that South West Water alone is the better comparator company for NI Water (NIWS) to be measured against.

We shall consider including the celtic fringe benchmark as part of our triangulated approach to setting efficiency targets.

### **10.8 Continuing efficiency assumptions**

Most regulators assess the trend in productivity growth over time before deciding upon views for their respective regulated industries. The extent of frontier shift for the industry is complicated by the present economic climate and expectation of a significant downturn nationally and across the island of Ireland.

We can normally expect as a direct consequence from a recession a shake-out, particularly within competitive industries, such that remaining firms display good levels of productivity. With the disappearance of lower productivity firms the industry would (*ceteris paribus*) display a rapid improvement in productivity; during the early 1980s recession the UK economy underwent a somewhat ephemeral productivity miracle.

The following examines recent research undertaken for Ofwat.

#### **10.8.1 Ofwat's PR09**

For our assessment of the scope for operating cost efficiency for our first Price Control of NI Water, covering the period 2010/11 to 2012/13 (PC10) we have taken Reckon's study for Ofwat. This builds on the UKWIR study 'Review of the approach to efficiency assessment in the regulation of the UK water industry' and identifies and explores other evidence to forecast future efficiency assumptions.

For PR09, Reckon advised Ofwat that they should, “forecast a rate of growth of 0 per cent per year relative to the RPI, for both water and sewerage”; appearing at first sight to be predicated largely upon an absence of a continuation of the 1990s privatisation effect for the E&W industry:

*“Between 1992/1993 and 2007/2008, base service operating expenditure in water and sewerage decreased relative to the RPI. The bulk of the cost reduction came in the years up to 2000/2001. We have made our forecast of 0 per cent per year on the view that the cost reductions relative to the RPI in the 1990s were brought about by privatisation and the development of incentive regulation, and that there will not be corresponding opportunities in the period from 2010 to 2015”.*

## **Key Assumptions**

### ***Privatisation Effect***

NI Water has already entered their own period of rapid change, similar to that of the E&W industry post-privatisation, and they continue their transformation from a government agency pre-2007 to a GoCo. This is important since we must therefore differentiate NI Water from the wider industry when setting frontier shift efficiency assumptions due to differences in the timing of our respective radical cost reduction programmes.

In constructing our COLS based efficiency analysis of NI Water compared to the E&W companies and Ofwat datasets, we shall implicitly reflect the previous E&W privatisation effect when establishing the extent of the relative efficiency gap facing NI Water. The speed of NI Water’s catch-up will then reflect the degree of success or otherwise of the recent imposition of incentive based regulation. On this basis, we are not minded to advocate any tougher forecast for the frontier shift facing NI Water compared to the E&W industry.

### ***Recent historical performance***

Although Reckon’s forecast is largely predicated on the above by use of time series analysis across split periods (growth in base service operating expenditure relative to RPI across 1992/93 to 2007/08, 1992/93 to 2001/2001 and 2002/01 to 2007/08) a variety of unit cost and expenditure data comparisons were possible. None were perfect and each displayed a unique degree of concern about vulnerability and limitation resulting from their choice of assumptions.

Reckon's preferred analysis of "LEMST unit costs"<sup>3</sup> uses the EU KLEMS database of 30 different industries over the period 1970 to 2005. The concern is that the E&W water industry trend in operating expenditure may simply reflect an atypical privatisation effect. Reckon examined a variety of other industries not subject to privatisation to the same extent as the water and sewerage industry, to establish whether any marked historical differences in growth of unit costs relative to RPI occurred which might otherwise suggest there are no corresponding opportunities for unit cost reductions in the future. Very few industries experienced any where near the reduction in LEMST unit costs experienced by the water and sewerage industry; consistent with the theory that a significant privatisation effect was at play during the 1990s.

In terms of Reckon's forecast growth rate of 0 per cent per year relative to the RPI the forecast percentage rate sits well and ranks 14<sup>th</sup> place over this period ie about middle of the range of industry LEMST unit cost growth rates evident between 1970 to 2005 (ranging from -2% to over 6%).

We are therefore minded to apply the same considerations to our own local context and advocate using the same forecast of frontier shift.

#### ***Differences in services immaterial***

Reckon chose not to differentiate between services as regards their forecast for operating expenditure frontier shift. Between 1992/93 and 2000/01 the compound annual growth rate in base service operating expenditure was the same for water and sewerage. From 2000/01 up to 2007/08 a difference of 0.7 per cent per year emerged in favour of sewerage but they found no reason to use such a difference to inform any future differential, either up/down for either service. We are therefore minded to apply the same considerations to our own local context and advocate using the same forecast for frontier shift.

