Private & Confidential
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Ofwat
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12 December 2014

Dear Sonia,

PwC review of Thames Water's doubtful debt cost models

Under the terms of Service Order SER/0379, you asked PricewaterhouseCoopers LLP ("us") to carry out a review of the econometric analysis undertaken on behalf of Thames Water ("TMS") by National Economic Research Associates Ltd ("Nera"). This analysis was used to support a doubtful debt and customer contact cost adjustment submitted in TMS' October 2014 representations. The adjustment claim covered Asset Management Period Six ("AMP6") which is the period from 2015/16 to 2019/20.

In their previous representations, TMS proposed a bad debt adjustment relating to increased bills as a result of the Thames Tideway Tunnel. This adjustment claim was not allowed by Ofwat in TMS' Draft Determination and has since been discontinued by TMS. Subsequently, TMS submitted a new bad debt adjustment claim in October 2014 related to above average levels of population transience in their area. We advised Ofwat on the robustness of the analysis TMS submitted. This letter describes the comments provided by us to Ofwat.

The value of the population transience related adjustment requested by TMS is £93.2m over AMP6, comprising £84.7m for doubtful debt and £8.5m for additional customer contacts[1].

Analysis submitted, October 2014

The rationale for the transience adjustment is that households that commonly move between locations are less likely to pay their bills and will have higher levels of doubtful debt. TMS attribute this to several factors, for example, it is more difficult to enforce sanctions for non-payment when transience is high and tracing and debt liability can also be more challenging[2]. In addition, with high levels of transience, a greater number of customer contacts may be needed to manage account closure and opening.

TMS submitted three principal pieces of analysis to support their transience related claim:

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[1] These values are in 2012/13 prices.

[2] Greater details of the rationale can be found in Appendix D TMS October Retail Household Submission (see page 50), and also a report by UKWIR which is referred to "Forecasting Future Levels of Water Debt" Report Ref. No. 13/CU/04/7, 2013, p.21.

1. They commissioned Experian to develop a bespoke measure of population transience for water companies, and assemble data on other proxies for transience – such as the proportion of homes that are privately rented and the age of householders;
2. They commissioned Nera to conduct econometric modelling to link doubtful debt to measures of transience;
3. They performed analysis that linked transience to customer contact related costs.

Experian transience measure

Due to the challenge of accurately measuring transience and the lack of an established data set, TMS commissioned Experian to develop a bespoke measure. Experian's analysis uses ONS data from a number of sources, including the 2011 Census and Annual Population Survey, to estimate a transience measure at a local authority level which is mapped to each water company's area. The measure is constructed as the sum of in-migration, out-migration and short-term migration[3] occurring in a given year, divided by the total resident population of the area. On this measure, TMS has the highest transience of any water company, and is 46% above the industry average[4].

Experian also compiled several publically available proxy measures for transience including the proportion of short-term residency in an area, the average age of the household head and the share of households in private rental properties. Each of these proxy measures suggests that TMS has the highest transience of all companies.

Nera econometric modelling

TMS also commissioned Nera to build an econometric model that links doubtful debt to the share of private rental accommodation in the overall housing stock. The approach broadly follows previous modelling approaches used by Oxera for selected companies that sought a bad debt adjustment as part of PR14, but data on the share of private rental properties has been added to the regression.

In the single model presented, the dependent variable is doubtful debt per unique customer; the independent variables are the share of private rental properties, the index for multiple deprivation, average combined bills and year dummies. A random effects panel model approach is used.

The model has been used to generate forecasts using 2 approaches – these again follow previous Oxera approaches[5]. In both cases the model is used to forecast TMS' doubtful debt costs based on: (a) TMS' current profile with respect to private rental properties; and (b) the industry average share of private rental properties. The comparison of these two numbers is used to estimate an adjustment value for TMS.

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[3] Short term migrants are those who both move in and out of the area within the same year.

[4] Note that the underlying data used in this analysis was not made available to PwC and that assuring the underlying data is outside of the scope of our review.

[5] A future time trend is generated in order to produce the forecast. The future time trend is either estimated on the period 2013/14-2019/20 (approach 1) or 2008/09-2019/20 (approach 2)

These approaches were used to estimate an adjustment value for doubtful debt costs of between £76.0m and £79.4m over AMP6 (in 2010/11 prices). The lower value of £76.0m was taken by TMS as the basis of their claim[6]. The economic rationale for this adjustment is that it implicitly assumes that the current difference in the share of privately rented properties between the TMS region and the industry average will persist during AMP6. No reduction in future costs due to efficiency improvements was assumed in the proposed adjustment.

Comments and results from statistical tests

We note several issues with the econometric analysis submitted.

- The Nera report makes no reference to the bespoke measure of population transience that was developed by Experian. Rather, it uses one of the proxy measures instead (the share of households in private rented accommodation). Where possible, it is preferable to use a direct measure over a proxy since this should more accurately reflect the effect that is being hypothesised. We conducted indicative testing using the Experian measure of population transience within the Nera model and it appeared to have no statistically significant relationship with doubtful debt[7].

- In modelling the impact of historic trends in the share of private rented accommodation on doubtful debt, Nera use a value for all years between 2007/08 and 2012/13 that appears to be based on 2011 data. This approach does not account for the changes in the level of private rented accommodation since 2007/08. We reviewed historic data and there have been significant trends in recent years. For example, between 2007 and 2011, the number of private rented properties grew by 30% in England and 26% in London[8].

