



Private & Confidential  
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29 August 2014

Dear Sonia,

### **PwC review of Severn Trent'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 Severn Trent Water ("SVT") by Frontier Economics Ltd ("Frontier"). This analysis was used to support a doubtful debt cost adjustment submitted in SVT's Retail Business Plan for Asset Management Period Six ("AMP6") which covers the period from 2015/16 to 2019/20.

In their December 2013 submission, SVT's proposed bad debt adjustment was not supported by any econometric modelling. SVT subsequently submitted a model in June 2014 to corroborate their earlier analysis. We advised Ofwat on the robustness of this modelling. This letter describes the comments provided by us to Ofwat on the June 2014 model.

### **Summary of June doubtful debt cost submission**

In June 2014, SVT submitted econometric modelling to support their original bad debt adjustment claim. This included analysis by Frontier that used a cross industry panel model to produce an estimate of the adjustment based on unemployment and bill levels.

The original adjustment value (submitted in December 2013) was for bad debt costs of 2.7% of revenues over AMP6<sup>1</sup>. The total bad debt cost computed from this percentage was compared with SVT's estimate of its allowable cost under the ACTS. This led to an adjustment value of £15.6m on an estimated total bad debt cost of £165.5m over the duration of AMP6 (in nominal prices).

In the June 2014 submission SVT slightly reduced their total doubtful debt claim to £162.4m over AMP6 due to a slight downward revision to their revenue forecasts. The Frontier analysis was designed to corroborate this assessment. It included a cross industry panel data model that replicated the PwC modelling approach which used unemployment and average bills as drivers of doubtful debt costs<sup>2</sup>. They also developed a reduced sample version of the model that used data on Water and Sewerage Companies ("WaSC"s) only. Frontier compared the fitted values for doubtful debt costs from these models to SVT's current bad debt costs and the projections in their business plan.

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<sup>1</sup> Based on the average share over the previous five years.

<sup>2</sup> Approach A as presented in "PwC review of South West Water's doubtful debt cost models" PwC, 29 April 2014.

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Because historically the model fitted values have been higher than SVT's actual bad debt costs, Frontier concluded that SVT are currently efficient in their collection and management of bad debt and therefore should be allowed to receive the current adjustment request. In addition, the forecasts they generated using these models for AMP6 were higher than the total bad debt costs SVT requested.

### *Comments and results from statistical tests*

Frontier's model was a replication of PwC "approach A" from our letter on the South West Water determination. They also used a reduced sample version of this model which used data on WaSCs only (but with the same specification). Both models performed relatively well on the main statistical tests (see Annex for full set of results).

We had no major theoretical concerns with the modelling approach although we note that in using a reduced sample version of the model (for WaSCs only) the model performance was weaker. The overall statistical significance of the model was diminished by restricting the sample<sup>3</sup>. The restricted sample model was also left with a relatively small sample of 60 datapoints. We generally consider 25-30 datapoints per explanatory variable to be a minimum. The WaSC only model is therefore on this minimum threshold (as it has two explanatory variables) which increases the chance of estimated coefficients being driven by outliers. This may have influenced the significant differences observed in the estimated coefficients for the full model and the WaSC only model. Frontier did not put forward a theoretical rationale why the relationship should differ between WaSCs and water only companies.

We also had some concerns relating to the interpretation of the modelling analysis. The focus of the Frontier analysis was on comparing the fitted values predicted by these models to the current and projected bad costs for SVT. However, we note that panel data models which have been submitted by other companies have given very different and much lower fitted values for SVT<sup>4</sup>.

For example, whilst the full sample model used by Frontier that uses unemployment as a driver of doubtful debts predicts total debt costs of £165.5m in AMP6<sup>5</sup>. The final model submitted by Dŵr Cymru predicts £117.9m and the four final South West Water approaches predict an average of £119.9<sup>6</sup>. There is significant variability in these estimates and large residuals for these models (i.e. the difference between the historic fitted and actual values). The model fitted values for SVT are highly sensitive to relatively small changes in the modelling approach used; therefore care should be taken in comparing these fitted values to business plan forecasts.

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<sup>3</sup> As illustrated by a Chi squared value of 25 for the WaSC only model, compared to 54 for the full model.

<sup>4</sup> This is in contrast to a number of other companies (e.g. South West Water, Dŵr Cymru, Southern Water) for whom the different modelling approaches predicted very similar fitted values for doubtful debt.

<sup>5</sup> Coincidentally this is the same value as that calculated by SVT in December 2013 as 2.7% of projected turnover, albeit the price basis differ.

<sup>6</sup> All figures in 2010/11 prices.



Frontier also presented the company specific effects obtained from the panel data model and used this to define SVT as efficient<sup>7</sup>. There are some issues when using the company specific effect to measure efficiency as it will capture a number of other statistical factors, such as the effects of variables that have been omitted from the models but that have different effects on companies. The observed value of the company specific effect may therefore be in part driven by deficiencies in the model. There have been extensions to this type of modelling that try to separate efficiency from other unobserved factors such as True Random Effects or Stochastic Frontier Analysis approaches<sup>8</sup>.

Furthermore, the high level of variability in the fitted values from different panel data models for SVT mean that the value of the company specific effect would also be very sensitive to the model selected.

In light of these issues Ofwat provided feedback to SVT that they should consider the results from other models as well and conduct analysis to calculate an adjustment value by comparing the fitted estimate for SVT with the equivalent fitted value if they had industry average bills and unemployment.