#### ***Outputs and capital to be constant***

An important assumption used by Reckon in advancing their 0 per cent per year relative to RPI rate of growth is the absence of any change in the quantity and quality of outputs of the water & sewerage industries, and no change in the amount and quality of capital. Reckon undertook analysis to examine the extent to which differences between total operating expenditure and base operating expenditure might be explained by changes in

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<sup>3</sup> LEMST measures growth (relative to the RPI) in labour, materials, energy, services costs and taxes on production (net of subsidies) per unit of gross output that is not attributed to changes in the volume of capital. In other words, it is designed to capture, albeit imperfectly, the growth in operating expenditure per unit of output under conditions of *constant capital*. Otherwise changes over time in an industry's unit labour or materials costs may simply reflect changes in the capital stock within the industry.

The EU KLEMS dataset draws upon national accounts across EU Member States, Japan and the United States.

*output* such as billed properties and population served. Whilst by definition the difference between the two versions of operating expenditure ought to be enhancement expenditure, (*ceteris paribus*, higher operating expenditure is expected to deliver to a higher output level) such over-simplification did not lend itself to a complete understanding of how changes in outputs may lead to changing operating expenditure. The results of such analysis were unsurprisingly inconclusive.

It therefore does not seem inappropriate to apply the same assumption for constant output and Reckon's conclusions to our local context. Indeed, if we were to advocate a relaxation of the assumption of *constant output* we would necessarily require an upwards adjustment to NI Water's efficiency targets given its relatively poorer performance across a wide range of outputs, especially as grouped within NI Water's Overall Performance Assessment. That said, by adoption of the *constant output* assumption we are minded to take a cautious approach in regard to setting efficiency targets.

Regarding the *constant capital assumption*, Reckon's preference for use of LEMST unit costs ensures change in productivity due to changes in the volume of capital are effectively ignored. We might reasonably expect, pending determination stages of our own PC10 and approval of the new level of funding for NI Water's Capital Investment Programmes, the company's capital volume to increase thereby releasing further potential for reduction in costs as a consequence of improved productivity. We are minded to adopt the same forecast of future efficiencies at the industry level to Reckon, so that by implication we would take a cautious approach towards setting efficiency targets.

### ***Impacts from recession***

We have considered First Economics advice to WaterUK, the Budget 2009 and various commentators/forecasts for the current recession.

In the short term period advanced under our 3-year PC10 we consider it necessary to examine the potential impacts of short duration volatility in the RPI. Some of the principal factors at play include:-

- Wages – despite an anticipated squeeze in local public finances for 2010/11 onwards, and given the quantum of local efficiency savings have yet to be agreed between Treasury and Stormont, there remains a reduced likelihood of any sudden decline in infrastructure investment locally. Rather Stormont may choose to delay some of its infrastructure expenditure within the Programme for Government which may affect demand for the construction industry towards the latter end of PC10, perhaps more so for PC13.  
As such the labour market facing NI Water will likely be less affected by the contraction in the economy (whether “V-” or “U-” shaped) compared to other

industries. Input costs facing the water industry will not be subject to the same extent of favourable downwards pressure as other industries, other things being equal;

- Labour/capital mix – as regards the water industry’s operational environment, there is much more reliance on labour than other industries.  
Given our geographical position in the world, local competition has to a degree been less favourable with respect to certain industries, especially where market entry costs have been subject to i) higher transportation/importation costs; and, ii) reduced scope for economies of scale within the local market place given the relative size of the Province compared to GB and/or the RoI.  
The expected decline in prices for materials of all types will not affect the water industry as favourably as other industries, other things being equal; and,
- Commodity prices – since the water industry tends to consume a larger proportion of materials subject to a higher degree of influence from commodity input prices it is likely, other things being equal, to experience a more favourable reduction in price inputs compared to other industries.

On balance, we would agree with Frontier Economics’ expert judgement that over time the major influencing factors cited above will act to cancel themselves out with regard to operational expenditure; the first two factors offsetting the third.

### **Conclusion**

Finally, Reckon are quite transparent as regards their thought processes in arriving at the 0 per cent per year; its not a result of a logical conclusion to any one piece of analysis, rather it’s a subjective view taken in the light of an analysis of recent historical performance data.