- In addition, Nera appear to have made no attempt to forecast the share of rental properties in the future. Under the approach used to estimate the potential adjustment value (described above), the key driver of the adjustment is the difference between the share of private rental properties in TMS' area and the industry average. Nera have implicitly assumed that this difference will remain constant in the future at the 2011 level. However, there is no discussion or justification for this critical assumption. For example, the analysis could have assessed historic trends in the data, reviewed any publically available forecasts, or considered how underlying drivers of the private rental market may evolve over AMP6 in different geographies.

- The models did not perform as well on statistical tests as previous versions of panel model analysis we reviewed, for example those submitted by South West Water and Dŵr Cymru (full test results are given in the Annex).

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[6] Note that when uplifted to 2012/13 prices using RPI this becomes £84.7m, as mentioned in the introduction.

[7] Note that in this indicative test we replaced the private rental variable with the Experian Population Transience measure. We followed Nera's approach to modelling historic trends in the data (i.e. we assumed that the single transience data point reported by Experian applied to the whole period 2008-2013). Both the levels and logarithmic values of the transience index were tested.

[8] Based on DCLG data on housing tenure. Note that we have reported this at a regional level not a company level as we have not undertaken a mapping analysis to company boundaries. However, it serves to illustrate the significant trends observed in the data.

- In particular, the models failed tests on the statistical properties of residuals, and the Sargan-Hansen test showed that a fixed effects approach should have been used rather than the random effects approach. The implications of the tests on residuals are that outliers may be an issue with these models, which can be controlled for using alternative regressors (e.g. a quantile regressor). This would result in different coefficients and estimates from the models. The Sargan-Hansen test implied that the results of a random effects model will be biased.

- We also note that the approach broadly follows the previous Oxera approaches we have reviewed and therefore shares their limitations. Whilst we focus on new issues above, a thorough exposition of the additional issues can also be found in our published letter on South West Water's submission[9].

Customer contact related costs

In addition to the doubtful debt claim, TMS submitted a claim for the cost of additional customer contacts related to the high levels of transience in their area. The rationale for this adjustment is that greater population transience leads to more phone calls and web form submissions (for account closure, issuing final bills, etc.) and additional meter readings.

TMS calculated this adjustment using the Experian transience measure (which suggests that transience in the TMS area is 46% above the industry average) combined with management data on costs related to calls and web form submissions for home moves, the issuance of bills for account closure and the number of meter readings relating to 'change of customer'.

The adjustment is then calculated based on 46% of these costs (this being the proportion of costs deemed to be in excess of the industry average). Whilst this approach appears to be broadly reasonable, we note that no assumption has been applied to reflect potential improvements in efficiency over AMP6. Also, as in the Nera analysis, there is no discussion or attempt to forecast the potential evolution of transience in the future, both in TMS' region and at an industry average level.

Summary

We have some concerns with the modelling undertaken linking private rental data to doubtful debts, principally that the approach taken does not adequately account for historic or potential future trends in private rental levels in TMS' region or at the industry average level. In terms of these methodological issues, and based on the test results, these models appear to perform less well than other versions of panel data econometric modelling that has been reviewed as part of this process, such as those submitted by South West Water and Welsh Water.

Another concern is that modelling using the Experian data on transience rather than private rental data suggests that there is no link to doubtful debt. This raises significant doubt over both the validity of the relationship found with the private rental proxy, and the estimated value of the adjustment in the absence of any further corroboratory evidence.

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[9] See "PwC review of South West Water's doubtful debt cost models" PwC, 29 April 2014.

![pwc logo]

Yours Sincerely

PricewaterhouseCoopers LLP

Annex – results of statistical tests

Summary of statistical test results (test values given in parentheses)

Test	Nera model
Ramsey RESET test for model specification	Failed using fitted value of independent variables (0.0000) Failed using fitted value of dependent variable (0.0000)
Linktest model specification test	Failed (0.006)
Breusch-Pagan test for heteroskedasticity	Failed (0.0000)
Shapiro-Wilk test for normality of residuals	Failed (0.0232)
White test for residual normality after Panel regression	Failed (0.0446)
Breusch-Pagan test on the validity of a random effects or pooled OLS approach	RE preferred to OLS (0.0000)
Sargan-Hansen test – on the validity of a random effects or fixed effects approach	FE preferred to RE (0.0200)

A model specification test (Ramsey RESET) was failed. The results of this test cannot be relied upon as they are not valid when heteroskedasdicity tests are failed (as is the case in this model). But if taken at face value the results suggest the model may have the wrong functional form (e.g. it may be the case that it should not be linear). This can also be indicative of omitted variables. A different model specification test (Linktest) was also failed.

We performed tests on whether the statistical properties of model residuals (i.e. the difference between the actual and modelled values) were consistent with those expected under a given modelling approach. The model failed the White test for normality of the residuals and the Shapiro-Wilk test. This suggests that some other estimator beside the ones used may have been more suitable (e.g. a robust or quantile regression approach).

A further test on the statistical properties of residuals (heteroskedasdicity) was also failed. This was controlled for by the use of robust standard errors in the regressions.

There is a standard test for panel data models (the Breusch-Pagan test) to identify whether a random effects model is more appropriate than an Ordinary Least Squares (OLS) model. This test confirmed that the random effects approach was preferable to the OLS approach.

Further tests can be used to assess whether a fixed effect panel approach is preferable to a random effects panel approach. Under heteroskedasticity (which tests show was present in this model), it is necessary to use the Sargan-Hansen test to determine whether a random effects or fixed effects model is more appropriate. The Sargan-Hansen test showed that the fixed effects approach should have been used for the model. However, the random effects approach was actually applied which has led to bias in the coefficients.