### **Frontier analysis 30 June 2014**

Following this feedback SVT submitted updated analysis on 30 June 2014, also undertaken by Frontier. The updated analysis contained two approaches that sought to estimate the value of an adjustment using the models alone. The approaches compared fitted estimates for SVT from the models to modelled estimates for SVT if it had industry average costs. These approaches were designed to provide further corroboration for SVT's adjustment request

In the first approach, Frontier produced an alternative forecast for SVT designed to simulate its doubtful debt cost if it had "industry average levels of efficiency". This was done by generating a forecast for SVT using the full sample and WaSC only models, but excluding the firm specific effect. The firm specific effect is a constant value that is different for each company and is estimated in the model based on historic data.

In this analysis, SVT's forecast doubtful debt cost was higher when the firm specific effect is assumed to be zero (since it is estimated to have a negative value). The difference between the forecasts for SVT with and without the firm specific effect was used to justify the adjustment value sought. However, we do not consider this approach to be a valid way of calculating the adjustment. As noted above, we do not believe the value of the firm specific effect to be an accurate measure of efficiency, since it will also capture other factors like omitted variables. An adjustment value estimated using this approach may be driven largely by deficiencies in the model used. Furthermore, this approach would result in significantly different adjustment estimates depending on which panel data model were used.

Frontier's second approach to estimating the adjustment value used forecasts from the full sample and WaSC only models for all companies (these forecasts were generated by including

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<sup>7</sup> The company specific effect is the time invariant element of the random effect that will act as a constant value when estimating a fitted value.

<sup>8</sup> See for example "Fixed and Random Effects in Stochastic Frontier Models", William Greene, Stern School of Business, New York University, October 2002.



the firm specific effects as normal). Frontier then calculated a simple average of doubtful debt costs per unique customer across all companies (and for WaSCs only). These values, combined with SVT's customer numbers were used to estimate a forecast for SVT if they had industry average doubtful debt costs per customer.

Using the model for all companies they estimated SVT's bad debt costs would be £189.2m (in nominal prices) over AMP6 if costs per customer were in line with the industry average. Frontier noted that this value was higher than the total doubtful debt funding requested in SVT's business plan and the fitted value for SVT from the same model (reported by Frontier as £178.7m in nominal prices).

This approach is similar to the first in that it estimates a cost for SVT based an industry average level of doubtful debt costs per customer, as estimated in the model. Given that this approach suggests that SVT's costs are lower than they would if its doubtful debt costs were in line with the industry average, it is unclear that a positive adjustment to the ACTs can be justified on this basis.

Frontier also considered the results from the reduced sample version of this model using WaSC data only. As discussed above, the WaSC only model had less explanatory power and statistical significance than the full model, and was operating on the limits of sample size. It also displayed significantly different coefficients to the full model. We considered the full sample model to be more appropriate in computing an adjustment.

## Conclusion

Overall we considered that comparing the model fitted values to SVT's business plan forecasts did not provide sufficient corroboration to the original adjustment request in this instance on account of the significant variability in fitted estimates between different models and large model residuals for SVT.

SVT's updated analysis looked at the adjustment by comparing their costs with the industry average within the models suggested that SVT's modelled costs were below those were it to have industry average levels of bad debt costs per customer. It is unclear that a positive adjustment to the ACTs can be justified on this basis as this suggests no excess costs above the ACTS would be incurred. The justification of the adjustment value appears to rest on the question of whether SVT are more efficient than other companies, for which we note there are weaknesses in the econometric evidence that has been submitted to support this.

Yours Sincerely

PricewaterhouseCoopers LLP



## Annex – results of statistical tests conducted by PwC

### Summary of statistical test results – Unemployment model (test values given in parenthesis)

Test	All companies	WASC only
Ramsey RESET test for model specification	Passed using fitted value of dependent variable (0.2544)	Passed using fitted value of dependent variable (0.3009)
	Passed using fitted value of independent variables (0.0827)	Passed using fitted value of independent variables (0.2519)
Linktest model specification test	Failed (0.169)	Passed (0.615)
Shapiro-Wilk test for normality of residuals	Failed (0.01309)	Passed (0.08456)
White test for residual normality after Panel regression	Failed (0.0024)	Failed (0.0004)
Heteroskedasticity following panel data	Failed (0.0000)	Failed (0.0000)
Breusch-Pagan test on the validity of a random effects or pooled OLS approach	RE preferred to OLS (0.0000)	RE preferred to OLS (0.0000)
Sargan-Hansen test – on the validity of a random effects or fixed effects approach	RE preferred to FE (0.5015)	RE preferred to FE (0.0723)

Model specification tests (Ramsey RESET) were passed for both models, although the results of this test cannot be fully relied upon as they are not valid when heteroskedasticity tests are failed (as in this case). A different model specification test (Linktest) had mixed results<sup>9</sup>. In circumstances where specification tests are contradictory, it is often recommended to seek an alternative specification.

Tests were performed 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. Both models failed the White test and the tests for Heteroskedasticity. There were mixed results on the Shapiro-Wilk test for normality of the residuals. These tests suggest that outliers may be present in the models, a remedy for which would be the use of an alternative estimator (e.g. a robust or quantile regression approach). Heteroskedasticity was controlled for in both models through using robust standard errors.

<sup>9</sup> The Linktest can provide different results to the Ramsey RESET test as it uses a different method to test model specification. However, its results are also not valid under heteroskedasticity.



The Breusch-Pagan and Sargan-Hansen tests confirmed that the random effects panel approach was appropriate for both of these models<sup>10</sup>.

This letter has been prepared only for Ofwat and solely for the purpose and on the terms agreed with Ofwat under Service Order SER/0379 dated 29 July 2013. We accept no liability (including for negligence) to anyone else in connection with this note, and it may not be provided to anyone else without our prior written consent.

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<sup>10</sup> The Hausman test is also used for this purpose but the results of this test are not reliable when heteroskedasticity is present.