We can conclude that we are minded to apply the same consideration to our own local context since we can find no material reason to dis-apply any of Reckon’s conclusions based on their analysis. Our view may alter if we decide to materially uplift NI Water’s allowed operating expenditure across PC10 for likely input price pressures.

That said, there may be material timing/profiling issues associated with RPI volatility relative to NI Water’s input price inflation in the short term. In the event of our being unable to reliably forecast such movements in the short term we would be minded to profile frontier shift using an average across the 3-year PC10 regulatory period, in other words apply 0 per cent per year in each and every year.

## 11. Application to AIR08 costs

There are a number of considerations we shall be required to make decisions on in respect of AIR08 costs. This is somewhat similar to the situation pertaining to our advising the DRD Minister on setting operational efficiency targets in the recent past. Sometimes there is good reason to exclude certain operating expenditure from efficiency targets and sometimes the converse is true. Such considerations are outlined below.

### 11.1. Controllable v uncontrollable costs

Ofwat's practice is to apply COLS relative efficiency targets to all operating expenditure, despite the fact that certain items of expenditure are excluded from modelling on the basis that they are "uncontrollable" or uncorrelated with the modelled cost drivers.

We intend excluding the following costs from NI Water's AIR08; service charges, expenditure on local authority rates, exceptional items and third party services.

Whilst it is correct to exclude such costs to ensure "like for like" comparison across the industry and between NI Water and the E&W industry, and exclude such allowed atypical and special factor expenditure, excluded costs remain within management control. On this basis, we are minded to apply efficiencies to all of NI Water's operational expenditure. As regards to our panel data and SFA modelling we are minded to adopt a total operating expenditure approach (including all uncontrollable or previously "excluded" costs) and compare against "controllable" opex results. Such comparison ought to shed some light on whether the argument to exclude/include certain costs is material to setting efficiency targets for NI Water at PC10 (into PC13).

The exception to this rule is atypical expenditure associated with the BIP and VER expenditure. Although both special factors and atypical costs will be excluded for the purpose of calculating the efficiency percentage, BIP and VER costs may be excluded from the total of operational expenditure subject to efficiencies. This is due to the fact that the Regulator may determine these costs as fully allowable if NI Water can offer convincing argument that such costs are designed to improve their overall efficiency and are:-

- ring fenced for the remainder of their duration ie they will expire during the PC10 period;
- their continuation into the PC10 period has been entirely due to unavoidable delay(s) outside the control of management; and,
- such costs are material.

Consider the example below:

Company A's Actual Cost = £200m  
Predicted Cost = £150m



Special Factor = £10m

Atypical expenditure = £10m

Relative Efficiency (%) =  $(200 - 10 - 10) / 150 = 120\%$  (20% over what the company should be)

Efficiency Target Reduction =  $£190 / 1.2$  (adding back specials but not atypical) = £31.7m

Target Cost =  $£200m - £31.7m = £168.3m$

As the example shows, both special factors and atypical cost are excluded in order to calculate an appropriate efficiency gap. However only the £10m atypical cost is exempt from efficiency targets as these costs are fully allowable. Were they subject to the efficiency treatment the target cost reduction would be more severe.

### **11.2. Excluded models**

Given the fact that domestic charging remains deferred NI Water's billing costs were artificially lower than would otherwise be the case in the E&W industry. Hence, using the Ofwat Business Activities models (water and sewerage) would not allow for a robust comparison to inform our COLS relative efficiency analysis. In simple terms we would be trying to compare "apples with pears". In our advice to Minister in respect of setting efficiency targets for 2009/10 we made the decision to exclude these particular models from our analysis of relative efficiency.

To do otherwise would have required heroic assumptions on what might have been a reasonable cost for billing domestic customers and we are minded to adopt a similar approach to our COLS analysis in support of PC10.

We remain able to model using our COLS approach (86% of total modelled operating expenditure reducing to 79% of total operating expenditure, including uncontrollable costs) since the Business Activities models account for a relatively small proportion to total operating costs. We are therefore minded to exclude both Business Activities models from our COLS analysis.

### **11.3. Treatment of PPPs**

PPP should form part of the efficiency assessment for PC10. The 2007-08 baseline does not include PPP costs, but represents the starting point for efficiency improvements upon which catch-up efficiencies are to be applied. The fact that assets will transfer to outsourced contractors does not change this requirement. We recognise that NI Water have limited scope to influence changes to such contacts so soon after commissioning.

However, the Utility Regulator (much like WICS) assumes that PPP contractors are likely to be more efficient than the current situation and should therefore be allowed to contribute to achieving the overall efficiency target. By PC13 when the unitary charges are well

established and arrangements around GainShare have been tested, it will be appropriate to include these costs within a separate efficiency assessment of PPPs.

Over time a comparative modelling approach to PPPs is to be developed; between and intra-company (ie PPP compared to the rest of NI Water's activities). This will facilitate appropriate PPP costs pass-through subject to an efficiency test.

Given the PPPs will begin operations fully during the PC10 period and NI Water's previous statement that they will realise immediate efficiencies from the PPPs, there is limited scope to increase PPP efficiencies other than through GainShare. Testing PPPs for efficiency will become more important in time and for PC13 once we have AIR09+ data, especially as GainShare does not easily facilitate  $P_0$  adjustments.

For PC10 there is a strong argument in favour of NI Water using PPP efficiencies to meet their PC10 efficiency targets (AIR08 based). We are minded to adopt this approach in light of data issues (which will vastly improve by PC13) and the fact that PC10 is a shorter regulatory period than usual.

## **12. Rate of catch-up**

To provide NI Water with adequate incentive to both meet and outperform their efficiency targets we shall apply the incentive based regulation used by both Ofwat and WICS; involving “carrots” and “sticks” alongside an eventual ratchet of baseline operating expenditure going forward into PC13.

### **12.1 Ofwat**

Ofwat regulates water and sewerage companies that are plcs and who are subject to the vagaries of the marketplace. As a consequence they have settled upon a catch-up rate of 60% for operational expenditure efficiencies over 5-years with a rolling incentives arrangement whereby savings made in the latter part of the regulatory period are carried across into the next subject to a maximum of 5 years. Continuing efficiency assumptions were split equally by “carrots” and “sticks”.

Afterwards a  $P_0$  adjustment is made such that reduced operating expenditure is carried across for future period baselining; 100% of the efficiency saving is handed back to consumers in the form of a reduced revenue requirement which *ceteris paribus* would be expected to lower bills.

### **12.2 WICS**

The WICS approach to setting catch-up factors for Scottish Water was predicated upon the view that the larger the operational efficiency gap the more likely a company can make larger efficiency savings and more quickly. On this basis, WICS have always taken a robust position such that in the early price controls they expected 80% catch-up across a 4-year

period (SR02 covering 2002-06). More recently they reduced this early robust stance to 50% at SR06 (2006-10).

We are minded to anticipate the same degree of scope for large efficiency savings for NI Water as was experienced by Scottish Water during its early years.

### **12.3 Local considerations**

There may also be some truth in an argument that the historical development of NI Water's network may require higher than normal operating expenditure. If this is the case, network imperfections might be resolved but only at the required additional cost to capital investment which may prove prohibitive both from a funding, but also a value for money perspective. We are not however aware of any definitive research that proves such an argument.

That said, we are minded to treat very large gaps in inefficiency with caution. Hence our preference for a mixture of analysis to enable a triangulated view of both the required or relative, and achievable year on year efficiencies established by an examination of industry precedent.

Two undeniable facts mark out NI Water as different to the E&W industry. First, NI Water as it presently operates has weaker incentives in comparison to the E&W industry to outperform. As such, there is a reduced imperative to hold out similar "carrots" to the E&W industry where 40% of a company's efficiency gap may be earned as outperformance, or excess profit. Second, we have not made any attempt to adjust our efficiency analysis for any lower level of service experienced by NI Water customers compared to that which would otherwise be the case if they were served by an E&W comparator company. Had we done so we would add additional expenditure into our modelling thereby increasing the degree of efficiency challenge faced by NI Water.

We are therefore minded to apply a high catch-up rate similar to that experienced in the Scottish context, although we shall include in our triangulation approach a number of sensitivities around differing catch-up assumptions.

## **13. Conclusion**

Having taken a view based primarily upon our COLS modeling, allied to our panel data and SFA approaches and alongside our views on frontier shift, our approach will be that which we have already laid out for NI Water in the PC10 Business Plan Information Requirements. This will therefore require geometric profiling of efficiencies having taken a view on NI Water PC10 Business Plan expectations, subject to our taking a view on allowed operating expenditure during determination stages.

We would welcome feedback from NI Water on both the scope of our intended efficiency analysis and the approaches we are minded to pursue. We hope this methodological note facilitates the required degree of understanding for NI Water to make constructive comment and representation within their PC10 Business Plan submission on 1<sup>st</sup> June 2009.